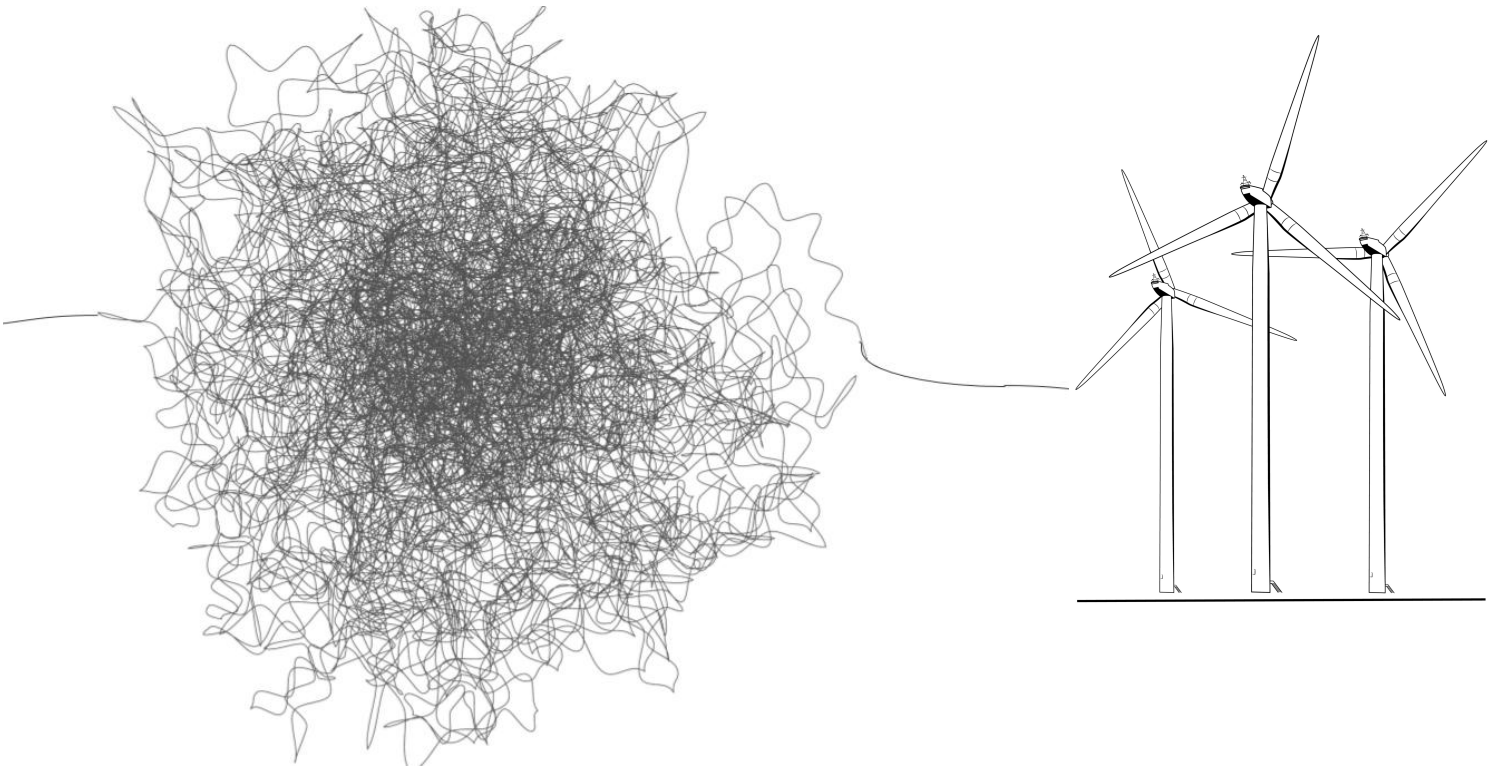
UNTANGLING THE CONDITIONS FOR DANISH WIND POWER IMPLEMENTATION

The dynamics of wind turbines' artefacts and social resistance



Master thesis

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Summary:

This report analyses how the Danish wind power has evolved from a former configuration to a new one, and aims at visualising what could be done in the future so that Danish wind power will continue to thrive.

Communities have rooted the development of wind power in the 1970s and established an important public acceptance of the technology. Nevertheless, nowadays, wind power meets a growing public resistance, which is sometimes leading to interruptions in the technological development.

The report deploys the socio-technological agencement theory in order to untangle the different configurations of the system through time. In order to grasp the intricate new stage in which the agencement is, the report uses both quantitative data in order to understand the shifts in the technology itself, and qualitative data in order to understand the consequences, and causes, of these shifts for the different actors of the configuration.

The results show that the wind turbines have massively expanded in size and capacity, which has had repercussions for the actors of the Danish wind power configuration.

The results indicate a lack of adjustment of the actors to each other due to this new materiality. Needs for greater governance, for appropriate communication between the actors, for contextualised knowledge of wind power project implementation, for active use of new calculative devices are identified.

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Table of contents

GLOSSARY OF TERMS AND ACRONYMS 9

1. INTRODUCTION 11

Questions under inquiry 15

Reading guide 15

2. METHODOLOGY 17

2.1. RESEARCH DESIGN 17

2.1.1. The need of a theoretical perspective 18

2.1.2. Quantitative research 20

2.1.3. Qualitative research 21

2.2. APPLIED METHODS 21

2.2.1. Collection of quantitative data 21

2.2.2. Collection of qualitative data 22

2.2.2.1. Literature review 22

2.2.2.2. Identifying the actors 22

2.2.2.3. Interview design 24

2.2.3. Reliability and validity 25

3. THEORETICAL FRAMEWORK 27

3.1. GOVERNING FOR SUSTAINABLE TECHNOLOGICAL CHANGE 27

3.2. INTRODUCTION TO THE WIND POWER SOCIO-TECHNICAL AGENCEMENT 29

3.2.1. STA and distributed action 30

3.2.2. Framing, overflows, and hot/cold momentums 31

3.3. THE CREATION OF ALTERNATIVE NEW KNOWLEDGE TO GENERATE CHANGE 32

3.4. SUMMARY 33

4. FIRST SHIFTS IN THE DANISH WIND POWER SOCIO-TECHNICAL AGENCEMENT: WHERE WERE WE? 35

4.1. LITERATURE REVIEW 35

4.1.1. Gap of research 35

4.1.2. Social acceptance: what does it mean? 36

4.1.3. Visual and sound impacts 37

4.1.4. Public planning 38

4.1.5. Importance of social acceptance through community ownership 39

4.2. EMPIRICAL ANALYSIS OF THE WIND POWER DEVELOPMENT IN DENMARK 40

4.2.1. The creation of an alternative vision to nuclear power 40

4.2.2. Wind power communities: from a vision to new actors in the making 41

4.2.3. Other shifts in the agencement's configuration contributing to the new direction 42

4.2.4. Summary 43

4.3. THE NEW MATERIALITY OF WIND POWER 43

4.3.1. Wind turbines: an evolving actor 43

4.3.2. The challenging actor for the electricity prices 47

4.3.3. The grid; another actor of the wind power agencement *50*
4.4. SUMMARY 52

5. UNTANGLING THE CURRENT CONFIGURATION OF THE DANISH SOCIO-TECHNICAL WIND POWER AGENCEMENT: WHERE ARE WE? 54
5.1. WIND POWER GOVERNANCE AT THE SUPRA AND NATIONAL LEVEL 54
5.1.1. Danish wind power under the dome of the EU *54*
5.1.2. Wind power governance within Denmark *56*
5.1.2.1. Governance and valuation devices 56
5.1.2.2. Governance reform to cope with the new materiality of wind turbines 57
5.1.2.3. The Government's reaction: The Renewable Energy Act and the replacement of community engagement 59
5.1.3. Summary *61*
5.2. IDENTIFIED OVERFLOWS PARTICIPATING INTO THE CREATION OF A NEW AGENCY: PUBLIC RESISTANCE OF WIND POWER 62
5.2.1. First overflow: the low price of electricity *62*
5.2.2. Second overflow: The Health Report and the lack of stabilised knowledge *63*
5.2.3. Third overflow: medias, communication and awareness *65*
5.2.3.1. Media and public discourse 65
5.2.3.2. Communication between the actors 67
5.2.4. Fourth identified overflow: the upcoming elections *68*
5.2.5. Summary and reflections *70*
5.3. HOT MOMENTUMS AND DISAGREEMENTS 71
5.3.1. The 20%: a tool subject to controversy *71*
5.3.2. The tendering process *73*
5.3.3. Mismatch between local implementation and global goals *76*
5.3.4. Different perceptions over land use *78*
5.3.5. Different views on offshore wind power *81*
5.3.6. Summary *83*
5.4. REFLECTION ON THE ANALYSIS 84

6. FUTURE OF THE DANISH WIND POWER AGENCEMENT: WHERE SHOULD WE GO? DISCUSSION AND RECOMMENDATIONS 85
6.1. DISCUSSION 85
6.2. RECOMMENDATIONS 89
6.3. LIMITATIONS 91

7. CONCLUSIONS 92

8. REFERENCES 93

Glossary of Terms and Acronyms

Acronyms	Description
CAT	Choice Awareness Theory
CO2	Carbon Dioxide
DEA	Danish Energy Agency
DKK	Danish Kroner
DTU	Technical University of Denmark
DWTOA	Danish Wind Turbines Owner Association
EU	European Union
EUR	Euros
IEA	International Energy Agency
MW	Mega Watts
NFC	Nordic Folkecenter
NGO	Non-Governmental Organisation
RES	Renewable energy sources
TSO	Transmission System Operator
STA	Socio-technical agencement
STS	Socio-technical systems
TIC	Techno-Institutional Complex

1. Introduction

The future development of wind power in Denmark is highly relying on its social acceptance. It is widely acknowledged that if wind power has been such a success in Denmark, it is eminently due to the implication of grassroots movements and communities (Hvelplund, 2001; Möller, 2005; 2006; Wüstenhagen, et. al 2007; Community Power, 2014). Local initiatives and renewable energy communities have been pillars of the Danish wind power expansion. Since the late 70s, these communities have participated in the local acceptance of the emergent technology by working together, participating in the area dynamics, sharing knowledge and the outcomes from the multiple wind power projects, whereas it is only since 1987 that energy utilities have started to invest in the technology (Hvelplund, 2001; Safarkhanlou et. al, 2009). This has made it possible for the Danish society to establish a strong social acceptation of the technology and to overcome the barriers of wind power, such as visual and sound impacts. Instead of being rejected, wind turbines have been part of the Danish societal and geographical landscape since then and perceived as a positive local development for the areas (Hvelplund, 2001, Wüstenhagen, et. al 2007; Maegaard et. al, 2014).

Nonetheless nowadays, wind power meets public resistance in Denmark which leads to interruptions of its development. For example, in a two weeks' time in March 2017, Tønder and Esbjerg, two Danish municipalities, have cancelled their wind power projects accounting for a total of 48 wind turbines due to public resistance (Pedersen, 2017 A).

Hence, it is of a crucial matter to understand the dynamics of the Danish wind power configuration in order to, in the days ahead, be able to implement onshore wind power and pursue the energy transition. Science and technology studies (STS) explain that there is no determinism in technologies' success or fail, and that it is of a crucial matter to comprehend technologies in their wider societal contexts (Unruh, 2000; Sismondo, 2010).

The existing literature is pointing out that it is mostly the lack of community ownership which generates the public resistance and hence, which harm the wind power development (Hvelplund, 2001, 2014; Wüstenhagen et. al, 2007; Hvelplund et. al, 2013):

> *(...) the present challenges to wind power development lead to the conclusion that it is necessary to develop a wind power model with a strongly increased share of local and regional ownership.* (Hvelplund, 2014 p. 87)

This report is challenging this perspective; it aims at analysing the wind power configuration with a more detailed and holistic approach to the relation between wind turbines and society. In order to do so, a multiplicity of factors is to be analysed, such as: the complexity of public resistance, the different levels of governance, and the evolution of the wind turbines themselves. These factors are introduced in the

following sections.

The acknowledged factors leading to wind power public resistance

It is acknowledged that wind power often meets public resistance, the *Not-In-My-Back-Yard* effect, due to the noise and visual impacts from the turbines (Wüstenhagen et. al 2007, Ladenburg 2007, Möller 2005, 2006, Community Power 2014). If these barriers have been overcome in the 70s-80s in Denmark, it seems that the situation has now changed. Wind turbines are nowadays often presented as a technology with impacts possibly influencing health conditions, or perceived as a threat to ecosystems (bird killers), and also especially intrusive in the landscape (Möller, 2005; 2006; Ladenburg, 2007; Warren et. al, 2008; Wittrup, 2017). Furthermore, the size of the wind turbines themselves has shifted; from 17m height in the 80s, they reach today 125m height, having more significant visual impacts than ever before (IEA, 2013).

Moreover, in Denmark in 2012, the Government achieved a broad agreement between different political parties aiming for 1,800MW onshore capacity by 2020, including 1,300MW for re-powering older turbines (The Government, 2012). Möller (2010) argues that the installation of the larger wind turbines increases the visibility of the technology, and that the removal of the many small turbines for re-powering do not reduce its visibility significantly. This is increasing the negative local implementation impacts from the turbines and thus, can increase the public resistance.

Also, the increased size of the turbines is making it more and more tedious to find suitable and correct locations for onshore wind development. In Denmark, the regulation stipulates that "*the minimum distance to a neighbouring home is four times the turbine's total height*" (The Danish Environmental Protection Agency, 2017). As the turbines themselves are four times bigger than before, it considerably reduces the spots available for wind turbines location. Sunak (et. al, 2016) argues that the land pressure from onshore wind power can lead to land capitalisation and relocation of citizens, which together can lead to the devitalisation of local areas and a fall of public acceptance. Furthermore, as argued by many scholars (Ladenbrug, 2007; Hvelplund et. al, 2013) offshore wind power benefits from a higher social acceptance than onshore wind power, which therefore drives energy planners to shift their planning from onshore to offshore.

Hence, today more than ever, onshore wind power needs a strong public support in order to be implemented in Denmark. Understanding its intricacy so to overcome these barriers is therefore one prerequisite of this report.

The importance of the multi-level governance

Governance, through regulations and policies, can alleviate or hinder the development of one technology over another (Kuzemko et. al, 2015). It is therefore one major entity that can steer the implementation of

Danish wind power.

The European Union (EU) governs at a supranational and intergovernmental level of decision making, and hence influences the national decision making of its member states. In December 2016, the EU has launched the Energy Winter Package, which aims to "*strengthen Europe's competitiveness*" (Europa.eu, 2017), and promotes "*opportunities for consumers to participate in the market*" (Losch et. al, 2016). Hence, the will of the EU is to enhance the European energy market whilst encouraging the member states to create space for communities to be part of the energy transition. It is in this legal framework that the Danish Government will have to establish its own policies and regulations.

Furthermore, throughout Danish history, the different Governments in place have steered the direction of the energy system in different directions. For example, the Government in place in 1976 has promoted the development of nuclear power through the establishment of the Nuclear Power Act, whereas the 2012's Government has promoted the development of wind power through the Danish Energy Agreement, which aims at having wind power to account for approximately 50% of the Danish electricity consumption by 2020 (Hadjilambrinos, 2000; Karnøe et. al, 2016).

Today, the current Government led by the prime minister Lars Løkke Rasmussen considers the energy transition less important than the one from 2012, and therefore considers the energy goals too ambitious and too expensive. The Government thus wishes to decrease the amount of subsidies allocated to wind development (Climate Network, 2015). Plus, on the 21st of February 2018, the current national onshore regulation for wind power will stop and a new regulation will need to be established. As the EU is steering towards an increased competition, there is a risk that the new Danish regulations will follow that path with the hope of decreasing the amount of subsidies granted, with no guarantee that opportunities for smaller actors will be promoted (Pedersen, 2017 B). As argued by Maegaard (et. al, 2014), these actors have rooted public acceptance of wind power, and therefore there is a possibility that their phase out will lead to an even greater public resistance and will complicate even further onshore wind projects implementation processes.

The expansion of wind power

Other important factors that need to be taken into account are the increased significance of wind power in terms of capacity installed and in terms of costs of the technology.

First, the greater capacity and efficiency installed of the wind turbines are implying new economic challenges for the wind power investors, whether they are energy communities or energy utilities. Indeed, the development of wind power has led to a percentage of 42.1% of the electricity consumption that was supplied from wind power in 2015 (Energinet.dk, 2016 A). Due to its low marginal costs (as no fuel is burnt), the large scale penetration of wind energy influences the power market and leads to a multiplicity

of new economic challenges for the market actors, such as low price of electricity and therefore, higher investment risks (EWEA, 2010).

Second, the new increased size of the wind turbines entails high upfront investment costs; for example, the 2MW industrial wind turbines cost roughly between 2,8 to 3,6 million EUR (Windustry, 2017). It creates a need for new actors for the turbines to exist; energy utilities and companies, with their greater resources and means, are a necessity for their implementation. It is therefore today these bodies that can greatly benefit from the implementation of wind power, and not the smaller communities that have implemented wind power at the first place. As these communities have rooted public acceptation of the technology in the 1980s, it transforms the dynamics of their establishment and leads to new challenges in regard to its public acceptance.

How to analyse the multiplicity of new challenges?

The challenges related to the implementation of onshore wind power are intertwined and complex. In order to analyse them, the report will develop insights of governance processes. As mentioned earlier, governance processes can steer the direction of the energy system through regulations and policies. Governing for a sustainable energy system refers to establishing new norms and regulations that will create the conditions for actors participating in the energy transition favourable (Kuzemko et. al 2015). Governance is hence one major factor that has to be understood in order to untangle the Danish wind power configurations.

Nevertheless, it is not sufficient to unravel the complexity of the mentioned challenges. Many scholars argue there is no such things such as pure technical artefact. Instead, technology has to be understood as an artefact that is shaped by, and is shaping, the different spheres of the social context from which it is part of (Bijker et. al, 1994; Unruh, 2000, Sismondo, 2010). Bijker et. al (1994) explains:

> *Our technologies mirror our societies. They reproduce and embody the complex interplay of professional, technical, economic, and political factors*. (Bijker et. al, 1994)

Hence, he underlines the importance of the wider social context in which a technology exists in order to fully grasp the ins and outs of its development. Therefore, the report is analysing the arising challenges with a science and technology study (STS) approach.

Furthermore, Callon (2008) expresses that even the different factors (e.g. technical, economic, political), are not "pure" either as they are as well composed of heterogeneous elements. He explains:

> *Humans, as well as procedures, calculation tools, instruments and technical devices collaborate and participate in a coordinated manner. All these entities contribute in their own way to the collective action that consequently consists of series of ordered acts*. (Callon, 2008)

Hence, Callon's angle of analysis goes beyond the one deployed by Bijker (et. al, 1994) as he perceives the world as a "seamless web". Instead of boxing different elements, he rather emphasises that the action is

distributed among the different heterogeneous elements that compose the web, and is interested into the relations between them. Callon also explains that the adjustment of the elements to each other is of a co-creation, and that a lack of adjustment – which would thus hinder action – can always be re-established. Hence, he draws a framework that will permit to unravel the necessary conditions for wind power implementation. It is under this dynamic and detailed perception of the world that the arising issues are analysed in this research.

Questions under inquiry

The aim of this thesis is to untangle the reasons that are today leading to a shift in the wind power development, and to help visualising the future alternatives. Therefore, the following general question is asked:

> *How have the conditions for developing Danish wind power shifted through time, and which conditions are needed to pursue the energy transition?*

In order to narrow down, the two following sub-questioned are posed:

- *How has the success of the Danish wind power development transformed the technical artefact itself?*
- *How has this shift in the artefact influenced the social context in which it exists, and what future is it possible to visualise for greater social acceptance?*

Reading guide

This report is divided into seven different sections. The first one, the introduction, has already depicted the problems under inquiry and has mentioned with which perception of the world the problems are going to be addressed along the report.

Second, the methodology chapter is discussing and presenting the research design and methods. It explains how the problems identified are analysed, and why these specifics methods are chosen. It presents the choices of the theoretical perspective, together with the choices of quantitative and qualitative data. It goes on by explaining the specifics of the methods, such as the collection of qualitative and quantitative data.

Third, the theoretical framework is deployed. It is an in-debt presentation of the theories and concepts chosen as argued in the methodology section. It develops the theories as following: governance, socio-technical agencement (STA), and the choice awareness theory (CAT).

Fourth, the first analysis starts by reviewing the literatures already existing upon wind turbines acceptance. It is presented in order to provide a ground understanding of the questions under inquiry, and draw conclusions from cross-readings. The analysis goes on by looking at the historical development of

wind turbines in Denmark: how they have evolved through time from an alternative vision of the civil society to a major technology *in the making* spread across the country. Then, their new *materiality* is analysed as a challenge for the power market due to among other low marginal costs and intermittency character. It demonstrates that from an innocent technology, wind turbines are today largely influencing the configuration of the STA.

Fifth, the second analysis is untangling the new configuration of the Danish wind power STA due to the new materiality of wind power. At first it analyses the governance at the European and national level. It analyses how the different policies and acts have steered the development of the Danish energy system and influenced the social acceptance of wind power. Second, through the eyes of the interviewees, an analysis of identified *overflows* due to the new materiality of wind turbines is depicted, such as: the low price of electricity, the Health Report, the medias, and the upcoming election. Third, disagreements between the actors interviewed over the new reality are analysed. The disagreements are upon policies, mismatch between national goals and local implementation, the land use, and the offshore wind power development.

All these analyses together are leading to section six which discusses the results. It is used to visualise how the future could be visualised and alleviated for the actors of the Danish wind power STA. The results are indicating that the Government should adopt a new steering role for the energy transition, that there is a lack of appropriate dialogue between the different actors of the STA, and that new devices are needed by the actors so to re-establish relevant and adequate knowledge of each specific situation.

Finally, the seventh section draws the findings of the report. It concludes that the new materiality of the wind turbines has led to significant shifts in the Danish wind power STA' configuration, and that the different elements that compose the web are today lacking adjustment.

2. Methodology

This section is presenting and discussing the research design and the research methodology. It describes how the problem is analysed and it explains why the specific theories and methods are chosen.

It first presents the research design. It explains the need for theories, quantitative research, and qualitative research in order to answer the problems under inquiry. The three specifics methodologies are depicted in three different sub-sections.

Second, the specific features of the quantitative and qualitative data collection are presented. A sub-section is discussing the reliability and validity of the data.

2.1. Research design

This report aims at explaining *what* is happening in the wind power energy configuration, and *how*. It is thus of a descriptive and explanatory research. It is not mere descriptions that are sought, but rather a new understanding of the situation in order to untie the complexity of the socio-technical configuration as only then, it is made possible to explain the occurring processes. Explanatory research aims at finding the casualties of phenomenon (De Vaus 2001).

It is a cross-sectional research design that is used in this report. It entails a collection of samples at a single point in time, which permits to collect quantifiable data that can be analysed so to detect similar patterns. Cross-sectional design includes semi-structured interviews, content analysis and statistics among other (Bryman, 2016). This research design is interested into having a wide diversity of samples. For this study, eleven interviews are carried out. The interviews are collected in a short period of time assuring reliable cross-comparison.

The report deploys both quantitative and qualitative data in order to answer the problem formulation. In this research, the quantitative research is deductive, it is used to test theories, whereas the qualitative research is inductive and generates theories (Bryman, 2016). In this report, quantitative data are used to understand the issues related to the materiality of wind power and to test correlations within the configuration. It is then used as a concrete basis to develop the qualitative data, which generates theories about the configuration of the heterogeneous actors. Overall, the aim of the report is inductive; it aims at creating knowledge about the current wind power configuration in Denmark.

***Table 01**: overview of the methods used.*

Sections	**Methods**
Introduction	Literature study
Methodological framework	Literature study

Theoretical framework	Literature study
First analysis	Literature study , Excel modelling, GIS, interviews
Second Analysis	Literature study, interviews

2.1.1. The need of a theoretical perspective

The aim of this section is to explain how the report is reducing the complexity of the world in a particular manner. The purpose is hence not to develop the specific features of each theory chosen for answering the questions under inquiry, but rather to justify why these specific theories are chosen.

As the purpose of this report is to understand how the shifts in the wind power configuration have occurred through time, and why, the research is descriptive and explanatory. It generates a need for a theoretical approach which can analyse the configuration of the elements in a flexible and integrated manner. Therefore, the theoretical approach will be articulated by the notions of governance, STS (more precisely by the notion of *socio-technical agencement*), and finally the notion of awareness, as argued in the following lines.

The integration of large amounts of renewable energy sources (RES) in the energy system could appear as a straightforward technical issue, that qualified engineers could program and deal with. Nevertheless, determinism in technology development does not exist – the success, or fail, of a technology is the result of co-constructions. Bijker (et. al, 1994) explains:

> *Technology do not, we suggest, evolve under the impetus of some necessary inner technical or scientific logic. They are not possessed of an inherent momentum. If they evolve or change, it is because they have been pressed into that shape*. (Bijker et. al, 1994)

He explains that the working, or failing, of technologies is shaped by a range of heterogeneous and disparate factors; it is the "*social shaping of technology*" (Bijker et. al, 1994).

Kuzemko (et. al 2015) explains that governance processes are one of the factors shaping a technology. By establishing market rules, regulations, practices, objectives, it favours the development of one technology over another. Hence, it indicates that theoretical insights of governance processes are a necessity to understand the social shaping of a technology; governance will be the first notion deployed in the theoretical chapter.

Nevertheless, solely the notion of governance is not sufficient to untangle the complexity of the Danish wind power configuration. If governance processes allow one technology to exist, to *be in the making* with policies, it does not mean that the technology will suddenly be spread across society. For

example, the Danish Government in 1976 has established the Nuclear Power Act but in fact, nuclear power has never been developed in Denmark (Hadjilambrinos, 2000). Therefore, as argued by STS scholars, technologies must be understood in their wider societal context; instead of considering technology, institution, economic, etc. as different spheres, they must be comprehended as co-productions through time. In order to explain why some technologies are more successful than some others in societies, Unruh (2000; 2002) develops the notion of *Techno-Institutional Complex* (TIC). He explains:

> "*TIC develop through path-dependant, co-evolutionary process involving positive feedbacks among technological infrastructures and the organisations and institutions that create, diffuse and employ them. Once locked-in, TIC are difficult to displace and can "lock-out" alternative technologies for extended periods, even when the alternative demonstrates improvements upon the established TIC*". (Unruh, 2000).

He thus explains that the wider societal context can be a brake for a new technology, as already existing and well established organisations and institutions are adjusted around a former one and therefore, there is no reason for these organisations to implement changes in their own configuration.

Nonetheless, Callon (2008) argues that when structures are locked and not evolving, it is rather a stage of the configuration than the results of lock-in sources. He uses the term *socio-technical agencement* (STA) to explain the dynamics of social contexts. STA refers to the configuration of heterogeneous elements (i.e. technologies, humans, discourses) to each other's; how they are configured, how they can act, and how these elements co-evolve together through time. It is their configuration to each other's that provide them the ability to act and to influence others. Their relations may be adjusted whilst the STA co-evolves and hence, keep on providing them this ability to act. Nevertheless, the elements may also loss adjustment and therefore, not be able to act anymore, leading to a breakdown of the configuration. The relations among these elements constitute *agencies*; it is an outcome of the STA from which they are made of (Callon, 2008). STA argues that the different agencies are of a co-shaping, and perceives the world as a seamless web (Çalışkan et. al, 2010). Callon (2008) explains:

> *The notion of socio-technical agencement enables us to build a complete picture of the elements that need to be present and mutually adjusted if interactive individual agency is to appear. It is therefore crucial for an understanding of the conditions of existence and development of network economies, whose functioning implies the mobilization and coordination of such agencies. It is also essential for explaining the shortcomings of these agencies and describing the policies design to prevent them. (Callon, 2008)*

STA hence focuses on what enables actors to be *in the making*, on what are the necessary conditions so that one is able to act and exist. Moreover, the notion also gives importance to all the elements part of the network and underlines the diversity of sources of actions. As underlined in the introduction chapter 1, the

configuration of the Danish wind power is complex and relies on a wide range of factors. Consequently, the STA notion is considered more relevant than the TIC notion; it can provide a deeper and new understanding of the configuration's intricacy. Throughout the report, some particular elements of the Danish wind power agencement will be investigated, such as: costs, size, goals, communication, participative tools, interests.

Last, STS scholars argue that knowledge production is socially constructed; Sismondo explains that "*scientists and technologists build socially situated knowledges and things*" (Sismondo, 2010, p. 71). In other words, STS argues that in different circumstances, the production of knowledge would have been different as there is a social character to scientific knowledge. Plus, STS scholars emphasise that systems are self-referential (Unruh, 2000; 2002). Therefore, depending on which paradigm a group of actors in the making is embedded within, the production of knowledge will be supporting its own model. However, the STA theory explains, as it will be seen in chapter 3, that the production of alternative new knowledge can be a source of change in the configuration of the agencement. Therefore, the Choice Awareness Theory (CAT) is necessary to understand how to generate genuine new and alternative knowledge, to create awareness "out of the box", out of the paradigm in which society is embedded. This will be the last point developed in the theoretical framework chapter 3.3.

To summarise, the theoretical framework chapter 3 will first develop the notion of governance, followed by the notion of socio-technical agencement, and finally the notion of choice awareness.

2.1.2. Quantitative research

In this research, the quantitative research deployed is deductive, it is used to test theories about the wind power development. It is used as a basis to develop the qualitative research. It is used to understand the ins and outs from the technicality of the wind power generation. It uses different indicators standing for specific concepts, such as: price of electricity, growth in wind power capacity installed, and wind fleet outputs. The indicators are thus economic as well as technical. Some indicators are analysed with the tool Excel, and some are analysed with the geographic information system QGIS. These indicators are used to test correlations between the large scale penetration of wind power and shifts in the configuration.

Nonetheless, these indicators are not exhaustive. More measures could have been employed in order to assess the impacts from the wind technology to the other electricity sectors such as i.e. heating or transport. It could have been done if the purpose of the study was to enlarge the impacts of the wind power agencement to an even broader perspective.

Overall, the quantitative indicators are chosen to assess the material impacts from integrating more wind power into the energy system.

2.1.3. Qualitative research

Qualitative research is putting an emphasis on words rather than on numbers (Bryman, 2016). As the research focuses on following the actors in the making and on their interpretations of the world, using qualitative research is of a great sense and aligned with the theoretical perspective developed section 2.1.1.

The qualitative research is an important part of the report, as it is needed to understand the diversity of interests and point of views of the different actors in order to discern how the Danish wind power conditions have been and are configured. As the purpose is to draw findings from the stakeholders' perception of the wind power agencement, a multiplicity of actors must be reached. Only in that way it is possible to grasp the overall context necessary to answer the problem formulation. Although inductive, the purpose here is not to draw general observations and conclusions based on particular facts, but rather to understand the processes of the wind power situation in Denmark in this special timeframe and context (Falk et. al, 2007; Bryman 2016).

From a general research question, relevant sites and subjects have been found. Here, it refers to Nørrekære Enge wind community, the Danish Wind Turbine Owners Association (DWTOA, Danmarks Vindmølleforening), Vattenfall, HOFOR, Nordic Folkecenter (NFC), among others. The identification of the actors is described under section 2.3.2. The first collections of data have led to a tighter research question, therefore leading to a greater collection of data. From there, findings have been drawn and conclusions made.

Also, as the amount of qualitative data generated has been high, a system of classification of the sayings per topics has been realised. This has permit to cross the multiplicity of point of views and opinions, and to identify specific themes and mechanisms steering the direction of the Danish wind power configuration. The transcriptions of the eleven interviews can be requested to the author.

2.2. Applied methods

In this section, the specific features of the data collection are presented. First, the collection of quantitative data is presented, followed by a presentation of the qualitative data collection.

2.2.1. Collection of quantitative data

The quantitative data are collected from different manners. Information and data on the Danish power market are gathered from for example the Danish Energy Agency (DEA) and Nord Pool Spot. The data collected are then used in Excel to model the growth in number of turbines, the growth in wind power capacity in Denmark, and are also use for testing the evolution of the electricity prices. Also, data from the DEA are used in the software QGIS for mapping the historical development and expansion of the turbines

across the country in number and in size. For representing the information on the map, the data are classified into different categories with the Jenks optimization method, as this classification maximizes the different between classes by identifying the groups with similar values (ArcGIS, 2017).

2.2.2. Collection of qualitative data

This section presents the specific features of the qualitative data collection. First it presents the literature review, then it presents the identification of the actors, and finally it presents the interview design.

2.2.2.1. Literature review

A wide range of literatures is used for the purpose of this study. A breadth of coverage insures a deep understanding of the energy situation in Denmark. Primary literature is used to understand the challenges related to intermittent energy sources such as wind power. It refers both to scientific papers (e.g. EWEA, 2010; Lund, 2014; DEA, 2016), and to literatures concerning the socio-technical agencement of wind power in Denmark (e.g. Hvelplund, 2001; Möller, 2005; 2006; Karnøe et. al, 2016). Together, they permit to frame the research questions by providing diverse and detailed descriptions of the challenges faced. Also, the primary literature encompasses theoretical and methodological materials, that are used to shape both the analysis design and the angle of observation (e.g. Callon, 2008; Bryman, 2016).

Then, secondary literatures are used to grasp the public discourse concerning the Danish wind power. Newspapers, publications from, and about, the actors of the agencement are used (e.g. European Commission, 2016; Energinet.dk, 2016 A, B; Pedersen 2017 A, B). The secondary literatures are also used to identify the actors and to help creating an interview guideline aligned with their roles.

From these literatures, a narrative reviewing is made section 4.1. Narrative reviews refer to traditional research that provides an account of what is already known. The purpose is to frame what has already been researched and to justify the inquiry of the report. It is used to frame the topic under study, as well as to provide a platform for establishing scientific contribution (Bryman, 2016). The research are compared and analysed, permitting among other to draw similar conclusions from different studies, to understand what is already known within the field, to place the study in a historical perspective and to highlight gaps in research (Bryman, 2016).

2.2.2.2. Identifying the actors

As argued by the STA theory, the making and re-making of agencies is dynamic and never absolute. It is therefore not possible, neither wanted, to list and identify all the actors from the wind power configuration. Nonetheless, in order to assure validity of the research, a multiplicity of actors from different sectors of the

Danish wind power are interviewed. From literature reviews, research on the internet, and discussions with colleagues, a small selection of actors appeared relevant to be contacted for the purpose of this research. Wind associations, wind project developers, communities, researchers and politicians have appeared adequate and relevant to contact for gathering information.

Also, the "snowball method" has been used to gather as much relevant actors as possible; each interviewee has been asked *who else* should be contacted. This has permit to generate a wide range of interviews and a great coverage of the important actors from the wind power agencement. The interviewees are listed in the following table:

Table 02: *List of the interviewees, roles and competences*

Actors	Roles	Competences
Helge Christiansen	Board member of the wind community Nørrekære Enge	The community is in conflict with Vattenfall, and appears as a controversial case where no solution has been found yet. The case shows a great involvement from citizens and represents a dynamic wind community.
Jane Kruse	Director, Head of Information at Nordic Folkecenter (NFC)	Pioneer of the wind power development in Denmark, Jane is today the director of Nordic Folkecenter (non-profit, independent, organisation that provides research in technology development).
Henning Bo Madsen	Project Coordinator at NOAH, in collaboration with Nordic Folkecenter	Energy community project coordinator at NOAH, Henning collaborates with Nordic Folkecenter in many tasks and collaborate with a multiplicity of stakeholders within the field.
Leire Gorroño Albizu	Local Energy Planning Consultant, Freelance at Nordic Folkecenter	Specialist in community power, Leire designs and manages projects at the Danish and European level.
Karl Vogt Nielsen	Adviser, spokesman for Energy policy of Enhedslisten M.P. Søren Egge Rasmussen	With an engineer background, Karl has created RES programs in the mid-80s, worked at DTU, and then became MP secretary at the Parliament for 7 years.
Jens Peter Hansen	Energy Policy senior analyst for the DWTOA	Development of energy policies, Jens is in regular contact with politicians, government officials, industry colleagues and other decision makers in the energy sector.
Thomas Holst	Chief consultant at the Danish Agriculture & Food Council (Landbrug & Fødevarer)	Senior consultant on climate, energy & plants, Thomas focuses on renewable energy, biomass, and seeds, an collaborate with farmers owning wind turbines.
Arne Rahbek	Chef of Communication at Vattenfall, Wind and Public Affairs	Vattenfall is one of Europe's leading generators of electricity and heat. The company is facing local resistance and is facing issues with implementing wind projects in Denmark.

Kim Pind Jensen	Wind power senior consultant at HOFOR	First employee in HOFOR's wind department (2010), Kim works especially with offshore wind power since 2014 and is responsible for the wind development strategy.
Hans Chr. Sørensen	Board member at Middelgrunden Vindmøllelaug. Board member of the DWOTA	Part of the group that has created Middelgrunden's offshore wind project, Hans is also a board member of DWTOA, and does consultancy for improving public acceptance around the world (EDF in France, Japan, South Korea) through SPOK ApS.
Kristian Borch	Senior researcher at DTU (Technical University of Denmark)	Kristian is the project manager of Wind2050, a multidisciplinary study on local acceptance and development of wind power projects.

2.2.2.3. Interview design

The purpose is to follow the actors in the making. It is therefore essential to see through their eyes and grasp their perceptions of the world (Bryman, 2016). Semi-structured interviews are conducted. The strategy is to give liberty to the interviewees to answer and to lead the conversation in other directions than the interview guide. The semi-structured form is, as argued by Bryman (2016), providing flexibility while doing the interview. It permits to see what matters for the interviewee to mention. The interview guide has been elaborated under the following categories:

- Background information
- Motivation of community members:
    - Social
    - Economical
- Governance of the socio-technical configuration:
    - How national policies and governance facilitate/hinder the making of "energy communities"?
    - The Municipal level
    - The European level
- Need for changes in rules and regulations
- General questions

The guide refers to a list of questions under specific topics that are to be investigated. It does not refer to a strict guideline, but rather allows for a leeway from the set of questions. All the questions are a result of collection of information, discussions with colleagues, literatures from previous research as well as on the internet. Internet has been used to read upon the different interviewees to generate an overall personal background and to ask contextualised questions. The same guideline is used for the different interviews, therefore ensuring cross comparability and a great breadth of coverage. The guideline has been nevertheless

revised according to whom the interview was designated to. The set of questions has also evolved through time, as more data were collected, thus permitting more precise and targeted questions.

The first category is used to introduce the interviewee and to grasp his/her role, work, and competences about the topic. The second category is focusing on the social aspect of communities. It is used to understand who is participating in these communities, why, and how do they participate. It is also relative to the economic issues in relation to the community and individual members. The third category is referring to the governance of the Danish wind power. Questions on governance are asked; the municipal, national, and European level are inquired, also along history. It leads to questions on possible changes in rules and regulations. Finally, the interview guideline closes with general questions concerning the actor's point of view and is used to open to new topics that might not have been discussed yet. All the categories are interlinked, and the questions under each one are not specific only to one but rather perceived as being part of a bigger picture. There is possible alteration of the order of the questions to allow a better flow whilst interviewing.

Under the different categories, both precise and wide questions are asked. Precise questions are used to answer issues raised from preliminary research. As argued by Bryman (2016), it can provide relevant and thorough descriptions for further analysis. Wider questions are also used to let the interviewee lead the exchange. The formulations of the questions are opening up for inquiry. Instead of asking: "*Are regulations the biggest barrier for the development of wind power communities in Denmark?*", the question asked is: "*What is the biggest barrier for the development of wind power communities in Denmark?*". This is made to ensure that no orientation is pre-given for the answers.

All the interviews have been recorded, allowing for more thorough examination of the contents and more precise data, and transcribed by the author.

2.2.3. Reliability and validity

Reliability and validity are important criteria for both quantitative and qualitative research. Nonetheless, these two terms have different meanings according to whether it is quantitative or qualitative research.

For quantitative research, reliability refers to the consistency, the stability of a measure. In this report, the quantitative data used are supplied by the Nord Pool Spot, Energinet.dk, and the DEA. Since these sources are providing data to the public, sometimes on an hourly basis, of the spot market prices or of the registration of the wind turbines for example, the measures are stable and replicable. Thus, the reliability is considered high. Validity refers to whether a measure of a concept really measures the concept in question. As the indicators used are measured in economic terms and in amount of capacity installed, validity is ensured (Bryman, 2016).

Reliability and validity are two key concepts that a qualitative research must also follow (Bryman, 2016). Reliability refers to the replicability of the research. As the research uses semi-structured interviews with actors from different sectors of the Danish wind energy and available literature, it is regarded as replicable. Validity refers to the degree of generalisation, so to the degree to which the study is applicable to other contexts (Falk et. al, 2007). As it is argued by the theoretical framework chapter 3, an agencement is always under construction and always in the making. The idea is therefore not to draw absolute generalisations nor conclusions, but rather to investigate how some specific configurations can lead to some specific results.

3. Theoretical framework

As explained in the theoretical methodology section 2.1.1, the theoretical framework is an important part of this report; it is used to steer the understanding of how the Danish wind power configuration is arranged. It has been said that the notion of governance is a necessary prerequisite to comprehend what enables actors to be able to act. It is therefore the first point developed in this chapter. Nonetheless, it has also been seen that technologies must be understood in their wider social context, and therefore solely the notion of governance it is not sufficient to analyse such a complex network. Thus, the notion of socio-technical agencement (STA) is depicted. Finally, the generation of alternative knowledge so to create change is elaborated.

3.1. Governing for sustainable technological change

When it concerns sustainable transition of the energy system, governance refers to the mechanisms that influence and steer the occurring modifications (Kuzemko et. al, 2015). It embeds different elements such as political institutions, rules, objectives and market regulations. By modifying these elements, governance processes can enable, or not, sustainable technological change; it can promote one technology over another to be able to act, so to *be in the making*. Kuzemko (et. al, 2015) explains:

> *In today's sustainable energy transition (...), the role of deliberate attempts to create rules, incentives and institutions to actually initiate and drive the transition is considered distinctive.*

For example, through the Nuclear Power Act in 1976, the Danish Government has promoted the technology nuclear power, whereas the Danish Energy Agreement for 2012-2020 has promoted wind power (Karnøe et. al, 2016).

Moreover, Kuzemko (et. al, 2015) explains that actors will seek to influence the decision-making processes, to control the terms of debates in order to be promoted more ability to act, to *be the making*. This creates power relations and fights between them; some of them will battle for continuity of the system, whereas others will battle for a sustainable change. Figure 01 illustrates the different forces and power relations when governing for a sustainable transition. It shows how the heterogeneous elements of the debates (e.g. objectives, practices, policymaking, etc.) are shaped by the two opposite forces and how therefore, it influences the trajectory of the energy system.

Kuzemko (et. al, 2015) also raises the idea that paradigms are shaping the governance processes. She highlights that the ideas of what governance should be are trapped into sets of formal and informal practices that have been shaped upon time, are highly self-referential and proven hard to change. In that sense, it refers to the ideas developed by Unruh (2000; 2002) about institutional lock-ins mentioned in section 2.1.1. Those in power will seek for continuity of the system, whereas those in favour for sustainable

change will influence the configuration of the system in the opposite direction. The ones seeking for continuity are embedded within their paradigm and will thus hinder the making of alternatives.

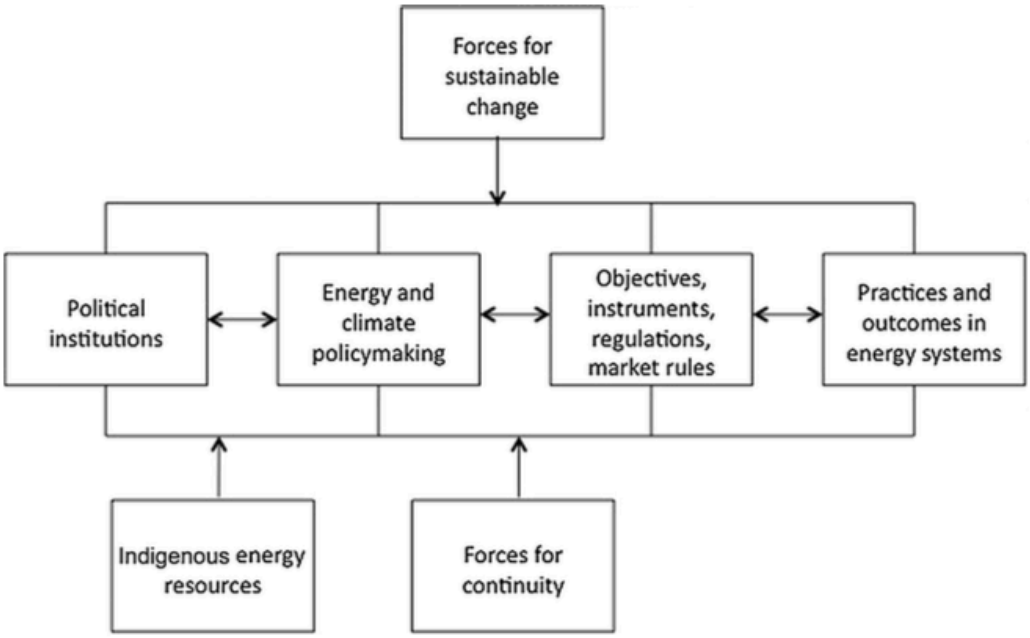

Figure 01: *Interconnections within processes of governing for a sustainable energy transition (Kuzemko et. al. 2015).*

This is a situation that the Danish energy system is facing today. As mentioned in the introduction, the current Government is considering the energy transition too expensive (Climate Network, 2015), whereas the Government in place in 2012 achieved a broad agreement supporting the development of wind power (The Government, 2012). Hence, the present Government is supporting the former energy system embedded with the existing paradigms, whereas the precedent Government was more a force for sustainable change with ambitious renewable energy targets.

Kuzemko (et. al 2015) also explains that governance does not occur in a vacuum. She explains that in practice, actors of the network must take into account a multiplicity of other elements of the system, and that governance processes are of a hierarchical structure. For example, the Danish Government cannot govern without taking into account the rules and regulations from the EU. It is under this influence that Denmark can apply its rules, regulations and goals over its own region and municipalities.

Moreover, Kuzemko (et. al, 2015) argues that understanding the historical energy landscape of the country under study is an essential matter, as it permits to identify the important actors, their interests, motivations, and specially their relationship to governance. This is also agreed by Meadow (2015), who argues that it is necessary to look at the long-term processes of a system in order to understand its behaviour and characteristics. Only then it is possible to interpret the dynamics on which a system relies on; to

understand not only *what* is happening, but also *why* it is happening.

It is hence a prerequisite to understand governance processes for the purpose of this report, but as argued in section 2.1.1., it is nevertheless insufficient. If governance is granting actors to exist and to be in the making, it should not be forgotten that these processes are co-produced. No strict separation should be installed between the different spheres. The processes for actors to be in the making are of a mutual shaping and cannot be considered as solely top-down and hierarchical mechanisms. This is why the notion of socio-technical agencement (STA) is elaborated in the following section.

3.2. Introduction to the wind power socio-technical agencement

Socio-technical refers to the notion that artefacts are not only social constructions, but that the production of technical artefacts co-evolve together with societal contexts (Sismondo, 2010). *Agencement* is a French word that has no absolute translation in English. It refers to entities that are adjusted to each other and create some kind of organisation. The notion is tightly linked to the notion of agency; the agencement distributes the agencies.

Agencies are networks of socio-technical elements that integrate the wider agencements (Karnøe et. al, 2016). Callon (2008) underlines that agencies are of a co-shaping. Instead of categorising entities in different static boxes (e.g. economic, professional, technical, etc.) (Bijker et. al, 1994), STA underscores and values the differences between entities and uses it as a starting point for analysis. By definition, categorising is to range entities according to common points, thus fading away their differences. STA considers the proliferation of differences as the basis of investigation, and considers the making of agencies as infinite (Çalışkan et. al, 2010). Agencies are not fixed entities; they rather are under perpetual construction (Karnøe et. al, 2016), hence so is the agencement as it is of a mutual shaping. The idea is however not to generate lists of all the elements, but rather to restore their diversity and capacity to act. By following the actors, it is feasible to "map" their differences, which can make them compete with each other's (Karnøe et. al 2016).

Moreover, also aligned with section 3.1, Muniesa (et. al, 2007) underlines the importance of history. Every agencement has its history, and looking at its past development can provide thorough details about how the agencement has been configured and how its trajectory has been shifting through time, and why. It is a crucial key to discern how the agencement has been arranged and how/why it is functioning in that particular way.

In the following sections, two specific concepts of STA are developed; first the concept of distributed action, and second the concept of overflows.

3.2.1. STA and distributed action

STA argues that the locus of action within an agency is distributed. According to Muniesa et. al (2007), agencies act, and/or make other agencies act. Hence agencies are the locus of actions. As agencies are composed of heterogeneous elements, when they are in the making and in action in the world, it is not due to one actor but rather due to their arrangement to each other (hence the notion of distributed action). In order to illustrate the concept of distributed action, the agencement of *bike riding* is used.

To be able to be in the making and to act, bike riding needs the contribution of other socio-technical agencies such as technologies, humans, discourses and regulations. Not all the actors act at the same time nor in the same manner, rather they act through a differential transformation which permits the bike riding to be "*out of the lab*", in the making. For example, scientists contribute to the creation of the bike artefact, whereas the consumers contribute to the existence of the bike in the world by riding it. Hence, the scientists and the end consumers do not contribute to the making of bike riding at the same time nor to the same extent, but they both participate in the establishment of the agencement.

Moreover, the individual action is also distributed; scientists can contribute to the creation of the bike artefact only because they have access to calculative devices, to materials, to already existing knowledge, to machines… It is of an infinite process to list all the entities that have been mobilised for the creation of the bike artefact by the scientists, but the action is granted to all of them. Hence, ability to act is an outcome of the agencement (Muniesa et. al, 2007).

Also, agencies can be, depending on their adjustments to each other, big or small. A "big" or "strong" agency is an agency that can impose its vision and will to other heterogeneous elements of the agencement. For example, if the bike riders, the car drivers, and the walkers respect the traffic signals, it is because the signals are imposing their will over the lane users - and therefore traffic signals are a "strong" agency. Nevertheless, as an agencement is always under construction, the signals can also be turned "small", or "weak". For example, if the users decide to not respect the signals because of new shifts in the agencement (maybe the signals have become obsolete because the cars are faster than before, because they do not match with the urban planning any longer, or because there is a mass movement…), then the signals do not "have agency" anymore. The agency cannot impose its will over the actors, because the latter have had to adjust to a new configuration of the heterogeneous elements that are composing the agencement.

Another factor that can lead to the weakening or strengthening of an agency is the generation of awareness. For example, the "car driving" agencement can be made weak if the bike riding agencement becomes visible to the car driving agencies; if car users become conscious that bike riding is cheaper, safe, easier to use due to back lanes and effective traffic signals, they might get attracted to it. Acting as a magnet, the bike riding agencement can therefore be reinforced by enrolling new actors. Hence, awareness can greatly influence the configuration of an agencement; ways of generating awareness are deployed in section

3.3.

The following figure aims at visualising how an agencement can look like.

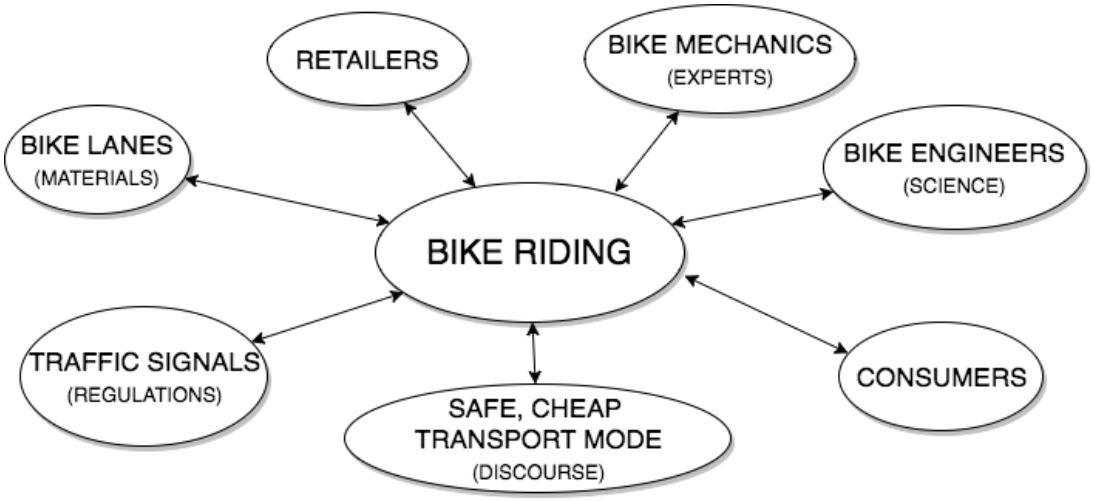

***Figure 02**: Non-exhaustive illustration of a bike's agencement.*

3.2.2. Framing, overflows, and hot/cold momentums

In economy, agents refer to *externalities* when there is a fail to account for the costs imposed to actors of the agencement. Let us take the example of noise pollution to illustrate the meaning: if someone plays loud music in his/her flat, he/she is maximising his/her well-being while reducing the well-being of his/her neighbours. In this case it is of a negative externality, but externalities can also be positive; a new metro station near by the flat will increase the value of the apartment, therefore bringing benefit to the owner - whom did not invest in the infrastructure. Externalities, positive or negative, thus create a gap between private incomes and social costs and render the market inefficient. The market is biased as externalities are not taken into account in the calculative devices of the different actors of the agencement (Callon, 1998).

The concept of externalities is tightly linked to the notion of framing. Framing means "*putting the outside world into brackets*" (Callon, 1998); it is a place where actors agree on the kind of interactions taking place. Nevertheless, framing is in direct relation with the outside world simply because what is mobilised in the frame means that the outside world is also present. Framing makes the market effective; it is a closed space of interactions where the different point of views of the actors, when taking a decision, are taken into account. Externalities are seen as imperfections of the framing process. It produces overflows, "accidents", repercussions of actors' agreements over other actors, not involved in the negotiations (Callon, 1998).

In order to be framed, overflows need to be made measurable and visible. For this, overflows must be proved real, and their sources identified. It generates a need for calculative devices and knowledge to

established effective frames and to avoid market failures. Nevertheless, different agencies will create different calculative devices, depending on which paradigm they are embedded within (Mortensen et. al, 2017). For example, in the case of social resistance towards wind turbines because of visual impacts: a citizen against turbines might embed in his/her frame "quality of life", "visual pollution", "health risk due to noise", and so one. Now, "CO2 emissions", "costs for society", "other health risks" are also overflows existing in the world and measurable. Nonetheless, the citizen whom does not want to see elevated a wind turbine nearby his/her property does not see nor identify them as valid, which hence renders the market inefficient.

The identification of the overflows' sources can lead to contestations, to "hot momentums" where agencies do not agree on the sources of the overflows and therefore, it leads to debates and opposite viewpoints on the actual situation. It does not mean that one is right nor one is wrong, but rather that their calculative devices and their way of perceiving the world are incomplete, which creates different realities. To escape from this situation and create "cold momentums", there is a need to establish stabilised knowledge and to map out the overflows (Callon, 1998). Thus, Callon (1998) argues that there is a need for institutions enable to render market negotiations feasible, and enable to stabilise knowledge among the agencement. In order to do so, the visibility of knowledge must be improved within an agencement. In the following section, means of ameliorating this visibility is deployed.

3.3. The creation of alternative new knowledge to generate change

As it has already been mentioned in the previous section 3.2 and as argued in the methodology section 2.1.1., awareness of alternatives can greatly influence the configuration of an agencement. This section is elaborating on how to generate this awareness with the *Choice Awareness Theory* (CAT) developed by Lund (2014).

In the CAT, Lund (2014) argues that there is a need to distinguish between a *true* and a *false* choice when society is facing a decision-making process. A false choice refers to a sort of illusion that there are no alternative decisions possible, whereas a true choice refers to the fact that there always is an alternative solution, only this alternative is not made visible by the ones in power, as an alternative development could harm their own situation. In order to promote awareness, Lund (2014) defines the following means:

- promoting the description of concrete technological alternatives in debates and decisions making across society
- promoting feasibility studies methodology
- promoting concrete description of public regulation measures to advance new technologies.

The promotion of an alternative implies more than an understanding of the situation; it requires

consciousness of the choices. This consciousness can be of a process over time, and it can result in opportunities for the actors to choose between pertinent alternatives (Lund, 2014).

Creating awareness within the agencement thus means, in STA terms, to make alternatives visible. If alternatives are visible to the actors, it can create a vision of another possible development that the agencies can enact. It makes space for other choices than the *normal* one offered by the configuration. Therefore, it influences the configuration of the actors whom can activate the vision created with this alternative knowledge.

Thus, the creation of new and alternative knowledge requires more than solely choices; it requires the visibility of new choices.

3.4. Summary

This section has presented the theoretical understanding to analyse the research questions. First of all, the notion of governing for sustainable transition has been depicted. The notion emphasises that governance permits actors to be in the making through rules and regulations. It shows that actors are competing to each other in order to be more influential for the decision making of the network's trajectory. It has also shown that governance can be embedded within paradigms that limit innovation towards sustainability. Forces for continuity and forces for sustainable change are opposite forces, and understanding these drivers is essential to understand the complexity of such a system.

Secondly, the STA notion has extended the complexity of technology' developments. It argues for an understanding of a seamless web instead of separated spheres, and considers the evolution of society and technology as a co-production. It explains that agencies are locus of actions and that the capacity to act is of a co-shaping. It explains that everything is able to act in a distributed manner, that the network is infinite and that it is made from the diversity of the heterogeneous actors. Also, it shows that an agencement is under constant construction and is of a moving configuration. The agencies generate different realities depending on the calculating devices that they develop, and the absence of stabilised knowledge can lead to controversial momentums.

Thirdly, the CAT has shown how choice awareness can make alternatives visible within the agencement, and how this creation of alternative knowledge can alter the trajectory of agencies.

It is therefore with this worldview that the problems under inquiry are going to be analysed. Specific elements of the Danish wind power socio-technical agencement are under focus in this research, such as governance at the European and national level, the energy system, the wind turbine artefact itself, the different and shifting investors in wind power, the relation with the residents, and the different discourses deployed by the multiplicity of actors. The following figure illustrates the agencement.

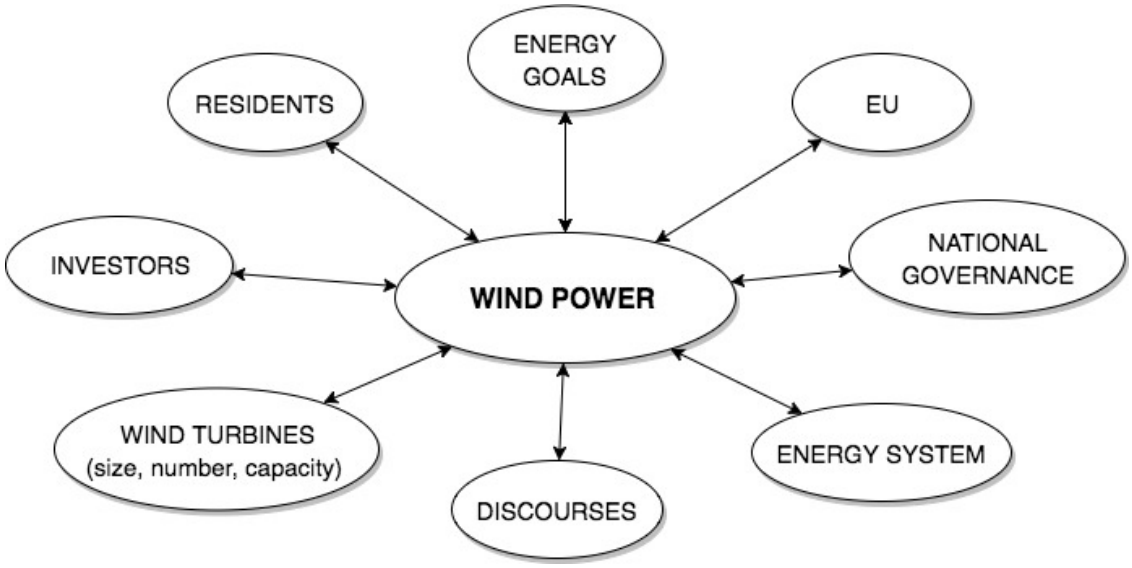

***Figure 03**: non-exhaustive representation of the Danish wind power socio-technical agencement under inquiry.*

4. First shifts in the Danish wind power socio-technical agencement: where were we?

Along the following sections, the first problem formulation is being answered. At first, a literature review is provided. Second, the historical development of the wind power STA is developed. Finally, the consequences of this development for the wind power artefacts is depicted.

4.1. Literature review

This section is presenting the main research made about social acceptance of wind power. This review of what has already been done is giving a ground understanding of the questions under inquiry and draw conclusions from cross-readings. The first section is highlighting gaps of research within the field. The second is framing the notion of "social acceptance" and what it can mean. The third section is focusing on both visual and sound impacts from wind power. The fourth section focuses on the link between planning and public acceptance, and finally the fifth section concludes by recognising the importance of social integration in wind power projects.

4.1.1. Gap of research

Research concerning the social acceptance of wind power has started rather late in comparison to the development of the technology. Wind power started in the 70s-80s, and even if some research were conducted in 1980s (Carlman, 1984), the topic began to be a scientific matter only in the late 2000s (Sperling et. al 2010). In fact, in the sections deployed here, the scientific papers used are dated from the earliest in 2005, and go up until nowadays, in 2017. Nevertheless, the following figure 04 indicates that the relationship between wind energy and community has become an increasing concern in research.

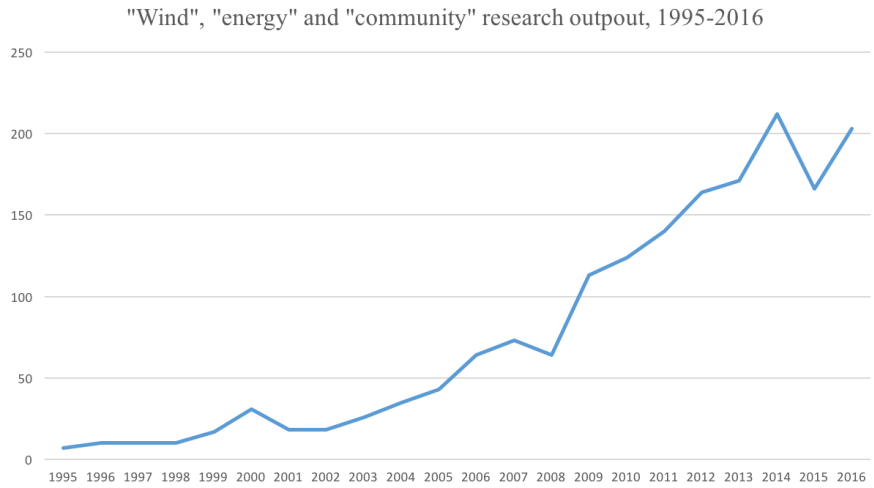

***Figure 04**: "Wind", "energy", and "community" research output, 1995-2016. Source: Scopus. Made by the author.*

However today, the perception of the impacts from wind turbines are still not fully understood (Van Renterghem et. al, 2013). Devine-Wright (2005) states: "*There is a lack of valid and reliable quantitative methodological tools for operationalizing public perceptions of wind farms*". Even nowadays, in 2016, Sunak (et. al, 2016) emphasises that lack of research concerning the impact of wind farms on property values, where first research on the topic were only conducted in 2007. Bernd Möller was in 2005 also highlighting the lack of study in northern Denmark (where wind power actually started) concerning the visual impacts of wind turbines (Möller, 2005). He argues that this lack of concerns is probably due to the limited visibly of the older small turbines and a quite high opinion for RES. This latter argument is also acknowledged by Wüstranagen (et. al, 2007), who states that the high polls and positive image of RES has led many stakeholders, including researchers and policy makers, to believe that social acceptance was not an issue for the development of wind power. As argued by Bryman (2016), surveys and polls are samples that can be used as basis for further investigations, but are not complete nor absolute data to be used as such.

Therefore, the gap highlighted by the different researchers represents a disparity of 20-30 years. Considered as "*residual questions*" (Wüstranagen et. al, 2007), the lack of consideration for public attitudes has led to misunderstandings of the actual situation.

4.1.2. Social acceptance: what does it mean?

After highlighting the lack of consideration for social acceptance in research, it is necessary to define what social acceptance actually means. Many are using the theory of NIMBYism (Not-In-My-Back-Yard), when referring to the situation where people are in favour of wind power, but are opposed to it if the turbines are located in their own area (Wolsink, 1999). Many scholars however emphasis the need of a new paradigm. Wolsnik (1999, 2007) explains that the NIMBY syndrome is too simplistic, too static, and illegitimate as it attributes the same motives to everybody, whereas only a deeper investigation could prove the reasons for opposition. Too often, the idea of ignorance and selfishness is used to explain resistance. Wolsink (1999) argues that it has become a "label" explanation for policy makers, and that it has influenced the policies in a way too static worldview, whereas the nature of opposition is much more complex than it can firstly appears. Furthermore, Wolsink (2007) explains that in most of the time, the opposition is risen not because of the vicinity of the project, but because of other factors. The scholar rather develops another concept, also recognised by Devine-Wright (2005), named the U-shape. It shows from empirical data that attitudes are changing along time; from a positive attitude when people are not facing the project, to a rejection phase when the project is announced, and back to a positive attitude after the construction phase.

Wüstranagen (et. al, 2007) also agrees that the NIMBYism syndrome is an improper explanation

for local resistance. Rather, he develops three dimensions of social acceptance: socio-political acceptance, community acceptance and market acceptance, illustrated in the following figure:

Figure 05: *The triangle of social acceptance of renewable energy innovation. (Wüstranagen et. al, 2007)*

The first one refers to a broad level, acceptance from policy makers, the public, key stakeholders, etc. The second one refers to the specific acceptance at the local level (residents, distributional justice, trust…), and emphasises the importance of the time dimension as previously argued. Finally, the third one refers to the process of market adoption when innovation is occurring. Sperling (et. al, 2010) agrees with Wüstranagen and develop his own view on the acceptance of the implementation process based on three pillars (financial incentive structure, public administration and planning procedures, local/regional economy and development dynamic). Social acceptance is therefore more complex and relies on many more factors than the solely selfishness and lack of knowledge from citizens.

4.1.3. Visual and sound impacts

This section is examining the relation between visual and sound impacts from wind turbines and public attitudes to wind power development. Möller (2005, 2006), Ladenburg (et. al, 2007), Warren (et. al, 2008), Sperling (et. al, 2010), Community Power (2014) … all agree that the visual impacts from wind turbines in the landscape is one of the biggest barriers for local acceptation. It alters the landscape which is of a cultural heritage, it changes the natural habitats, sometimes is a threat for the ecosystem (the case of the golden eagle, Sperling et. al, 2010), and a threat to tourism (Warren et. al, 2008; Sperling et. al, 2010).

However, it is still quite uncertain to which extent the public attitude is linked to the proximity of the wind turbines. Wüstranagen (et. al, 2007) argues that "*proximity does have strong influence on public attitudes to proposed projects*", whereas Ladenburg (et. al, 2007) shows that "*people living close to wind turbines do not have a more negative attitude towards wind power*". Nonetheless, the shift from small wind

turbines to bigger ones is acknowledged to increase visual impacts. Möller (2006) states that "*there is the risk that the opinion will turn against wind power as wind turbines are higher*", idea shared by Sperling (et. al, 2010) and Warren (et. al 2008) among others. Concerning offshore wind turbines, Ladenburg (et. al 2007) concludes that the respondents are more positive towards offshore wind than to onshore.

Möller (2006) is conducting a research on the visual impact from wind turbines in the Danish landscape. He emphasises the fact that many turbines are getting older, and will be replaced by higher new ones. He argues: "*with decreasing number and increasing size, changes in landscape prominence and visual impact will become apparent*" (Möller, 2006). From his research, Möller (2006, 2010) found that the new wind turbines will have an even bigger impact in the landscape than before at the regional level, whereas the removal of many small turbines will not reduce the overall visibility. However, Toke (2005) has found no evidence that these shifts in size and numbers have serious impacts on public opinion.

Sound impact, just as visual impact, is also widely acknowledged to be a barrier for local acceptation, and even more in the recent development as the height of wind turbines has grown. Nonetheless, many scholars (Van Renterghem et. al, 2013; Jalali et. al, 2016) show that the actual impacts from noise on health are inconsistent. According to the study conducted by Van Renterghem (et. al, 2013), the impacts from wind turbine noise are highly cognitive processes relying on personal factors. Wolsink (2007) and Jalali (et. al, 2016) also conclude that noise irritation is more related to visual impacts than to actual sound pressure.

4.1.4. Public planning

The two impacts developed in the previous section 4.1.3 are key challenges when it comes to wind power planning. Already in 2007, Wolsink (2007) has highlighted the complicated processes of planning wind power in different countries. Möller (2005) found that the stricter land-use planning and the lack of national planning procedures in Denmark has hindered the development of onshore wind power. Sperling (et. al, 2010) also agrees with Möller, especially as wind turbines are growing in size, thus reducing the numbers of sites available. Wüstranagen (et. al, 2007) shares this vision, and adds that because the sitting decision affects many actors, it cannot be the decision of solely an investor, but rather should be a common approval. Wolsink (2007) shares this idea of a collaborative approach to planning, and Sperling (et. al, 2010) emphasises the role of municipalities. He argues that in Denmark, there is a tendency for municipalities to group large wind turbines on as few sites as possible, hence complicating the planning process per site (since more local impacts have to be taken into account). At the same time, it also has the disadvantage to be of a risky planning; in case where the project is not conducted to the end, it leaves the municipality with no capacity installed, and such after a time consuming and expensive process. Nevertheless, if successful, it saves time in term of project work. Thus, Sperling (et. al 2010) advocates for flexibility in the planning

framework in Denmark, so that smaller projects and faster planning processes can be part of the future development. Wolsink (2007) underlines the importance of public participation in the planning phase as early as possible.

4.1.5. Importance of social acceptance through community ownership

It has been deployed in the previous sections the meaning of social acceptance, the impacts from wind turbines, as well as the importance of public planning. This section is bearing the acknowledged importance of community ownership for the development of wind power. Many studies (Toke, 2005; Möller, 2006; 2010; Wolsink, 2007; Warren et. al, 2008; Rogers et. al, 2008; Hvelplund, 2013; 2014; Community Power, 2014…) agree that public participation and/or ownership are prerequisites for social acceptance, and that they are the ground of wind power development in Denmark. By realising projects made by, and for, the locals, citizens have created a vision of a local green energy which has built social capital, local dynamism, and positive opinion of wind power (Hvelplund, 2013; 2014; Community Power, 2014). Without participation, public protests arise and lead to the abandon of planned wind farms, to time consuming processes, and/or to local dissatisfaction. This leads the policy makers towards two directions: not planning or planning smaller onshore wind power capacity, and shifting towards offshore resources (Ladenburg, 2007).

Many also underline the issue that, as the wind turbines are bigger and as large projects are generally not realised in the cooperative model, it increases the risk of unpopular wind projects (Möller, 2006; Hvelplund, 2013). Möller (2006) states:

> "*Together with the fact that multi-megawatt projects rarely can be realised as the type of co-operatives that made wind-power development so popular and successful in Denmark, there is the risk that the opinion will turn against wind power"*.

With public participation only, it is possible to decrease local resistance and to generate an understanding of wind power, which is even more necessary now with the large scale integration of the resource (Hvelplund, 2013).

It is thus widely acknowledged that public participation is an important feature for the future of wind development, in Denmark and abroad. In Denmark, co-ownership has been the development model of wind power. As new challenges are arising, there is an even greater need for public participation.

The next sections are analysing how the Danish public participation has generated shifts in the wind power STA, and how it has transformed the wind turbines artefacts themselves.

4.2. Empirical analysis of the wind power development in Denmark

As argued by the theoretical framework developed chapter 3, understanding the historical development of the Danish wind power socio-technical agencement is an important matter in order to grasp today's configurations. It permits to understand not only in *which* situation the agencement is, but also *why*. The literature review section 4.1 has mentioned that the development of wind power in Denmark has come from bottom-up experimentations and local initiatives. This section is analysing how communities have created room in the agencement for an alternative energy development, and how wind power has not been of a planned trajectory.

Along this section, it will be seen that the shift from a fossil fuel energy system to a large scale integration of wind power is rooted in a context of crisis which is, according to Unruh (2002), how radical technological change mostly occurs.

4.2.1. The creation of an alternative vision to nuclear power

If Denmark is today a pioneer in wind power, it is greatly acknowledged that it is not the result of a planned trajectory from the Government, but rather due to the intervention of civil society (Hvelplund, 2001; Möller, 2005; Wolsink, 2005; Sperling et. al, 2010; Community Power, 2014).

In the 1970s Denmark was heavily relying on fossil fuel importations; around 95% of the country's electricity production was generated in large centralised thermal power stations (Hadjilambrinos, 2000; Karnøe, 2016). Hence agencies were organised around a centralised energy system of production and distribution. The socio-technical agencement embedded knowledge, routines, actors, all set up in a network dependant on fuel importations which was greatly settled. Therefore, in 1973 when the first oil shock occurred, Denmark realised its high energy dependency towards fossil fuels and had to undergo severe consequences. The price of oil quadrupled overnight, and a solution had to be found quickly in order to replace the former energy source of the system. Nuclear power appeared as the natural answer in the eyes of the Government so to face the problem (Hadjilambrinos, 2000; Hvelplund, 2001; Karnøe et. al, 2016). Indeed, nuclear power is a centralised source of energy and thus it corresponded well to the current socio-technical configuration. Thus in 1976, the Government established the Nuclear Power Act, which was planning on building five nuclear plants, providing up to 23% of the total energy demand by 1995. At that time, wind power was barely mentioned; it was considered as a marginal technology that could never be able to meet the required energy supply, and considered as harming the stability of the grid and the security of supply (Hadjilambrinos, 2000). By establishing such an Act, the Government has promoted forces for continuity of the system and has steered the direction of the agencement.

Nonetheless, opposition to nuclear power appeared immediately, both from inside and outside the

Government. Within the Government, the non-democratic process provided for the Nuclear Power Act raised scepticism among the politicians. Indeed, the Act had been conducted without debates neither parliamentary approval, hence rooting critics, reluctance, and influencing the perceptions over the technology. This scepticism has delayed the processes of establishing nuclear power plans *in the making*; the pro-nuclear discourse was eroding by time (Hadjilambrinos, 2000).

At the same time, grassroots organisations started to create room for an alternative vision of what the future of the energy system could be. Indeed, in reaction to the debates, local initiatives started in Northern Jutland. Locals started to activate themselves in clusters and to share best practices in relation to wind power. In the interview, Jane Kruse explains how Nordic Folkecenter, Tvind, as well as many other citizens started to build best practices by sharing knowledge in open source. When asked about the motivations for doing so, she explains:

> "*It was to show that we could be without atomic energy, this was the primer reason. And because we were thinking in a green way already"*. (00.00.05)

Citizens were therefore in the making of an alternative solution in reaction to the normal solution offered. Because they did not accept the Government's decision, citizens and communities became part of an agencement where they did not take active actions previously. As argued in the theory section 3.3, raising awareness is a way to create room in the agencement by making alternatives visible. By sharing knowledge and developing another choice, citizens have modified the configurations of the agencies.

In short words, citizens have activated themselves because of a situation of crisis. As the Government was steering the energy system in an unwanted direction, civilians reacted by creating an alternative vision to the one offered. By sharing and developing wind power practices, they have developed a common vision for a different path that the agencement could take. Whilst the agencement was pursuing continuity of the energy system by replacing fossil fuels by nuclear power, civil society has put pressure with forces for sustainable change by rooting space for an alternative direction to be taken.

4.2.2. Wind power communities: from a vision to new actors in the making

By advocating their visions and creating awareness, communities and citizens have rooted space for an alternative energy system development.

In 1976, the carpenter Riisager connected for the first time and in total illegality his own wind turbine to the grid; by doing so, he made real the vision developed by the communities. The parliament was under constraints, and had to give permission to the carpenter to use his turbine and defined a set of regulations granting him and thus, other citizens, the right to be connected to the grid (Karnøe, 2013). Jane Kruse (2017) explains:

> *One thing is to have the technology, another thing is to have the system around it functioning too.*

> *We made three decisions very quickly, and made it accepted by the Danish parliament. The first one was that one was allowed to set up a wind mill that produced electricity. The second one was that one was allowed to deliver electricity to the grid, and the grid cannot say no to it. The third one was the guarantee of a price. These three things are the background for cooperatives to operate in the market.* (00.18.15)

A new space was thus created in the socio-technical agencement; ability to act was endowed to new actors. The alignment of new regulations together with the formation of new actors has changed the network set up: from a vision, a concrete alternative has been enacted. The citizen's vision has co-evolved together with the governance agency, they have shaped each other; citizens were in the making in reaction to the governance decision to establish nuclear power, whilst the governance regulations has been shaped by the reaction of the citizens. This co-evolution, as mentioned in section 4.1., has strongly participated in the public acceptance of the visual and noise impacts of wind power. By 1981, more than 1,000 turbines were already privately owned (Hadjilambrinos, 2000). Wind power was recognised as not harming the grid stability, and the turbines themselves became new actors in the agencement.

4.2.3. Other shifts in the agencement's configuration contributing to the new direction

Nevertheless, as argued by the theoretical framework, action is an outcome of the configuration of the agencement. Therefore, it is not only due to the implication of citizens that the whole configuration has radically shifted from nuclear power towards wind power, but it is rather due to a multiplicity of factors. In the following, it is seen which other factors have contributed on shifting the pre-established direction set by the Government.

Firstly, in 1976 a new agency became in the making by publishing the Alternative Energy Plan (Karnøe et. al, 2016). Composed of citizens, NGOs and scientists, the agency was based on different valuation devices than the Government when considering wind power, which created awareness about a different plausible future. As argued by Lund (2014), promoting concrete measures of new technology is a mean to promote technological radical change.

Secondly in 1981, the Government established an energy efficiency plan. The plan has been so successful that the energy demand considerably dropped, thus making the nuclear proposal of 1976 obsolete (Hadjilambrinos, 2000).

Thirdly, the anti-nuclear organisation OOA (Organisationen til Oplysning om Atomkraft) created the Smiling Logo, still representing today the biggest worldwide symbol of the anti-nuclear power movement (OOA Fonden, 2016). OOA was strongly supporting wind power and the expansion of

cogeneration of heat and power as it was an alternative to nuclear (Hvelplund, 2001). Their international recognition and strong support from civil society has put pressure on the agencies, shifting perceptions and shaping the debates. In reaction to these pressures, the new Minister of Energy recognised in 1989 the potential from decentralised cogeneration. This has enhanced even further the communities' capacity to act; more than half of the co-generation units were community owned in the following years (Hvelplund, 2001). Hence, the space for communities in the socio-technical agencement kept on enlarging, whilst the space for nuclear power kept on reducing.

Thirdly in the mid-80s, the Danish wind power network created jobs and incomes through wind turbines exportations, legitimating and making popular the new technology among society (Karnøe et. al, 2016). In reaction to these shifts in agencies in 1985, the Energy Act targeted a 50% of wind power by 2020, signing the direction chosen by the agencement for the future of the Danish energy system.

4.2.4. Summary

The vision built by the communities has made the agencement taking a decisive turn. In reaction to the energy system trajectory designed by the Government, a group of actors reacted and empowered themselves. They created an alternative trajectory vision by gathering, creating and sharing knowledge. Then, they applied their vision in the real world by connecting wind turbines to the grid, which shifted the Government's agency's configuration. The alternative vision developed by the actors became real; communities and wind power became *in the making*. Together with new adjustments of agencies within the configuration, the trajectory of the agencement shifted from nuclear to wind power. Hence, the shift from nuclear power to wind power is the result of the co-shaping of civil society and governance, and of a distributed action within the agencement.

4.3. The new materiality of wind power

In the previous sections it has been analysed how wind power has come from unexpected adjustments rather than from a planned trajectory. In the following sections, the shifting *materiality* of wind power is analysed; as mentioned, both the integration of large scale wind power capacity and the landscape' impacts from the turbines are challenging the acceptance of the technology.

4.3.1. Wind turbines: an evolving actor

As it has been seen in section 4.2, the development of wind power has come from bottom-up experimentations from the 1980s. In the following figure, it can be seen the active participation of communities in building wind power from 1980 to 2001. After March 2001, a new regulation for the wind

turbines has been established by the DEA and thus since then, only estimations about the amount of cooperatives and citizens' ownership can be made (DWTOA, 2016).

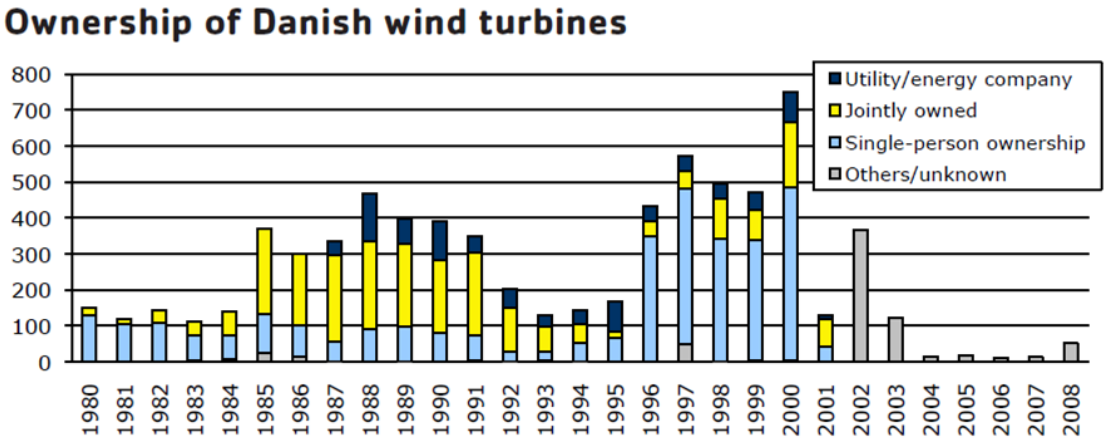

Figure 06: *Ownership of Danish wind turbines from 1980 to 2001. Source: Safarkhanlou (et. al, 2009).*

In this graph, the importance of communities and citizens can be greatly observed in regards to wind power development. The number of wind turbines has greatly increased in the Danish landscape since 1980, and it is only in 1987 that energy companies started to invest in the technology; before that, the development of wind power was only due to citizens and communities. And even after 1987 and until 2001, energy utilities represented only a small percentage of the wind turbines development. At that time, the turbines were placed on land, on suitable locations for the different actors and without planning regulations from legal authorities. As the communities and citizens were collaborating together, together with the fact that wind turbines were not higher than 50m, local acceptance for projects was high and the public attitude towards wind power positive (Möller, 2005; IEA, 2013).

The following figure is showing the annual growth in number of turbines and in wind power capacity in Denmark from 1976 to 2016.

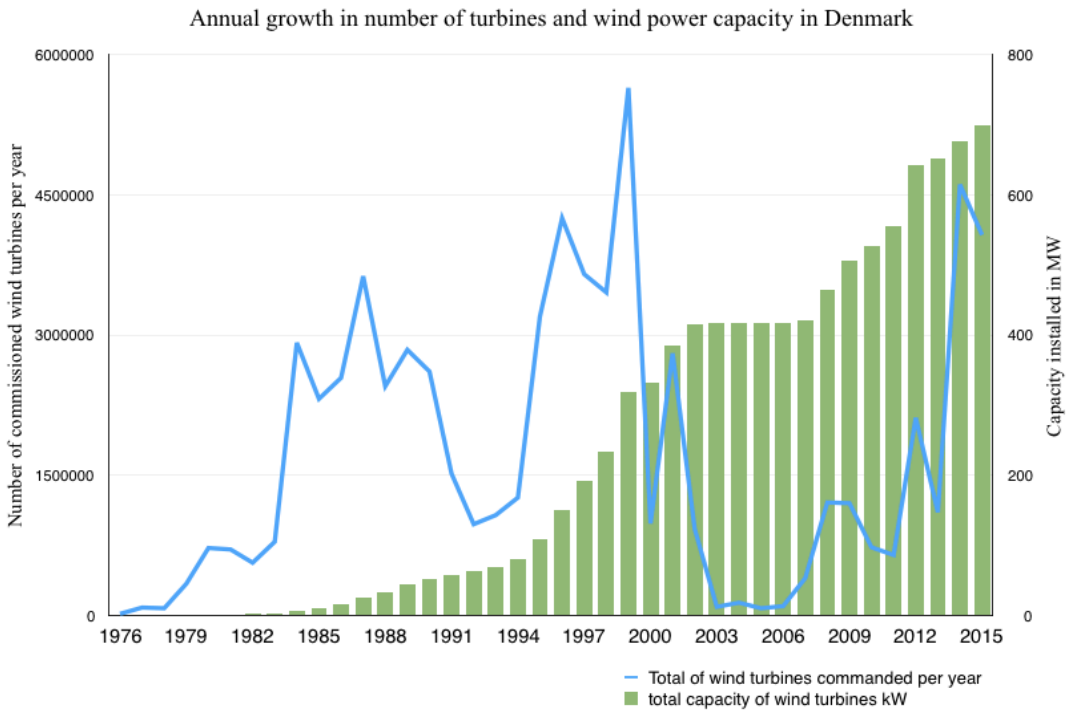

***Figure 07**: Annual growth in number of turbines and in wind power capacity in Denmark from 1976 until 2016. Made by the author. Source: DEA (2017).*

It can be observed that the wind power development has not been regular throughout the years. Nonetheless at the end of 2015, Denmark has reached an accumulated installed capacity of 5,070 MW (DEA, 2017). With this figure, it can easily be observed that the turbines have shifted from being a small actor to being a major one in the Danish wind power STA. The technology has put more pressure on the landscape; their increase in size and number is illustrated in the following maps.

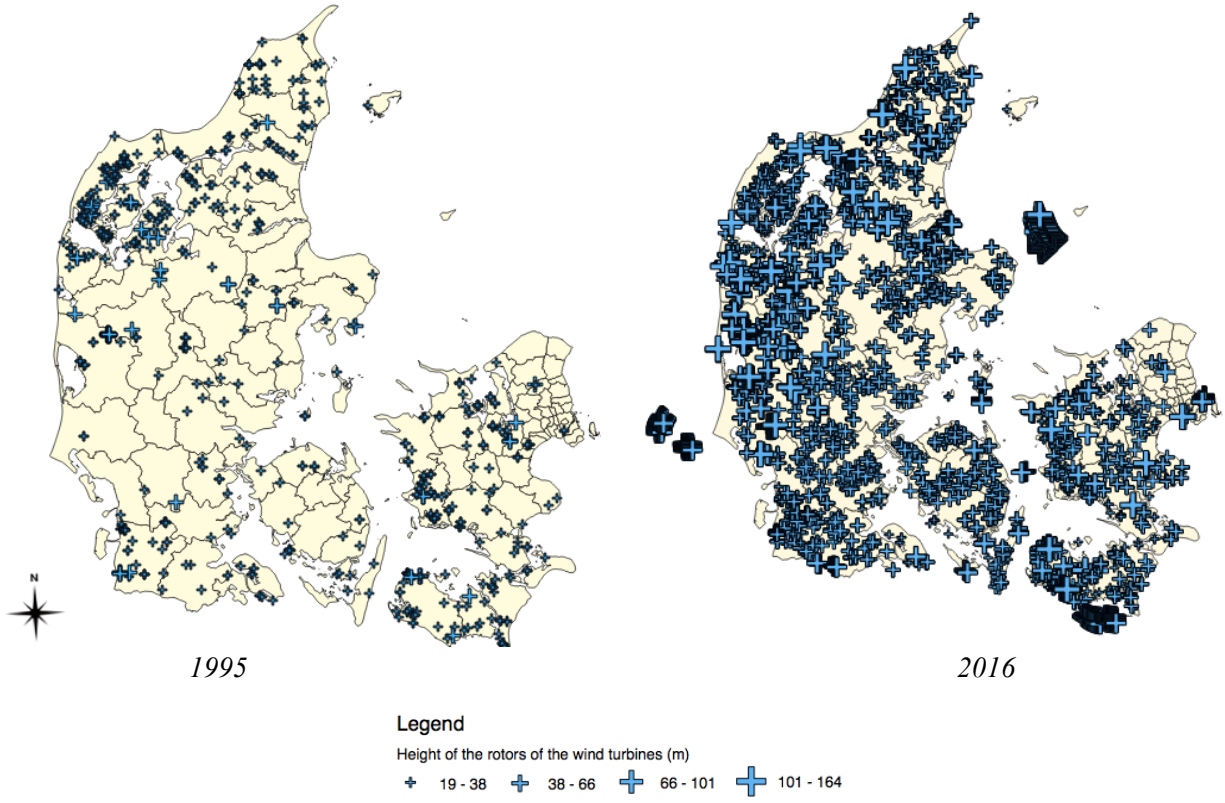

***Figure 08**: The evolution in number and size of the wind turbines, in 1995 and in 2016. Made by the author. Source: DEA (2017).*

It becomes evident that the wind turbines materiality has shifted from an innocent and sparse technology to a major one spread across the country. In a 20 years' time, the technology has evolved drastically in number but also in size, being more invasive in the landscape. It is not the same wind turbines that are implemented today and in the past: it has evolved from domestic wind turbines to large commercial wind turbines. In the following figure 09, it is shown the growth in size of wind turbines and the prospects:

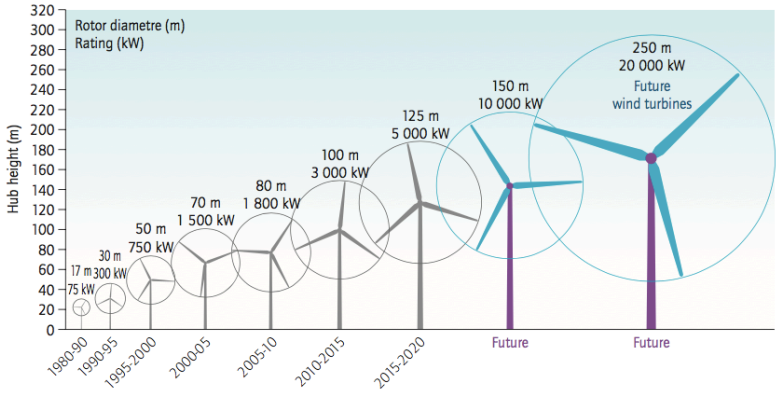

***Figure 09**: Growth in size of wind turbines since 1980 and prospects. (IEA, 2013)*

The growth in size of the turbines bears economic repercussions; the price of a turbine is highly depending on its size, and around 80% of the capital costs for a typical wind power project in Denmark is accounting for the turbine itself (DEA, 2016). Even if the costs for establishing a wind farm varies greatly according to a number of factors (such as the number of turbines ordered, construction contracts, location, quality of wind, grid connection), the new commercial wind turbines have higher investment costs than the former smaller turbines established in the past. Also, wind turbines are benefitting from economies of scale; smaller turbines are cheaper overall, but are more expensive per kilowatt produced, explaining the will of developing large turbines (Windustry, 2017).

Hence, the wind turbines from the early stage of development are not the same ones as the wind turbines being implemented today. The technology has evolved from a low-cost, "innocent" and sparse artefact, to a major one. Spread across the country with a higher size and higher investment costs, the turbines have shifted in their *materiality*, implying changes in the agencement's configuration in a multiplicity of ways. In the following sections, overflows for the power market generated by this new materiality are analysed.

4.3.2. The challenging actor for the electricity prices

Wind is a fluctuating resource which challenges the energy system due to its intermittency character, and hence is influencing the power market. Electricity is sold on the power market which relies on supply and demand. Since 2004, Denmark is part of the greater power market Nord Pool Spot, organised as following (NordpoolSpot, 2016, 2017 A):

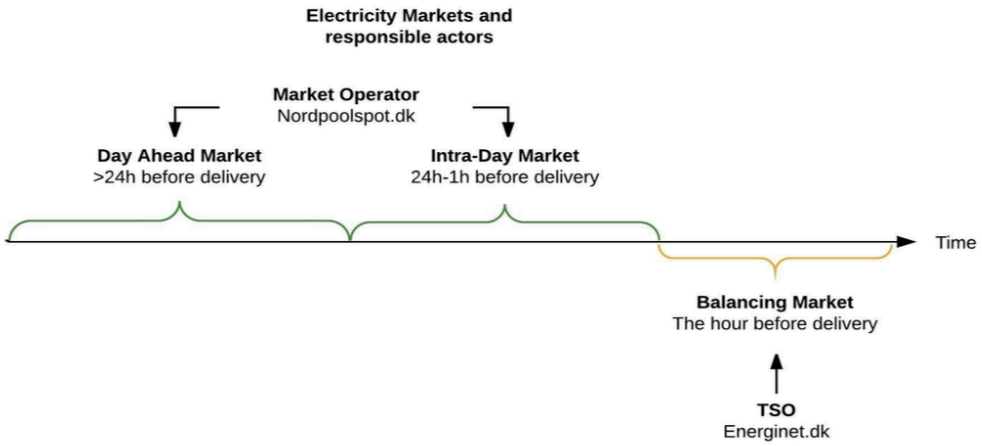

***Figure 10**: The connection between the day-ahead market, the intraday market and the balancing market, with their respective responsible actors (created by the author based on Nord Pool Spot, 2017 A and EWEA, 2010)*

The Day-Ahead market is based on supply and demand. Players bid, and the resulting prices are added together 24h before the delivery covering the whole next day. The Intra-Day market is a place for participants to trade bilaterally during the day, usually trading one-hour power contract. These markets are managed by the market operator Nord Pool Spot. Then, there is the Balancing Market, managed by the Danish TSO (Transmission System Operator) Energinet.dk. In this market, the imbalances from the participants (in case of excess electricity for example) are handled the hour before delivery. The ordering of the power supply from the different bidders is depending on the amount of power they can supply and at what cost. The marginal cost refers to what it would cost to produce the next unit of electricity generated. As wind power has no fuel costs, its marginal cost is low and thus enters at the bottom of the supply curve with the lower price; it is the merit order effect. Thus, wind power can often underbid technologies with fuel costs (which therefore have higher marginal costs). An example of an aggregated curve in the Day-ahead Market is illustrated in figure 11:

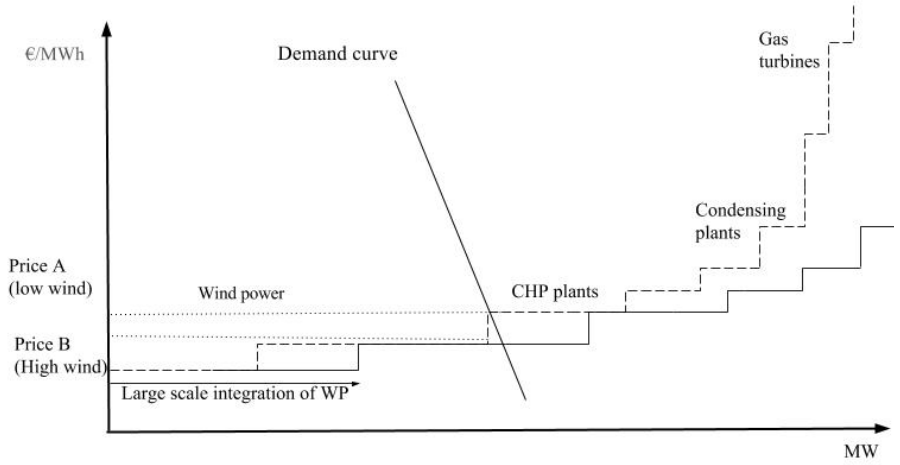

Figure 11: *Merit Order Curve with inflexible demand curve. Made by the author. Source: EWEA (2010).*

The market design therefore serves the consumers well as it adjusts to the demand. Nonetheless, it weakens both conventional technologies and wind energy producers. First, the more wind is integrated in the system, the less profitable it is for CHP plants to operate in the power market. Indeed, the higher wind integration decreases the hour of operations of the CHP, which harms their business case and can lead to their phased out of the power market. Nonetheless, conventional technologies are a necessity for the stability of the grid (DEA, 2012).

Second, it weakens the business case of wind producers whom are almost never able to benefit from high electricity prices. In the following graph, it can be observed the direct correlation between wind power production and electricity prices.

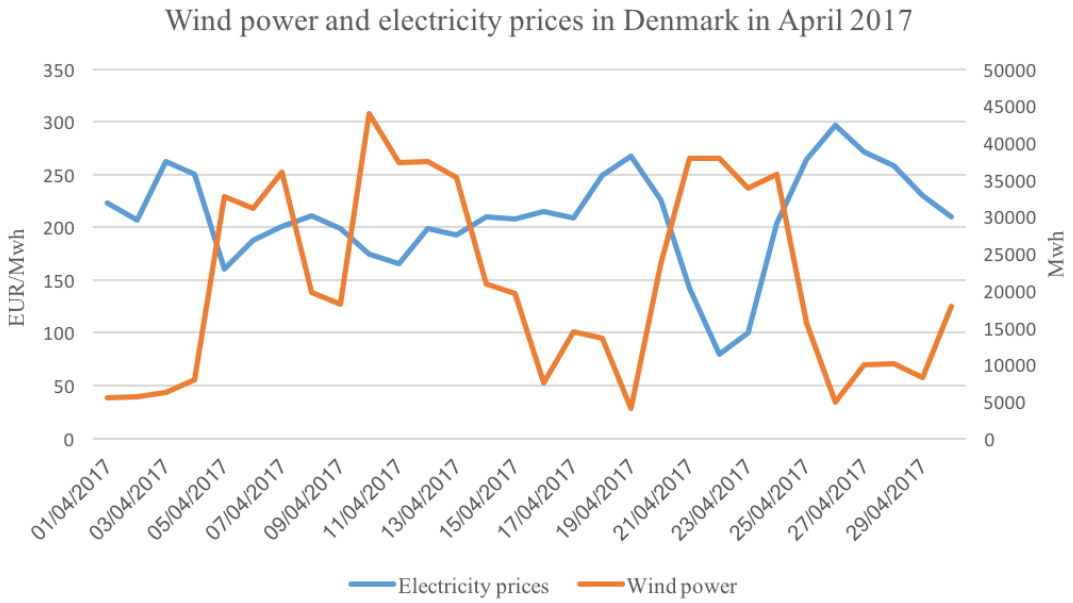

Figure 12: *Wind power and electricity prices in Denmark, April 2017. Made by the author, source Nordpoolspot.com (2017 B)*

When the wind production is high, the price of electricity drops, and when the wind production is low, the price is high. It can thus greatly be observed that, as argued by O'Brian (et. al, 2017), wind power is cannibalising its own revenues. Furthermore, as more wind power capacity has been installed in Denmark through the years as seen in figure 07 and 08, the average annual price of electricity has dropped. This can be seen in the following figure 13:

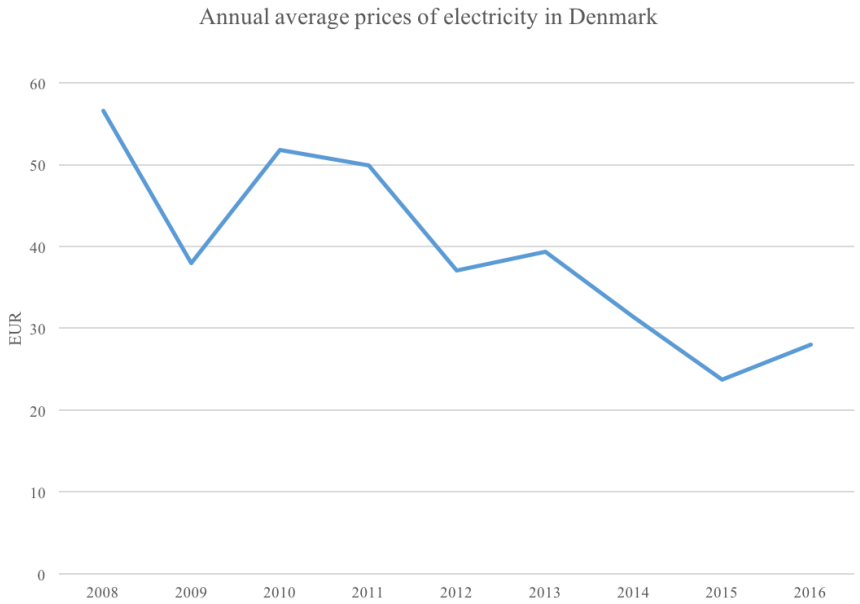

Figure 13: *Annual average price of electricity in Denmark Made by the author, source Nordpoolspot.com (2017 B)*

From an annual average of 56.5EUR in 2008, the average annual price of electricity has dropped to 23.7EUR in 2015, representing a decrease in growth rate of 58% in only 7 years. A too low price of electricity can be a problem as it can lead to non-profitable situations for wind investors (O'Brians et. al, 2017). This is a problem also perceived across Europe, as examined in the following section 4.3.3 (European Commission, 2016).

Thus, the importance of the wind turbines capacity installed in Denmark is challenging the power market configuration; the new materiality of wind turbines is transforming the arrangement set ups and creates overflows. In the following section, it is analysed the link between this new materiality and the repercussions over another actor: the grid.

4.3.3. The grid; another actor of the wind power agencement

An energy system does not exist in a vacuum. Denmark has grid connections with Norway, Sweden, and Germany as illustrated in the following figure:

Figure 14: *Denmark' interconnectors. Source: Energinet.dk (2014)*

In addition to the actual connections, a new interconnector is scheduled by 2019 to the Netherlands, as well as two others to Great Britain and Germany (Energinet.dk, 2016 B). The grid is owned by the Danish Transmission System Operator (TSO) Energinet.dk, who has the role of maintaining the grid stability and ensuring the security of supply. The grid must today be able to integrate large amounts of often

unpredictable wind energy without compromising the security of supply. The new materiality of wind power can lead to times of excess electricity, i.e. when the production is greater than the demand. In these situations, stability of the grid is harmed (Lund, 2014). A solution to address this problem is to build more interconnectors capacity in order to export excess electricity from wind power when needed. Interconnectors have several positive effects:

- They contribute to a higher security of supply; a deficit in one area can be supplied by a neighbouring area (DEA, 2012)
- They can contribute to the integration of renewables; in times of high wind and low demand, the fluctuations of electricity from wind power can be exported (instead of stopping the turbines to operate).
- They enhance the power market competitiveness; they transport electricity from a low price area to a high price area, and through the merit order effect alleviate competition (Biggar et. al, 2014).

Energinet.dk and the EU are willing to develop this solution for the future of the European power market; they are willing to build more interconnectors so to deal with the increasing amount of renewable energy (Safarkhanlou et. al, 2009; Losch et. al, 2016). In the Energy Winter Package, a set of legislative proposals from the European Commission established in December 2016, it is clearly stated that the new market will be characterised by "*an increased interdependence between systems cross-border*", and will establish "*prohibition for TSOs to limit the volume of interconnection capacity to be allocated*" (Losch et. al, 2016). The Winter Package is analysed further in section 5.1.1.

Nevertheless, as the neighbouring countries are also integrating more wind power in their own energy systems, and as wind dynamics are wider than a country scale, it can lead to times of similar peak production, weakening the possibility to export electricity (Hvelplund et. al, 2013).

ENTSO-e is the European network of transmission system operators for electricity. It gathers information from the different member states and shares production data; it is hence possible to download data about the European wind fleet output in MW. A study made by Erland Christensen (2016) shows that, when adding the outputs from neighbouring countries such as France, Denmark, Poland and the Netherlands, these countries have the same peaks and low wind capacity production. This is illustrated in the following figure 15:

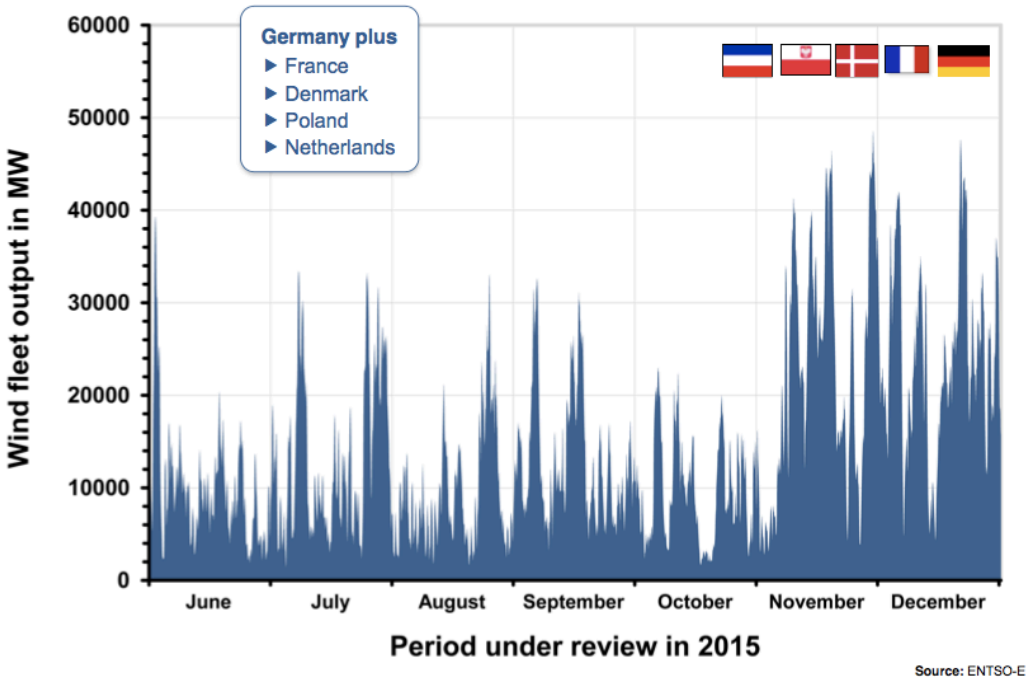

Figure 15: *Wind fleet output in MW of Germany, France, Denmark, Poland and the Netherlands in 2015. Source: Christensen (2016)*

The direct correlation is that when wind is blowing in Denmark, it is also blowing in the neighbouring countries. As the countries from the EU are to install more wind capacity generation, times of peaks and low wind outputs in MW will increase in the near future. Therefore, as also conclude by Erland Christensen (2016), building interconnectors will not solve the issues of peaks and low wind power production alone, and there is a need to react within few years to ensure security of supply across Europe.

Thus, Denmark cannot govern its energy system in a vacuum but rather has to take into account the European grid when steering the development of its own energy system. If interconnectors are a necessity for the Danish wind power agencement to function, it is not of an absolute solution to solve problems of fluctuating energy production. Lund (2014) rather argues that there is a need for a holistic perspective for the future of the Danish energy system. He argues that there is a need to establish a *Smart Energy System* approach, where the different sub-systems (i.e. cooling, heating, transport) are connected to each other in order to create flexibility within the energy system and not from the outside.

4.4. Summary

In the previous sections it has been shown how, from a vision carried by communities and local actors, the energy agencement in Denmark has shifted from a planned trajectory heading for nuclear power towards

the wind power development known today. The establishment of wind power has been of a co-shaping of the agencies; the Government, embedded in a paradigm of nuclear power as being the "normal" solution, did not consider other alternatives. Communities, in reaction to the trajectory designed by the Government, have conceived another possible future and have created awareness of another vision; by making wind power a visible alternative in the agencement, they created room for another solution to exist.

The vision was enacted when the turbines were firstly connected to the grid. This has shaped the governance agency which has had to create a set of regulations to allow the wind turbines' existence. Also, other adjustments within the agencement occurred, such as the emergence of OOA against nuclear, their recognition, and later the generation of jobs and incomes from wind power. The evolution of the agencement has hence been of a differential transformation of the agencies, evolving together through time and in reaction to new configurations.

Benefitting from high local acceptance, wind turbines have since then been in the making. Their expanding development has created a new materiality of the technology; wind turbines have evolved from an innocent technology not perturbing the agencement's configuration, to a new technology that has grown in size and number, thus provoking greater visual impacts, together with new economic challenges, new challenges for the power market, and new challenges for the grid too.

Wind turbines are a new actor in the configuration, and are having new repercussions for the current Danish wind power STA agencement. These consequences for the different actors are untangled in the next sections.

5. Untangling the current configuration of the Danish socio-technical wind power agencement: where are we?

Along these sections, the second research question is being answered. Together with the perceptions and views of the interviewees, the current status of the Danish wind power agencement is analysed. First, the recent and current governance of the Danish wind power STA are investigated. Second, different factors contributing in a decline in public participation of wind power are identified. Third, overflows where no closures have been found yet are put into perspectives with the views of the different actors interviewed.

5.1. Wind power governance at the supra and national level

5.1.1. Danish wind power under the dome of the EU

It has been seen in chapter 3 that governance occurs at different levels and that Denmark is governing under the influence of the EU's regulations. The EU is an important actor concerning environmental policies; it governs at a supranational and intergovernmental level of decision making. Mitigating climate change is one of the top priorities of EU's environmental policies. The EU has a target of keeping the global temperature below a raise of 2°C, and therefore has established climate goals for its member countries (Europa.eu, 2016); by 2050, 80-95% of the CO2 emissions from the member states should be cut compared to the 1990 levels. With this goal, the EU also aims to "*strengthen Europe's competitiveness*" (Europa.eu, 2017). In total, the European Union has developed over 500 directives and regulations concerning environmental policy for the member states (Farmer, 2012).

More recently in December 2016, the EU has launched the Energy Winter Package, consisting of new legislations, documents, measures aiming at reinforcing and standardising the EU's energy market (Losch et. al, 2016). One of the key goals of the package is to establish a common power market across the Union. In order to do so, the EU wants, as already mention under section 4.3.3, to "*increase interdependence between systems cross-border"*, which means to expand the European market for trading electricity across nations. The regulations prohibit TSOs to limit their interconnections capacity to neighbouring countries and ensure power market competition cross-countries with tendering processes. At the same time, the package advocates for "*opportunities for consumers to participate in the market*" (Losch et. al, 2016). Overall, the EU is leading its member states towards tendering models and greater competition but also wants to leave opportunities for smaller actors to be in the making.

The three interviewees from Nordic Folkecenter (NFC), Karl Vogt Nielsen, Jens Peter Hansen, Kim Pind Jensen, Thomas Holst, all acknowledge that the EU is a strong actor and that the Danish Government has to comply with the EU's rules and regulations. In the first interview at NFC, Henning Bo

Madsen explains that the 21st of February 2018 the current subsidy scheme for onshore wind turbines will stop and that therefore, the Energy Winter Package will influence the decision to be taken by the Government:

> *There is a discussion between the different stakeholders and the politicians to decide what support scheme should be chosen, but they have to comply with the EU directives*. (01.20.35, Interview 1)

When asked why the EU wants to strengthen EU's competitiveness through interconnectors and through the tendering model, Leire Gorroño explains:

> *What they are saying is that, in that way, the competition is higher so the prices of subsidies will be lower*. (0.07.20, interview 2)

According to Karl Vogt Nielsen, the EU is only thinking in terms of cables and interconnectors. He mentions one of the new materiality challenges of wind power analysed in the previous section 4.3.3:

> *The EU wants one big grid because of companies, of trades… There is a lot of money to make when selling electricity. But of course, when the wind is blowing in Denmark it is also blowing in Germany and Sweden, and that is a problem*. (00.55.20)

According to him, building only interconnectors is an end-of-pipe solution; it will lower even more the price of electricity due to peak production hours, whereas excess wind production could be used locally in a Smart Energy System as argued by Lund (2014).

So, the will from the EU to lead its member states, thus Denmark, towards a tendering model and an increased competition is well identified by the different interviewees. Nevertheless as previously mentioned, the Winter Package also opens the possibility for consumers to participate in the power market through auto-production (Losch et. al, 2016). Henning Bo Madsen, who assisted at the conference at Christiansborg with Leire Gorroño the 21st February 2017, explains:

> *They are for the tendering, but everything below 18MW or 6 wind mills will be allowed to be without tendering. So they are open to small projects but the tendency is for tendering in the future. (*01.22.03, interview 1)

If it is recognised by the interviewees that the new directives allow consumers to be in the making, their point of views concerning how and why it will be implemented are divergent. According to Karl Vogt Nielsen, the EU is not interested into small projects. He explains:

> *EU is only for big companies and liberalisation, (...) they only focus on that. In the Winter Package, how much is headlines and how much is real, it is hard to see, only time will tell*. (00.53.23)

On that particular point, Thomas Holst has a different perception. He explains that competition is needed if the EU is to reach ambitious climate goals. He explains the motive for the tendering process as following:

> *They have seen how large scale we were talking. If you look at Germany's power plant and look at*

how many wind turbines you need to replace the capacity, it can be difficult to find enough small communities to put that capacity up. You need very large investors, and I think that is one of the reasons why they have been doing so. They have seen that it was a very huge task. (00.32.06)

In his opinion, the EU is trying to make sure that small actors such as communities could still get involved, but that most of the projects will have to be coming from big investors.

Thus, the EU is steering the Danish wind power agencement with high goals of RES production. The institution is providing actors with large resources a greater capacity to act within the arrangement by promoting competition and large scale power market; regulations and directives for increasing the exchange of electricity cross-borders and for increasing the competition through tendering process are established. Nonetheless, the institution does not aim at phasing out communities and other actors with modest means, as it also opens specific regulations for small scale wind projects.

It can here be seen that the climate goals and the EU's governance are new actors in the agencement of the Danish wind power. In the 1980s, the EU was not an actor influencing the energy system of its members' states. Today, its governance influences greatly the making of the actors in Denmark. Also in the beginning of the wind power STA, there was no climate goals and today, the ambitious targets are steering the agencement towards an increasing efficiency. These two new actors are participating in the transformation of the Danish wind power socio-technical agencement, for which the governance at the national level is being analysed in the following sections.

5.1.2. Wind power governance within Denmark

5.1.2.1. Governance and valuation devices

It has been seen in section 4.3.1. the growth of wind power installations in Denmark from 1980s until today, and it has been observed that the development has not been of a regular planning but rather of a discontinuous trajectory. According to Karnøe (et. al, 2016), these shifts in growth rates are directly linked to governmental shifts. He argues that the different Danish Governments have influenced the configuration of the agencement; social-democratic coalitions have supported wind power, whereas centre-right governments have stopped or reduced the developments. These correlations are illustrated in the following figure:

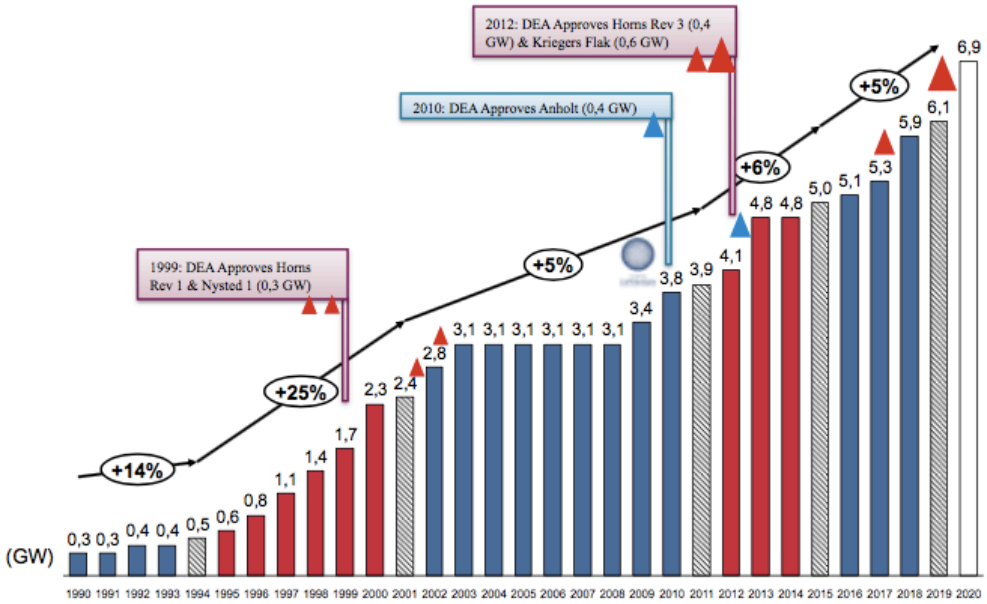

***Figure 16**: The increased installation of wind power in Denmark (1990–2015) and projected installations (2016–2020). The blue and red bar colours indicate respectively a centre-right and a social democratic government in office. Source: Karnøe (et. al, 2016).*

The two competing parties have influenced the configuration of the agencement and steered the development of the technology in opposite directions. One agency (i.e. centre-right) has pressured the configuration of the network towards continuity of the system, whereas the other one (i.e. social democrats) has pressured for a sustainable transition with wind power development. The two political agencies have assigned to wind power a different value, using different calculative devices, and have used it to legitimate their actions (Karnøe et. al, 2016). From this, it can greatly be observed the importance of the governance agencies' framings for the development of wind power in Denmark.

In the following sections, two specifics tools used to steer the agencement by the Governments are under analysis: first, the Local Government Reform (2007) is under inquiry, second, the Promotion of Renewable Energy Act (2009) is analysed. Thirdly, the mismatch between these regulations and the current context are depicted by the interviewees.

5.1.2.2. Governance reform to cope with the new materiality of wind turbines

Whilst under a centre-right office in 2007, the Government established the *Local Government Reform*. The aim of the reform was to strengthen the public service by decentralising tasks and by empowering the municipalities with more responsibilities. It created a new map of Denmark, turning the number of municipalities from 271 to solely 98. At the same time, as wind power has local implementation impacts, municipalities have been granted the new task of selecting wind turbines sites and of approving, or not, the

development of wind power projects (Indenrigs- og Sundhedsministeriet, 2006). The governmental reform has thus granted to municipalities a new significant role in regards to wind power development.

This reform has been emphasised by many of the interviewees as being highly influential for the wind power development. According to the three interviewees from Nordic Folkecenter, as well as Karl Vogt Nielsen and Jens Peter Hansen, this reform has modified the dynamics of the local implementation of wind power. Jane Kruse (2017) explains:

> *What has totally changed is the planning system. (...) The municipality started to point out which spots should be allowed to have windmills, and then investors would come and talk to the farmers. After this new planning, we have never ever known what the price for the land was again*. (00.28.31)

She explains that it opened up debates about how the wind turbines should be placed on land, whether if it was better to have a concentration of few wind turbines in some areas, or if it should be an alignment of turbines, or if it should rather be big parks in order to limit the visual impacts, and so one. As seen in section 4.1.4, public planning is a decisive factor in regards to public acceptation of the technology. Also, the repercussions on the valuation of property began to be an issue for residents. Overall, the important materiality of the turbines in the landscape started to be a problem and topic of debate at the local level.

Moreover, according to the interviewees from Nordic Folkecenter, money has never been a motive for communities to invest in wind power in the early stage of development. Nonetheless they explain that after the planning processes, farmers and companies realised the quality of the business case. Leire Gorroño explains that "*New players came into the market*" (00.37.19, interview 1), and Jane Kruse agrees that it has created new tensions among actors and has increased the opacity of the market. She adds on:

> *With the planning, the social balance started to change. (...) People protested against the wind mills because they were getting no common goods from it.* (00.40.35)

So according to her, the fact that cooperatives and citizens did not get benefits from the wind projects anymore raised contestations, as also acknowledged by the different scholars in section 4.1.5. She explains that since then, some municipalities like Thisted have never implemented wind turbines again because of the too important public protests.

According to Jens Peter Hansen, the fact that new actors came into the market was nonetheless not solely due to the reform. He explains.

> *The reform from 2008 is part of what has changed the whole dynamics about onshore wind turbines. Also the technology development has changed something. The turbines are bigger than before and therefore more expensive. In the good old days, maybe with 1-2 million DKK one would be able to invest in a wind turbine, and now it is maybe 20 times more expensive, so you need to be more professional to start on a project like this than before.* (00.36.15)

As seen in the previous analysis section 4.3.1., he argues that the new materiality of the technology is a

factor that has changed the situation; bigger and more expensive, investing in the technology requires greater financial resources. This is related to the sayings from Thomas Holst, whom explained that the costs and the significance of the energy transition are leading to a need for bigger actors at the European level.

It can thus be greatly observed from these statements that the new materiality of wind power has largely influenced the overall configuration of the Danish wind power STA, and so from different aspects:

- First, it is now the municipalities that have governance over wind turbines implementation. Also, the importance of the turbines onshore has led to new debates about how should the turbines be placed.
- Second, financial interest has appeared as a new motive within the field, occulting the deals between project developers and land owners.
- Third, the new investment costs of the turbines have changed which actors are actually able to invest in the technology.

Municipalities, financial interest, and higher investment costs are three new actors of the wind power socio-technical agencement. These new actors together have led to the co-creation of another one: public resistance. Communities did not have as much room in the configuration, they could not participate in wind power projects as they used to do. Their capacity to act has been reduced, which has changed their perception of the technology, generating this resistance.

5.1.2.3. The Government's reaction: The Renewable Energy Act and the replacement of community engagement

The agencement was at that time in a configuration leading to an increase of public resistance and to local protests against wind power. As a response, the Government established in 2009 the Promotion of Renewable Energy Act (Folketinget, 2008). The attempt was to decrease social resistance by enhancing the conditions for onshore wind turbines and by re-establishing citizens' ownership. The reform was aiming inter alia at:

- Promoting RES and reducing CO2 emissions
- Ensuring the fulfilment of the national climate goals
- Promoting wind turbines expansion.

The Act contained provisions implementing parts of European directives. Therefore, already in 2007 the governance of the Danish wind power agencement was framed by the European governance and goals (Folketinget, 2008). For the last point, for promoting wind turbines expansion, the Government set up the following new regulations:

- Compensation for loss of value to real property due to the erection of wind turbines (§6)

- Obligation on all new wind energy projects to offer minimum 20% ownership to local residents in a radius of 4.5km to the turbines (§13-§17)
- A guarantee fund to support the financing of preliminary investigations by local wind associations. (§21)

By doing so, the governance shifted the configuration of the agencement in a way which has granted more room for communities and local residents to be in the making. By "re-attaching" them in the current configuration, the Government alleviated the situation and enhanced public acceptation of the technology. In regards to the first new regulation, Helge Christiansen from Nørrekære Enge community explains:

> *The law of the 20% was made because the Government wanted the locals to accept the wind mills. The problem is that people didn't accept the wind mills anymore, and they protested if some were planned to be built in their neighbourhood. That leads the municipalities to refuse the projects. But if the locals get a share, then they think that it is a good idea and accept it better*. (00.26.50)

It has permit single-person ownership in large energy company wind projects since then. Nevertheless, some actors are not convinced on the quality of this new regulation. When asked about his perception of the tool, Hans Chr. Sørensen, board member of DWTOA, explains:

> *I think we should increase the 20%. People are saying that it is only a good excuse to bride people to accept wind projects. The Government proposed 20%, but nobody tried 30%*. (00.14.46)

He considers that the 20% are not high enough, but also that it is a figure without concrete bond to reality nor justification. Also, according to the DWTOA, this law has replaced the creation of cooperatives for local participation (DWTOA, 2017). Jane Kruse also explains:

> *Since the reform, people buy private shares. It is very different than the notion of common shares.* (00.50.22)

According to her and the DWTOA, the new regulation has not permitted to re-established the same dynamic as the one previously existing. She also explains that if people are against the location or against the wind power project in general, then there will be no reason for them to invest in the 20% and that therefore, it is mainly people who already have a positive perception of wind power that will invest in it. Henning Bo Madsen shares this perception, and also underlines a problem of definition between private ownership and community ownership. He tells:

> *In the new directives, citizen ownership is considered as community ownership. So we have a single household with solar cells, and it is considered as a community.* (00.01.50, interview 2)

The three interviewees are thus sharing the perception that the new configuration with the 20% has changed the dynamic of the citizen's ownership; it has transformed ownership from collective to private. The evolution of the ownership form has been of a co-shaping from the governance agencies, the public resistance, and the communities through time.

For many of the interviewees, public ownership remains an important criterion to establish acceptation of wind power among society, like seen in section 4.1.5. What remains non-agreed among the interviewees, however, is in how should the public participation be. The different points of views are analysed in section 5.3.1.

5.1.3. Summary

Governing for sustainable transition is of a multi-level approach. It is clear that Denmark cannot govern for its energy transition without taking into account the neighbouring countries' production capacities nor the regulations from the European Union.

The Winter Package launched in December 2016 is influencing the conditions for the actors of the Danish wind power agencement to operate. Because of the significance of the climate goals and the will of decreasing the energy transition costs, a large competition between the actors is engaged. The ambitious climate goals are creating a need for actors with great means and thus, the regulations are building up space for these actors to be in the making. At the same time, the regulations are leaving room in the agencement for communities and smaller actors to participate in modest projects. In Denmark, these European directives are leading towards the establishment of a tendering scheme for onshore wind power projects, except if the project is less than 18MW.

Furthermore, the governance processes at the national level are also highly influencing the development of wind power. According to the value granted to wind power by the different political parties, the politicians have steered the configuration towards continuity or towards a sustainable transformation. Due to pressures from the expanding materiality of wind power and its impacts, the Government has granted municipalities the responsibility to locate potential wind power projects sites, hence granting them governance over the realisation of wind projects. The new financial motive from energy companies together with the new costs of the turbines and the new climate goals have shifted which actors are actually able to enact wind power projects; it has increased the room for companies with greater resources while at the same time decreased the capacity to act from communities. This has led to a reduction of public acceptance.

To adjust to the new configurations, the Government established the Renewable Energy Act in 2009 which stipulates, among other regulations, a new obligation on all new wind energy projects to offer minimum 20% ownership to local residents. From the interviewees, it seems that this regulation has not permit to re-establish the same dynamic as before due to the fact that it has shifted the ownership from being collective to being private.

In the following sections, identified overflows due to the new configuration of the agencement are analysed.

5.2. Identified overflows participating into the creation of a new agency: public resistance of wind power

In the previous sections, it has been seen that the evolution of the materiality of wind turbines together with governance processes have led to an increase in public resistance. In the following sections, it will be seen that the decline in public acceptance is also due to other factors than governance. At first, the consequences from the low price of electricity for the actors of the agencement are analysed. Second, the importance of the Health Report launched by the Government is investigated. Finally, the role of the medias and of the communication between different actors of the network are examined.

5.2.1. First overflow: the low price of electricity

In section 4.3.2., it has been seen that the price of electricity has fundamentally dropped in the last couple of years. Besides in section 5.1.2.3, it has been seen that the Danish Government attempted to alleviate public acceptance of wind power through the Promotion of Renewable Energy Act in 2009, which offered a minimum of 20% ownership to local residents (EIA, 2014). The 20% rule has been established in 2009 and today, eight years later in 2017, it is still applied in the agencement. Even if many citizens have been – and still are – able to enjoy benefits of this regulation, all the interviewees in this research are agreeing that the 20% shares are not functioning anymore; the shares are not getting filled up. Jens Peter Hansen explains:

> *It used to be quite a good business, but now because of the low price of electricity we need more time before having return on investment. That makes people think twice before investing in wind turbines. (00.19.40)*

Karl Vogt Nielsen himself has shares in wind projects and relates the same issue:

> *The problem is that today the electricity prices are really low, so the interest is not as big as before… I have shares in different parks, and the incomes are decreasing year per year* (00.13.54)

Arne Rhabek agrees with that there is a decreased interest in public ownership and tells that indeed nowadays, Vattenfall as well as their competitors, are not having the 20% of shares getting filled up. He explains that it is due to the same reasons mentioned by Jens Peter Hansen and Karl Vogt Nielsen, i.e. the low price of electricity which is leading to higher risks in investments and therefore are decreasing the public interest. Nonetheless, he questions:

> *But if we think it is a good business, why people shouldn't think the same?* (00.08.30)

Helge Christiansen tells another consequence of this low price in regard to the development of their community owned wind project. He relates:

> *The problem is to make an appointment with the bank, because the price of electricity is very low. Three years ago, it was easier to make these appointments. (00.40.00)*

These two statements clearly show that the low price of electricity is a real problem for actors with small resources whereas, for actors with greater financial resources, it has no major consequences for their business case.

Hence, the low price of electricity is an overflow due to the new materiality of wind power which generates two market failures:

- First, it decreases the public interest; the higher investment' risks and prolonged payback time are shifting the public's interest in investing in wind power.
- Second, it creates issues for communities to develop wind projects; the higher investment risk reduces the possibility for communities to loan from the bank.

As seen in section 4.1.5., public ownership is a prerequisite for wind power acceptance. Here, the mentioned factors appear to be participating in decreasing the possibility of citizens' ownership, whilst at the same time not influencing the business model of the bigger actors. The overflows generated by the new price of electricity is hence not having the same impacts for the different actors of the agencement. Hence, it participates in the creation of a new agency: public resistance.

5.2.2. Second overflow: The Health Report and the lack of stabilised knowledge

Many of the interviewees have mentioned the importance of another factor concerning the recent interruptions in the wind power development in Denmark. In 2013, the Ministry of Environment, the Ministry of Health and Climate, Energy and Building have gathered to fund a study concerning the possible correlation between wind turbine noise and cancer (Vindinfo, 2013). The study has been launched to clarify health uncertainties and some concerns carried by the wind turbines neighbours. At present, there are no studies on the correlation between wind turbine noise and cardiovascular disorders, and as explained in section 4.1.3, there has been no consistency in the results from studies investigating correlations between noise and sleep disorder or stress factors.

The study was launched in 2013 and was expected to be completed in a two years' time, it is to say it was expected to be published in 2015 (Vindinfo, 2013). Four years later in 2017, the study has still not been released. Arne Rhabek tells:

> *The future of wind power in Denmark is really depending on for example the investigation on the health issue. It should have been delivered some time ago but it has been delayed. We hope that it will be released before summer because that will of course help us. Hopefully then, the municipalities will be aware that it will not be an issue for their residents.* (00.06.36)

He thus explains that the future of wind power implementation is highly relying on the results of this research, and also seems optimistic on the outcome. According to him, the eventually positive results from

the research will create awareness among municipalities and alleviate the perception for wind power in Denmark. It will ameliorate the arrangement of the agencies by making visible that turbines are not an issue for citizens' health.

Henning Bo Madsen also mentions the Health Report as a brake for wind power implementation in Denmark. Nonetheless according to him, it is not necessarily due to a lack of awareness, but rather due to the fact that municipalities are using the Report as an argument to stop wind planning. He tells:

> *I think it is important to mention that we have a big group of municipalities that are saying "we will postpone every decision until the survey of the Health Risk of Wind Noise is finished". (...) The point is that this research is used by the municipalities to say "we stop planning wind power", even though the government of that time said that it should not stop the municipalities for going on with the planning*. (00.58.14)

Indeed, in 2013 the Ministry of Environment and Climate, Energy and Building stated that the study should not be used as an argument to stop the planning for wind turbines as in 2012, so a year before the launch of the study, a broad agreement until 2020 was adopted in the Parliament (Vindinfo, 2013). Nonetheless, Thomas Holst, Jens Peter Hansen, Kim Pind Jensen, Arne Rhabek and the three interviewees from Nordic Folkecenter, all agree that many municipalities are using it as an argument to stop wind planning. Jens Peter Hansen explains that if the municipalities are doing so, it is because of the public opinion. He tells:

> *Yes, municipalities are waiting for this Health Report before doing wind planning. But the reason why people are afraid is because of these stories about low frequency sounds and all that kind of things. But it is impossible to find valid research supporting these allegations. But normal citizens that do not have time to check the sources get scared of these news. Politicians are afraid to lose votes, so maybe two or three people make protests, and that is enough for municipalities to stop their projects. (00.13.36)*

He relates that it is by fear of losing votes that municipalities are stopping their projects. The relation between the medias and the votes to the development of wind power are analysed further in respectively section 5.2.3.1 and section 5.2.4. Nonetheless, what is noticeable is the fear generated by the lack of stabilised knowledge as the Report is remaining unpublished. Thomas Holst also relates:

> *We have farmers who are nervous of getting turbines too close to their farms, and others that want the wind turbines. The farmers are afraid that their cows won't be able to breed as good if there is a wind turbine nearby, but there is no proof of that effect. We have no experiences showing this, but it is there. He (i.e. a farmer who called two days before) heard it, and now it is too late.* (00.12.39)

In his point of view, the Report creates rumours on the effects of wind turbines and influences the public perception, and as seen in section 4.1.3., he mentions that there is no evidence on such health correlation.

Kristian Borch explains that the Report creates non-stabilised knowledge and that, therefore, it is a source of overflows and creation of different realities of the actual situation. He explains:

> *It is very important to be where the dialogue is, and they (i.e. wind developers and municipalities) are not. That is a very clear explanation why fake news have so much importance. It is very easy to say that wind turbines make you sick, but why is that? It is because there is no answer. Scientist don't give answers; authorities don't give answers.* (00.31.58)

The Report is an element part of the agencement having a strong influence for its configuration; it is precisely because it is not published yet that it creates overflows:

- Even if its purpose is to create awareness, it rather hinders awareness creation on wind turbines for both citizens and municipalities as it has still not been published and leaves open room for non-stabilised knowledge.
- The lack of awareness among citizens makes municipalities scared of losing voters.
- It creates an argument for municipalities that are not in favour of wind to stop wind planning.

By being delayed in its publication, the Report hinders closure on the actual situation and leads to reinforcing the public resistance towards wind power. The lack of stabilised knowledge renders the market inefficient and hinders the making of wind turbines. The agencement distributes the actions; here it is greatly seen that the configuration is not meeting the necessary configurations for wind power developers to be able to implement projects. The lack of stabilised knowledge does not permit the wind turbines to fulfil its purpose of generation of electricity. In the next section, the specifics overflows related to communication, and particularly in relation to the medias, are investigated.

5.2.3. Third overflow: medias, communication and awareness

5.2.3.1. Media and public discourse

In the precedent section, it has been mentioned the importance of the medias concerning awareness of the Health Report. In this section, issues related to the medias and to communication in general are investigated.

An article published the 28th of March 2017 in Altinget.dk stated: "*Fake news and election campaign obstruct wind turbines development*" (Lyall, 2017), or again the 20th of April: "*Wind turbines: False news influencing the debate"* (Kjær et. al, 2017). In the later one, the directors of the DWTOA and of the Danish Wind Turbines Industry explain:

> "*The windmill debate in Denmark is characterized by a lot of false information. It is a major democratic problem, and municipal politicians should be more critical of wind turbine critics."* (Kjær et. al, 2017)

In these articles, the journalists relate examples of fake news about wind turbines and property devaluation,

noise pollution, health impacts, and so one. They explain that the significance of the misinformation is big – and increasing – and that it influences greatly the debates at the local level. As seen in section 5.1.2.3., it is since 2009 the responsibility of the municipalities to valid wind power projects. According to these articles, the misinformation is used by municipalities as arguments to stop wind power planning. This is an issue that the journalist Sanne Wittrup has also analysed. In an article posted in ing.dk, she explains that politicians and citizens have engaged a battle against wind turbines in which facts do not count (Wittrup, 2017). She relates other examples and shows how different post-factual facts are used by politicians to depict a negative image of wind power. This is a perception shared by many of the interviewees. Arne Rhabek explains:

> *I think the media have a role to play. They don't tell facts but feelings, because that makes good stories. Some things that have been said as facts are not documented in no ways and that is a big problem, especially when it comes to low frequency noise.* (00.11.01)

Also in these three articles mentioned, the journalists relate that actually, the resistance towards wind turbines groups only a minority of people, but a minority with a stronger voice in the medias (Wittrup, 2017; Kjær, 2017; Lyall, 2017). This viewpoint is also perceived by Hans Chr. Sørensen, Kristian Borch, Jens Peter Hansen, Kim Pind Jensen, Karl Vogt Nielsen and Kristian Borch. Hans Chr. Sørensen explains:

> *Only few people are shouting out about all kind of risks from turbines, non-documented too, and politicians are getting nervous. The people who are in favour of wind projects don't shout as loudly as people who are against. And the press has a tendency to refer only to the people who are against wind.* (00.20.00)

For the purpose of his research, Kristian Borch explains that he has been confronted with the same problem: he could only find the cases with local resistance and not the successful cases. He relates:

> *Klim (i.e. wind farm) was not on our map because it was a success, and that is a problem. We are only looking at projects with problems, and not the one that are a success. That is a problem in the media.* (00.12.19)

Thomas Holst explains that the discourse of the media has shifted and that today, the press is emphasising the negative aspect of wind projects without telling both sides of the story.

> *I think that there will always people who don't like wind mills, but they have gotten more voice than 10 years ago. The press likes to find these conflicts. Now, it is really a conflict between the big companies and the little men, and it is a good story for the newspapers. They are using that instead of telling the good story of what is happening. (00.07.20)*

Hence, it seems that the medias are a new important agency steering the public discourse and hindering the creation of stabilised knowledge which then, creates overflows and has repercussions on other actors of the agencement:

- Firstly, medias are using fake news concerning impacts of wind turbines.
- Second, medias are relating most of the time only one side of the story – and not the positive one.

Therefore, the medias are not participating in the making of wind power and rather hinder possible closure by framing the debates with erroneous facts, participating in reinforcing public resistance.

5.2.3.2. Communication between the actors

It is often said that resistance towards wind power is due to the NIMBYism effect, which is increased by the new size of the turbines. Kristian Borch, project manager of the multidisciplinary study on local acceptance and development of wind power projects Wind2050, explains:

> *NIMBYism is one theory; it explains some of it but not everything. If communication is based on the idea that NIMYism is driving people, then it leads to miscommunication, immediately*. (00.06.25)

Rather, he argues such as in section 4.1.2. that the U-shape is more likely to explain the reasons of local contestation towards wind turbines, and explains that only thorough examinations of each cases can permit to understand the reasons of local resistance. He argues that one of the main reasons is the lack of communication between project developers and citizens, which is also acknowledged by many of the interviewees. In relation to the Health Report, Kim Pind Jensen relates:

> *I think us, and supplier of wind power, should be better at communicating message, what is scientifically proved and not. That is the background of this Health Report. (00.26.00)*

Hans Christian Sørensen perceives as well a lack of communication between project developers and citizens, and explains:

> *There is a need to build projects with very upfront local communication. If there is no local backing group to work with you, then people showing up at meetings have a negative opinion towards the project. It is a basic communication tool*. (00.30.13)

During the interview, Kirstian Borch explains that not only communication, but dialogue and cooperation are necessary so to succeed in the establishment of wind power projects. He explains that the social medias are a tool under-used by project developers and that it is creating a huge imbalance in the public discourse. He explains:

> *The social media are really important; the municipalities and developers are not on the social medias, but the opponents are. So there is a new technology that they are missing out on. And that is an explanation on why these projects don't go through.* (00.30.30)

He relates the success of a specific wind developers:

> *JyskVindEnergi is very good at being in close contact with the locals, at understanding what are the concerns of the locals. They offer to the public not what the company think they want, but what*

they told them they want. (00.48 .20)

It is therefore an appropriate and contextualised communication that Kristian Borch argues for.

During the interview, Arne Rhabek is asked if a better collaboration with the residents from Tønder would have change the decision from the municipality. He answers:

> *This is not the issue, because we have made a lot of cooperation with the locals, and there has been a lot of support locally for this project. But of course there is always someone that is against it.* (00.03.35)

When asked where he thinks that the discrepancy between this discourse and the one from Tønder municipality comes from, Kristian Borch answers:

> *Vattenfall is doing their best, with the competencies they have. (…) Vattenfall is using a model that does not fit, and they know that now.* (00.26.23)

The problem hence comes from the framing of the developers: if they do take account in their framing communication with the local population, they do not have the appropriate calculative devices to establish appropriate dialogue.

Thus, the results indicate that the actors have identified the communication between project developers and citizens as a source of overflows reinforcing the public resistance. There is an identified need for developers to take into their valuation frameworks the dialogue with the public in a new and more appropriate manner. New tools and new methods such as the social medias appear to be needed so to be successful in wind project implementation.

5.2.4. Fourth identified overflow: the upcoming elections

Nine of the interviewees (i.e. Jane Kruse, Leire Gorroño, Henning Bo Madsen, Arne Rhabek, Thomas Holst, Jens Peter Hansen, Kim Pind Jensen, Hans Chr. Sørensen and Kristian Borch) pointed out the strong importance of the coming elections in November 2017 regarding the development of wind power in Denmark. Leire Gorroño explains:

> *The expectation is that it will create local protests, conflicts, contests and so on and they don't want to create this kind of atmosphere before the elections.* (01.00.40, interview 2)

Thomas Holst shares this perception and tells:

> *I think that it is very important to remember that there are elections in November, and politicians are afraid of taking unpopular decisions and therefore, not getting elected.* (00.36.34)

Or again Jens Peter Hansen to tell:

> *I think the interest and attitude (i.e. towards wind power) is still about the same as before, but I*

think because we will have an election in autumn, politicians are more nervous than they were one or two years ago. (00.16.00)

As previously mention in a two weeks' time, Tønder and Esbjerg municipalities have dropped their wind power development (Pedersen, 2017 A). Esbjerg was supposed to implement 18 wind turbines and Tønder 29 (3.5MW) in collaboration with Vattenfall, this for a total of 1.2 billion DKK. Arne Rhabek explains that the company did not understand what has happened. He relates:

In the process, the technical and environment groups said "Yes, you can continue". Also, which is very very important, the economy group in the municipality has approved to continue. And also, the administration in the municipality had say yes, and that is why it is very strange that it ended up with this result. (00.04.31)

He explains that there was no sign for such an interruption, as the day before the vote the municipality was still positive on continuing the Environmental Impact Assessment of the project. Nonetheless, he clearly sees the election as the main reason of this negative vote. He explains:

The main reason why these projects are not going through is because there will be an election this year in November 2017, and therefore the municipalities want to avoid to keep these projects. We have seen that before. When it comes close to an election, we can see that it happens more often. Maybe we should have prepared differently to avoid to do a proposal at this time of the year. (00.05.23)

If Kim Pind Jensen agrees that the upcoming elections are a barrier for the development of wind projects in Denmark, he nonetheless advocates for flexibility on the situations. He explains:

This year is election years, so municipalities are afraid to say their opinions out loud. In Copenhagen, it would be the other way around. (00.56.03)

He explains that in Copenhagen municipalities the polls for wind power are very positive and that therefore, the elections have a different effect as politicians are pushed to developed wind projects. This also refers to section 4.1.2. which has underlined that politicians rely on polls to make decisions, even though polls do not provide complete pictures of the public opinion and can sometimes mislead them.

Thus, because the political agency is undergoing a situation of change due to the upcoming elections, politicians rather be motionless than to act in order to keep their votes, even if high costs are a stakes for the wind developers. As other overflows have led, and are leading, to more contests and a decrease in public acceptation of wind power, politicians are perceiving wind power implementation as a brake towards their re-elections and therefore, rather not take risks of being phased-out from the political agency.

5.2.5. Summary and reflections

Along these sections, four major overflows have been identified. First, the low price of electricity has been identified as having different repercussions on the actors of the agencement; whilst the business case remains unchanged for actors with great means, it considerably reduces possibilities for actors with modest means to be in the making. For individuals, the new materiality of wind power makes it less interesting to invest in shares. Public participation is a prerequisite for wind power acceptance, hence the low price of electricity is participating to an increase in public resistance.

Second, the Health Report is an element that aimed at creating closure on the relationship between cancer and wind turbine noise. Nevertheless, because the launch of the Report has been delayed, it has left room for non-stabilised knowledge, generating "fake news" used by the medias and shaping a false awareness of the outcomes of wind power noise. It influences the municipalities which become afraid of losing voters; the whole configuration leads to a halt in wind power establishment and an increase in public resistance.

Third, the role of the medias and of communication between the actors are identified as a source of overflows. The medias, by using post-factual facts and telling mostly one side of the story, are hindering public awareness of the situation. Also, the social media have taken a new importance in the public debate, and it seems that wind developers and municipalities are not using this tool to communicate with citizens, which therefore gives supplementary voices to opponents to wind projects.

Fourth, the upcoming elections in November 2017 are recognised as being an overflow leading to a halt of wind power planning from the municipalities; politicians rather *not* be in the making whilst the elections are on-going, as they are afraid that a decision could lead them to loose votes, and therefore they could end up phased-out of the governance agency.

The four overflows identified are generated by the new materiality of wind power, and are all co-contributing to the establishment of a new agency: *social resistance*. The social resistance has always existed but currently, as a result of the configuration of the agencies, the agency is "fed" by a multiplicity of overflows and hence, becomes stronger and bigger in the agencement. Therefore, it weakens the Danish wind power agencement which leads to interruptions in wind power project implementations.

In the following sections, unidentified sources of overflows are under analysis.

5.3. Hot momentums and disagreements

In the previous sections, overflows identified by the actors of the Danish socio-technical agencement have been analysed. In the following sections, overflows where sources have not been identified are investigated. First, the consequences of the Government reform of 2009 are investigated. Second, the consequences of the establishment of the tendering process are analysed. Third, a mismatch between global goals and local implementation perceived by the interviewees is explored. Fourth, the new land use due to the increased materiality of wind power is inquired, and finally fifth the debate over offshore wind power is presented.

5.3.1. The 20%: a tool subject to controversy

In 2009, the Government reform has established the obligation of offering 20% of the shares to all new wind projects to local citizens in a radius of 4.5km. During the interviews, the different respondents have questioned this regulation and expressed their perceptions on its repercussions. This section is elaborating on the different point of views of the actors.

In the previous section 5.2.1. it has been seen that the low price of electricity is leading to an ineffective use of the 20% rule. When asked if the regulation has become obsolete in the new configuration of the Danish wind power agencement, Kristian Borch explains:

> *The 20% are good, but they need to be used actively. It is not something just to throw on the table. It might create a situation where people can't even afford it. It is a tool, but there is a need to use it in an appropriate way. For example, to give a 50% discount to resident living in a 1km distance, and 25% discount in 2km distance. That is a more flexible way to use the tool.* (00.34.15)

He advocates for greater flexibility in order to use the instrument appropriately to the new configuration of the agencement. This is what Nørrekære Enge is trying to achieve; Helge Christiansen explains that the idea of their community is to go away from these private 20%, and to rather collectively own 50% of the shares so to fairly dispatch the benefits among the residents of the municipality. He tells:

> *Normally, the 20% are private ownerships. Here, we own the 20% all together. The money will be used for local projects, like bicycle paths, like stores… But it is not enough, we want 50%.* (00.13.00)

During the interview, he tells how the community has gathered 800 citizens and Aalborg municipality together in order to claim more than the 20% normally offered. He explains that, if they obtain the 50%, it would be the first case of collective ownership of a wind farm of this scale in Denmark. Helge Christiansen relates that the hope with this farm is also to create a pilot project. He tells:

> *The hope is that this project will be a pilot project. If we can succeed a 50% ownership, then the rest of Denmark will realise that they can do it too.* (00.32.00)

In other words, the ambition is to raise awareness in Denmark about other forms of ownership possible by

making alternatives visible. Nonetheless, Helge Christiansen explains that the process of getting these 50% is not easy. He tells:

> *We have had four meetings with Vattenfall, and they have invited all the citizens in a 4.5km radius to talk about the project. It is our experience that it is extremely difficult to make concrete agreement with them, but they are forced to cooperate in order to get the municipality approval.* (00.20.00)

Arne Rhabek, Communication chef at Vattenfall, nonetheless explains that the company is willing to offer these 50%. He tells:

> *Last but not least, I have to say that in a lot of wind farms that we would like to develop, we offer more than 20%, we are even saying that it could be 50%.* (00.11.45)

It therefore seems that the two actors are having different perceptions of the reality as they do not perceive the situation in the same manner. It does not mean that one is right and one is wrong; it reflects the fact that the two actors are perceiving the world differently due to the particular frames they are using. This situation leads to a hot momentum with contestations, where no closure has been yet found.

These two different perceptions of reality are for the specific case of Nørrekære Enge, but they are actually also perceived in the overall configuration. Henning Bo Madsen relates:

> *Investors are not keen on selling the shares, because they have to sell it at the cost price and therefore don't make benefits out of it.* (00.56.25)

This relates to the vision shared by Helge Christiansen. However, Thomas Holst explains:

> *What happened yesterday in Esbjerg, this is what is going to happened if you don't get to have the local community to want the wind turbines. Now in Esbjerg, no one can put windmills anymore. That is why Vattenfall and DONG really want to get a strong cooperation with the locals*. (00.04.43)

What Thomas Holst explains is thus that wind projects developers are actually aware of the necessity of public acceptation and already value it. Wittrup (2017) also underlines the will from Vattenfall to increase local ownership in order to facilitate the processes and to avoid cases like Tønder and Esbjerg. The willingness for greater cooperation from the project developers with the local citizens is also reflected in the case of Prøvestenen; HOFOR has offered one of the three wind turbine, and Kim Pind Jensen explains during the interview:

> *What we did in Prøvestern was that we decided to tender a whole turbine. Within two months, we didn't sell it, more than 20-30% remained so we bought it back. We have the biggest share, but we don't want to rule anything, so a chairman was elected.* (00.16.50)

If the case did not succeed entirely, it does however reflect the will of a greater participation with local residents and for a repartition of power. A thorough analysis of the case would explain why the whole

turbine was not bought by the residents, but it could be presumed according the results that a lack of appropriate dialogue with the residents is one of the reasons.

Thus, a hot momentum can be identified in the socio-technical agencement of wind power in Denmark. The lack of flexibility in the use of the 20% rule is leading to disagreement between the actors, whom hence don't find closure on what the reality is; some consider that companies are so profit-oriented that they do not take public acceptance and public ownership in their calculation frameworks, whereas some other actors consider that companies are already aware of the need for public ownership and already take it into account. These two perceptions of realities are leading the actors to misunderstandings of the actual situation and therefore, it is leading to contestations and overflows. Overall, it seems that there is a lack of appropriate use of the 20% tool, and that if wind project developers are taking public acceptance into their calculation framework, the results indicate that they do not value it accordingly to its actual value.

5.3.2. The tendering process

As mentioned previously, the 21st of February 2018 the current national subsidy scheme will stop, and a new regulation will have to be agreed upon. At the moment, it is more likely that the regulation will favour a technology neutrality tender model – meaning that each tender will be according to one specific technology so to support technology diversity in the energy system (Holst, 2017). Tender model is what is currently applied in Denmark for offshore wind power.

The shift from the current subsidy scheme towards a tendering model will have consequences for the wind power socio-technical agencement. If all the interviewees are aware of that, it does not mean that they all share the same point of view on what the repercussions will be. According to Thomas Holst, Karl Vogt Nielsen and Kristian Borch, the tendering is a good way to get the right price of electricity and to decrease the subsidy costs. Thomas Holst explains:

> *It depends on how it is applied but I think that the tender is a good idea. In that way we will have the right price instead of the 25øre. Instead, the project makers will say what do they need. Maybe they only need 22øre, and then electricity will be at the right price.* (00. 18.14)

Leire Gorroño does not share this point of view. She explains that the theory is biased in comparison to how it actually functions in real life:

> *What they are saying is that, in that way, the competition is higher so the prices of subsidies will be lower. The theory is fantastic, really, but in real life it is another story.* (00.07.20, interview 2)

In her point of view, the competition is not fair because the conditions to participate depend on prerequisites that only few actors actually have. According to her, these prerequisites are ruling out citizens and communities:

> *The problem with that tendering, and it has been seen in other countries as well, is the conditions*

that are set so one is eligible to participate. These conditions go from technical, economical background, know-how, to many other things. So it totally rules out citizens and communities. (01.14.30, interview 1)

This is a problem also recognised by Hans Chr. Sørensen who relates:

It is impossible for a cooperative to go for a tender against these big actors, because establishing a tender is quite expensive. (00.12.38)

Jens Peter Hansen also shares this point of view. He explains that the requirements are establishing a barrier for smaller actors to participate in wind projects due to insufficient resources:

As it is for now, the requirements are so high that the competition is not fair for communities. I know some examples that have tried to participate in call for tenders for offshore, and they could not participate because of guarantee financial that weren't strong enough. (00.05.35)

For the renewal of Middelgrunden, Hans Chr. Sørensen shows a complete uncertainty about what will happen. Middelgrunden is an offshore wind farm established in 2000 and was, at that time, the biggest offshore wind farm in the world. It is half owned by Copenhagen Utility and half owned by Middelgrunden Cooperative, from which Hans Chr. Sørensen is board member (Sørensen et. al, 2002). The wind turbines will stop receiving the current subsidy scheme in a three years' time. Today, the turbines have reached the end of their lifetimes; the operation and maintenance costs are getting more expensive than the actual revenues from the wind power generation (which is partly due to the low price of electricity). When the subsidy will stop, the incomes won't be sufficient to keep the turbines up and running any longer. It leads the community to two choices for the future: establishing new turbines on the pre-existing infrastructures, or dismantling the wind farm. Hans Chr. Sørensen explains that the community is willing to start a new project on the current foundations, but nonetheless shows doubts about what the community will actually be able to realise if the competition due to the tendering model is applied. He says:

We honestly don't know what will happen if the tender law is past. (00.04.21)

Moreover, Leire Gorroño relates that, even if able to enter the market, the competition will be so high that actors without great means will actually not be able to compete. She explains:

Sometimes, the sooner you make the bids, the more points you get. So if you bid at 09h00, you make more points than at 09h01. So basically, the more capacity you have, the more points you get. (0.09.42, interview 2)

Karl Vogt Nielsen and Kim Pind Jensen agree with this point of view. Kim Pind Jensen explains that in order to reach the 2025 Copenhagen goals, HOFOR has to implement much more wind power capacity in the coming years. He explains that recently, HOFOR participated in two different offshore tender projects, and won none of them due to the high competition. When asked what will be the consequences for them if the tendering is approved, he hence answers:

We will not have any chance when we look ahead in the future competition if we have to compete against Vattenfall for example, they are too big. So, in my opinion we have to stay away from these tenders. (…) With the tender, our only option is the 18MW projects but that is far too small to reach the goals. (00.12.37)

During the interview, he explains that if the call for tender model is approved next February, their only option will be to invest in offshore projects in neighbouring countries, as there will be more potential sites to put up turbines. In that way only they will have the chance to win some projects and reach the Copenhagen climate goals. Also, the goals are appearing once again as a strong actor.

Moreover, it is interesting to see that the two project developers met for this study, i.e. Vattenfall and HOFOR, are not in favour of the tendering model. Arne Rhabek is also against this new model. He explains:

I think we have a good model in Denmark until now one and I don't know why it should be changed because as we have heard it could have continued. (00.10.01)

Arne Rhabek refers to the fact that the current subsidy has been considered illegal in the EU framework as it did not set up a fair competition between different member states actors, but actually a change in the regulation could have allow it to continue (Glerup et. al, 2016). Even if project developers with great means such as Vattenfall appear to be the only actors that will be able to be in the making if the tender for onshore wind power is enacted in February 2018, they do not seem to see the change as beneficial and would rather keep the model as it currently is.

To summarise, the tendering model is perceived as positive for some of the actors as it would provide the right price of subsidy, and according to others, this model would be a barrier for smaller actors as the new conditions set would not allow them to even enter the market:

- First, the requirements for participating to tendering processes are high, and are a first barrier for actors with modest means to enter the market.
- Second, the competition within a tendering process is so high that, even if able to enter the market, actors with less resources will have only little chance to win projects.
- Third, the regulation will create a place for small actors to participate in projects without the tendering process of only less than 18MW, which appears to be a problem for actors with climate goals (e.g. HOFOR) as the capacity offered is too small and limit the range of possibilities.

If the onshore tendering model is enacted the 21st of February 2018, it will considerably reduce the space for smaller actors in the socio-technical configuration. As argued by section 4.1.5. and many of the interviewees, public ownership is an important prerequisite to ensure social acceptance of wind projects. There is thus a high chance that, if approved and used in an inappropriate manner, the new tendering model

will lead to a decrease of wind power acceptation in Denmark, which could itself lead to more complicated process for local implementation of projects.

5.3.3. Mismatch between local implementation and global goals

As explained in section 5.1.2.2., it is since 2007 the role of the municipalities to find the wind turbines potential implementation sites. This decision was taken as the settlement of turbines has local impacts, and at that time the ambition was to alleviate public acceptance of the technology. Nonetheless, Leire Gorroño sees a mismatch in this task repartition. She explains:

> *There is an imbalance between these types of renewable energy projects that are locally based, but that are having global benefits. It is this mismatch that people don't like about wind power. It is not the technology itself, it is the model behind it*. (01.05.26, interview 1)

According to Wittrup (2017), wind turbines are used as scapegoats to illustrate the battle between the elites (the capital city, the big businesses) and the local residents. Jens Peter Hansen also underlines the mismatch between the goals from the Government and the local implementation. He relates:

> *The Government wants more wind turbines but we see more and more municipalities who do not want to make space for wind turbines because there are few people that are angry when there are plans for wind projects.* (00.06.55)

In the case of Nørrekære Enge, Helge Christiansen explains why contestations have arisen and why they are trying to find a greater partnership with Vattenfall:

> *Vattenfall comes from Sweden. Here, we have very good wind, one of the best winds in Denmark, so the area is very attractive. Then Vattenfall arrives, build its windmills and bring back all the benefits to Sweden, and pay no tax in Denmark. It is not fair. It is our wind, so we want to share 50/50.* (00.43.35)

Hans Chr. Sørensen shares this perception of the situation; he agrees that the mismatch between the global goals and the local implementation is a problem. Nonetheless, according to him, as well as according to Jens Peter Hansen, Arne Rhabek and Thomas Holst, it is the absence of policy for the situation when municipalities drop their plans that is a problem. He explains:

> *We have a dilemma today. The Government put up a target, but the municipalities have to implement it. It is a good idea because the impacts from wind are local, but on the other hand you cannot make a policy where politicians can just drop projects at the very last minute*. (00.22.01)

Thomas Holst agrees that it is a problem that municipalities are saying no to wind project. Nonetheless for him, the problem does not solely rely in the policy concerning municipalities. He explains:

> *When the municipalities have found the place, and someone ask if they can put a wind mills there, they answer no. Then we have a problem, and the Parliament is afraid of saying what the*

municipalities should do. (00.16.32)

The problem for him is not solely coming from the municipality and the policies, but is also coming from the role of the Parliament which does not take action. He believes that the relation between these two levels of governance is configured in such a way that no action is taken. Karl Vogt Nielsen has the same perception but explains that they cannot decide for municipalities, and that actually their political party is working for the creation of a new regulation in order to avoid this situation:

> *We also have a lot of discussion internally about how to change regulation so that municipalities don't roll back their wind projects because of local protests. But we can't decide what the municipalities are doing, and if they have chosen to listen to their residents we have no right to contradict them*. (00.32.06)

This is also a perception shared by Kristian Borch and Kim Pind Jensen; the Local Government Reform of 2007 has provided municipalities the responsibility of deciding about the implementation of wind power projects, and other actors would have no legitimacy to force them to do otherwise. Kim Pind Jensen thinks that it would create contestations if the Parliament would force the municipalities to implement the wind projects. He explains:

> *I don't think we can force municipalities to have energy goals. With such kind of rules, everyone is going to be opposed. I would like to create incentives instead, and that is what we are trying to do.* (00.59.11)

Instead of underlining a lack of policies to force municipalities to act, he underlines the lack of incentives given to municipalities.

Kim Pind Jensen also underlines another mismatch; he explains that there is a discrepancy between the reality in which politicians are embedded and the actual materiality of wind power. He explains:

> *I think in the mind of the politicians in Copenhagen Municipality, all the wind turbines should be placed here in the area, but that is impossible. We have no space for that amount of turbines, so we have to place them offshore, nearshore, or in other municipalities.* (00.06.28)

He thus sees a mismatch between the perception of the politicians on how to reach the climate goals (with onshore wind development) and the reality (that the turbines have grown in size and that there is no space onshore as Copenhagen is a dense city).

Hence, the discrepancy between the global climate goals from the Government, which actors can benefit from the wind turbines, and the actual local implementation is a barrier towards public acceptance of wind power:

- First, the discrepancy between the goals that need to be reach for society as a whole, and the locally undergone impacts from wind power are leading to a decline in public acceptance.

- Second, the divergence between the benefits made by the wind developers and the local negative impacts from the turbines are resulting in a feeling of injustice and thus, lead to public resistance.

The fear of public protests from the municipalities is a real threat to wind projects establishment. It has been seen in section 5.2.3.2. that it is too simplistic to talk about NIMBYism. Here, it seems that it is not the vicinity of the turbines that is a problem but rather the fact that the technology is standing as a technical artefact without benefiting the local residents. Nonetheless, not all the actors agree on the source of the problem within the agencement leading to these issues. For some, it comes from the configuration of the institution agencies (i.e. the relation between the Parliament and the municipalities). For others, it comes from regulations and policies that are allowing the system to act as such. This clearly shows that the action within the agencement is distributed; it is not the responsibility of solely one actor but rather, it is the arrangement of the actors to each other's that generates this overflow.

Hence, a conclusion from this analysis is that the current configuration of the agencement is inefficient. Public resistance is a new strong agency in the agencement, and the distribution of the agencement does not permit to deal with it. Thus, there is a need for the agencies to be re-adjusted in a way that will not allow such immobility.

5.3.4. Different perceptions over land use

In this section, the local impacts from the onshore wind power projects are analysed further. It has been seen it the literature review section 4.1.3. that the physical aspect of onshore wind power is a barrier towards its acceptation. Also, it has been seen that it can lead to property devaluation. Jens Peter Hansen agrees that this is a fact, and tells that it is feared by residents. However, he assures that it should not be a worry as residents are being compensated. He explains:

> *My impression is that there is a number of people who are worried about property devaluation. But indeed, properties will lose value if they got a wind turbine close to their house, but they are compensated for it, so there are no worries to have about this*. (00.13.36)

Nonetheless, it appears that the actors don't all agree on the land impacts from onshore wind power. For example, when ask if onshore wind power leads to land capitalisation, Thomas Holst explains:

> *Actually, I would have answer yes when they put up the plans in 2008. Some lands did get more expensive because farmers have experienced that they could get a lot of money from having windmills. But since then, it has been difficult to put up the windmills so now, I don't think that it actually capitalises the land. If it was easy to put a wind mill, it would definitely have that effect.* (00.24.07)

When this point of view has been exposed to Kim Pind Jensen, he completely disagreed. In his point of view, wind power really leads to land capitalisation. He explains:

I don't agree at all. Because we know the amount of money we are paying to land owners, and it is millions that we are paying. (00.28.45)

The lack of stabilised knowledge about the price paid to land owners for establishing wind project refers to the saying of Jane Kruse (2017) whom explained under section 5.1.2.2 that since the reform, the price has never been public again.

The different frames of the actors are leading them to perceive two different realities of the situation. Once again, it does not mean that one is right and one is wrong, but rather mean that their different frameworks and ways of evaluating the world is leading to disagreements where no closure of the actual situation is being found. Henning Bo Madsen perceives this reality as more complex, and explains the situation from an external point of view than developers and land owners. He tells:

Farmers have different views; they have an economic interest in selling a lot of land to big companies and make a lot of money (…). Of course there is this kind of interest, but there is also a lot of farmers that are more traditional and want to keep the land for the next generation. They want to be part of the community and some are quite active. So they also want benefits for the communities and local development. (0.32.50, interview 1)

Henning Bo Madsen advocates for the diversity of situations and underlines that there is a multiplicity of interests in between groups of people. Thus, as argued by the theoretical framework, differences are a point of investigation and should be emphasised rather than being faded away.

Also, another fact leading to these disagreements between the actors is the relocation of households. It is indeed quite often that, when a wind project is planned, the project developer needs to relocate households so to respect the radius distance between the turbines and the closest houses. As seen in section 5.1.2.3., the Promotion Renewable Energy Act has been established in order to alleviate conditions due to the new materiality of wind turbines and due to the decline in public acceptance. Since then, "*the minimum distance to a neighbouring home is four times the turbine's total height*" (The Danish Environmental Protection Agency, 2017). As the wind turbines are higher than before, it considerably reduces the spot available and increases the need for relocations. In the case of Nørrekære Enge's wind farm, Helge Christiansen explains that already twelve households have been bought by Vattenfall, and tells:

The people who have sell their houses are happy, because they had a good price for it. But the rest of the people thinks that it is bad that Vattenfall has destroy these houses, because now there are no people out there anymore, but windmills instead. People who are left in the small towns don't like it. (00.16.00)

This might also lead Vattenfall to have a biased perception of reality; if they communicate only with the citizens satisfied of selling their houses and not to the diversity of the inhabitants of the municipality, it

might lead them to an incomplete picture of the contentment. Leire Gorroño shares Helge Christiansen point of view and explains that if it makes few residents pleased, it also creates a negative dynamic for the rural area:

> *In these rural areas where people are already moving out, these kinds of projects will create even more movements of people. It has huge impacts for local communities. In the case of Nørrekære Enge, there is maybe a school that will have to shut down because they won't be enough children anymore. And then it is a reinforcement mechanism. You can create a disaster in the local area, even thou the state will be proud of its good numbers.* (1.10.05, interview 1)

She underlines once more the discrepancy between the national targets and the local implementation of the turbines. Nonetheless, these points of view are more pondered by Kim Pind Jensen, Arne Rhabek, Jens Peter Hansen, Karl Vogt Nielsen and Thomas Holst. According to them, there is many empty and old houses on the country side and therefore, buying them to put up wind turbines is actually a good thing. Arne Rhabek also explains:

> *If we have houses on the country side that are old, then it is a good thing to buy them*. (00.27.01)

And Jens Peter Hansen quantifies the problem:

> *It could be a problem but it could also be a help for local areas. In Denmark we have 6,000 houses in rural areas that actually should be taken down because they are low quality and hard to sell. I think that we should try to connect the idea about making space for wind turbines and places where such houses are.* (00.10.27)

For Karl Vogt Nielsen, it is an important tool in order to establish onshore wind power project. If possible it is better to avoid relocations, but as there is less space available than before due to the new materiality of the turbines, it is essential to keep the tool. He tells:

> *We think it is also OK if an investor relocate population for onshore wind projects. If there is a good place for windmills, and there is one house on the spot, then we think it is alright. I am not saying that it is a good practice, but I think it should still be a tool possible to use.* (00.37.40)

Therefore, it appears that there is a multiplicity of perceptions of reality. Some believe that it creates land capitalisation, whereas some believe that it doesn't. Some believe that it is not a problem to buy households as there are many old houses that have become obsolete, whereas some believes that it will establish a negative dynamic in the area. It is a hot momentum, a situation in which the different actors do not agree on what should be done and what are the consequences of one action over another. If actors don't perceive the same repercussions, it is not because some are wrong and some are right, but it is rather because the actors are framing the situation with different values and therefore, do not perceive the same reality which hinders closure and possible return to a cold situation.

In the next section, the offshore wind development is analysed through the eyes of the actors, and it is seen that they do not all share the same perception of reality either.

5.3.5. Different views on offshore wind power

Some municipalities are nowadays refusing to implement onshore wind power due to public resistance. As seen in the literature review, the visual impact from wind turbine is one of the biggest barrier toward wind acceptation, and it leads politicians to plan offshore wind power as there is no such resistance and as research shows that public opinion is higher than for onshore wind power (Ladenburg, 2007). Jens Peter Hansen agrees on these facts, but nonetheless explains that actually, even if the onshore wind turbines are bigger, the perception of the impacts should remain unchanged. He tells:

> *The increasing size of wind turbines is a barrier. There is a lot of fear about these wind turbines, but the reality is that when driving in rural areas it is hard to make the distinction between large and small turbines because the proportions are the same. So you have to be close to it before you can actually see that it is a bigger one.* (00.12.08)

He therefore explains that it is rather the worries due to the new size of the turbines that is a problem than the actual new landscape impacts. This is however in contradiction with the studies from Möller (2006, 2010), whom concludes that the visual impact at the regional level is higher with the increased size. The factor that Jens Peter Hansen might not have been taking into account is the increasing number of turbines on land. Thomas Holst relates a change in the public attitude towards onshore wind turbines. He tells:

> *The last couple of years, people have just found out that they don't like wind mills anymore, because they don't think they are pretty or…* (00.06.30)

Karl Vogt Nielsen explains that their party has a strong interest in offshore wind power. He explains that onshore projects are "*seen as problem projects"* (00.41.06), and tells:

> *There is a lot of complications with onshore, and we don't need these discussions. Per year we need around 540MW more from today, and it is not possible only with onshore.* (01.08.20)

Kim Pind Jensen emphasises the positive aspect from offshore wind turbines regarding public attitudes. He tells:

> *What we can see is that the local citizens are not opposed to offshore projects. It is the summer house owners that are against it. Most of the locals see it as job opportunities and job development, and I think that is mainly for offshore because there is so much activities related to it, compared to onshore that are quite easy to implement.* (00.39.26)

This is a perception shared by Kristian Borch, whom nonetheless advocates for more thorough and contextual analysis. He explains:

> *Offshore is a completely different story, because the municipality don't have the planning authority.*

> *Resistance really depends on case to case. Summer house owners are against. Locals are in favour. If you are young you are more for it, if you are old you are more against it. It is all contextual.* (00.55.19)

Offshore wind power could hence benefit from a greater social acceptation than onshore wind projects, and a shift from onshore to offshore planning could be a way to reduce public resistance.

Moreover, the price of offshore wind power has greatly dropped in the last recent years (AOH, 2016) and many interviewees agree that it will influence the future of the Danish wind power planning (i.e. Thomas Holst, Karl Vogt Nielsen, Jens Peter Hansen, Hans Chr. Sørensen, Kim Pind Jensen). Karl Vogt Nielsen perceives the fall in price of offshore as a great opportunity for the energy system. He explains:

> *Everyone was very surprise that the price went so low. A couple of years ago, a winning project cost 105øre/kW. (...). The last project was around 39øre if I can remember well. The price for offshore has gone down very fast, more than we expected*. (00.17.41)

Nonetheless, Jens Peter Hansen explains that offshore is still much more expensive than onshore for society. He tells:

> *If the public opinion declines, politicians will be pressured to invest in offshore wind turbines. It is not a big problem, but it will cost society much more money. According to Energinet.dk prognostics, it will cost us 3 billion DKK/year.* (00.17.03)

Later in the interview, he adds:

> *Some are saying that offshore is so cheap now that they can compete with onshore, but it is actually not true. The prices have dropped very much, but still offshore is 30% more expensive than onshore*. (00.09.40)

Him, together with Thomas Holst, Hans Chr. Sørensen, Leire Gorroño, Henning Bo Madsen, Kim Pind Jensen, and Kristian Borch, all agree that offshore wind power is still more expensive than onshore. Also, in Leire Gorroño's perceptions, offshore wind power cannot participate in developing the local area by generating incomes as in the case of onshore wind power. She explains:

> *Offshore and near shore are very expensive, and that makes the transition too expensive to start with. And second of all, it is design in a way where only the big companies can have their piece of the cake. With offshore, the added value cannot be used to develop the local area.* (01.16.44, interview 2)

This relates to the case of HOFOR which recently tried to participate in two offshore projects, but won none of them due to the too high competition. Kim Pind Jensen is since 2014 specialised in offshore wind power development in the company, and even if he agrees that the price for offshore has recently dropped, he tells:

> *It depends on case to case, on the location and on the grid costs. But in average it is around twice as much expensive as onshore. But in my opinion, if it is near shore or open door, it is actually very*

competitive, price wise. (00.51.20)

Thomas Holst also thinks that offshore remains much more expensive than onshore, and believes that it is still important to find a solution for onshore wind projects even if the prices have fallen. He however relates that the support for onshore in the Parliament is decreasing:

> *The Government is definitely listening to our point of views, but it is not the same as finding support in the Parliament. Most of the parties would like to find a solution, but there are still some that want only offshore even though it is more expensive. They don't care about the price.* (00.35.40)

Thus, the sayings from the interviewees are confirming the conclusions drawn by the literature review section 4.1.3. The pressures on the municipalities due, among other, to the decline in public acceptance of wind power, is pushing the planning of projects from onshore to offshore. On the one hand, it will have consequences for society as it will increase the price of the energy transition, and will phase out smaller actors such as communities and municipalities with climate goals. On the other hand, it could avoid costly negotiations and projects revocation due to the decline in public acceptance as in the cases of Tønder and Esbjerg, as public acceptance will not be an important barrier.

From the sayings of the interviewees, it seems that the lack of knowledge of the actual cost of offshore wind turbines is leading to contestations. As the actors are using different calculative devices to quantify the outcomes of offshore wind power, they do not agree on the socio-economic externalities of a shift from onshore to offshore wind power planning. These devices are leading to non-stable knowledge, as no closure is found, which therefore lead to contradicting perceptions of reality.

5.3.6. Summary

Along these sections, five different outcomes of the configuration of the socio-technical agencement have been identified as hot momentums. Firstly, some actors consider energy companies so profit-oriented that they do not take public acceptance framing, whereas some others believe that companies are already aware of this need and take it into account. Overall, it seems that the 20% rule tool is used in an inappropriate manner, and that project developers are doing their best for establishing public acceptance of their wind power projects, the issue remaining that they lack competencies and practices.

Second, it appears that, if enacted in February 2018, the onshore tendering process would reduce the space for smaller actors in the socio-technical configuration to act. This could give more agency to public resistance, and complicate even further the local implementation of wind projects.

Third, the mismatch between the global goals and the local impacts from wind power is leading to an increase in public resistance; it seems that it is not the vicinity of the turbines that is a problem, but rather

the fact that turbines are standing as a technical artefact without benefiting the local residents.

Fourth, the actors do not agree on the overflows from the increased materiality of wind power over the land use. Some believe that it leads to land capitalisation, whereas some don't. Some believe that relocation of citizens is a great tool, whereas some believe that it has severe consequences for the local area. It seems that the different actors are using different valuation framework, which lead to the creation of different perceptions of reality.

Fifth, the lack of stabilised knowledge on the socio-economic externalities of a shift from onshore to offshore wind power planning is leading to different discourses on the topic and creates controversies.

Overall, it seems that the current configuration of the socio-technical Danish wind power agencement is leading to several hot situations due to the different calculative devices used by the actors and by the lack of stabilised knowledge. These overflows are the results of co-evolutions of the different agencies of the agencement, such as public resistance, financial interest, governance, land use, offshore wind power.

5.4. Reflection on the analysis

Overall, it appears that the configuration of the Danish wind power agencement has gotten more and more complex. The transforming distribution of the agencies to each other is a result of, and has created, new actors in the making, leading to a more intricate seamless web. Some of these actors are the EU, the large energy companies, the medias, and definitely the wind turbines themselves. The actors are using different calculative devices to perceive the world and thus, they create a multiplicity of realities. This leads to unstable knowledge, which is source of conflicts and opposite views. It therefore results in the creation of overflows; the latter have become so significant that they have co-produced a new agency: public resistance. Public resistance towards wind power does not exist by its own, but exist due to the configuration of the cited actors together with other elements such as the Health Report, the low price of electricity, the energy goals. Overall, the lack of adjustment from the agencies to the new significant of the wind turbines' artefact appears to be the main source of the resistance.

It hence seems that the agencement has an increased need for new and more appropriate devices for the actual configuration of the agencement. Only this way it will be possible to make visible for the actors what reality is, and so contribute to shape the same perceptions over the situation. By this way, it will be possible to redistribute the agencies in a way that will permit the turbines to fulfil their primary goal: the generation of wind power.

6. Future of the Danish wind power agencement: where should we go? Discussion and recommendations

Along the precedent sections, it has been seen how the Danish socio-technical agencement has evolved from a vision to being *in the making* and how, from there, the agencies have co-evolved and how the agencement has gotten more and more complex. This complexity is sometimes leading to a halt in wind projects, threatening the energy transition.

Nevertheless, an agencement is under constant construction. If the Danish wind power is today facing challenges in regards to its implementation, it is only a stage of its evolution and does not mean that these challenges will keep on threatening the development of the technology. Rather, a multiplicity of possible trajectories is to be perceived. It is important to make solutions and alternatives visible to the actors so that wind power projects interruptions will not become normalised, but instead so that it will only remain few exceptions from the past. In the following sections, a discussion is leading to a set of recommendations for the different actors of the Danish wind power socio-technical agencement. It is followed by limitations of the research and results.

6.1. Discussion

The present study investigates the configuration of the Danish wind power socio-technical agencement. The following questions have been under inquiry:

> *How have the conditions for developing Danish wind power shifted through time, and which conditions are needed to pursue the energy transition?*

In order to be answered, the two following sub-questioned are posed:

- *How has the success of the Danish wind power development transformed the technical artefact itself?*
- *How has this shift in the artefact influenced the social context in which it exists, and what future is it possible to visualise for greater social acceptance?*

To be answered, the investigation has aimed at seeing the world through the eyes of the actors. Along the report, it has been seen that the complexity of the agencement has greatly evolved, and is sometimes leading to a halt in wind power project development. One of the main findings of this study is that the wind turbines have thrived through time; they have grown in installed capacity, number, size, purpose, which has implied significant re-configurations of the agencement leading to the co-creation of a new agency: *public resistance*. The agencement has mutated from one stage to another, and the stage in which it is now will

keep on evolving in the future. The results are indicating a multiplicity of co-evolutions of the agencies, which are discussed in the following lines.

A hypothesis confirmed along this report is the importance of the governance processes. The results have corroborated that Denmark cannot govern its energy system in a vacuum but rather, must expand a wider approach when developing its own rules and regulations. Two major influences have been identified. First, the greater expansion of wind power across Europe is reinforcing the decrease in electricity prices and hence, Denmark must convert its energy system into a *Smart Energy System* in order to use efficiently its wind power. Second, the energy goals and the directives from the EU have appeared has new actors in the agencement, greatly influencing the national governance. The importance of the ambitious targets set by the EU are creating a need for actors with great resources in terms of finance, organisation and know-hows. Only in that way it is possible to achieve a sustainable transition across the continent. Thus, the results suggest that it would be unrealistic to achieve a sustainable energy transition solely based on communities' involvement. Also, the results confirm that if a tendering model is applied for onshore wind power in Denmark, it will decrease the smaller actors' ability to act. The results are hence implying a need for establishing a flexible tendering model which would permit smaller actors to be in the making, also in project larger than 6MW. Furthermore, it should be noted that the EU is aware of the need for community involvement, and suggest other forms of participation; for example, the European Commission (2016) promotes consumers to become prosumers, in other words promotes consumers to produce their own electricity and sell it to the grid in times of production excess.

Moreover, a hypothesis confirmed along the report is that offshore wind power seems to benefit from a higher social acceptance than onshore wind power, which therefore pushes the Government to shift its planning strategy regardless of the socio-economic costs. The results hence indicate a need from the governance agency to re-consider the ins and outs from one technology over the other.

Another hypothesis developed has been that the decline in communities' participation in wind projects is one of the sources of public resistance; the results suggest a more complex situation.

A finding from this report is that the communities themselves have evolved. In the 1980s, communities have been activated by a situation of crisis; the nuclear power discourse has configured communities to be in the making with a will to develop an alternative to nuclear power. Today, their vision has been enacted: wind power represents around 42% of the Danish' electricity consumption (Energinet.dk, 2016 A). Thus, their reason of being in the making today is completely different as is the beginning of the wind power development.

Furthermore, the results are suggesting that actually, even if communities are not involved in the same manner as in the past, public opinion probably remains mostly positive, and resistance is detained by fewer persons than it seems. The results indicate that the major difference is that there is an imbalance between the visibility of the positive and the negative opinions of wind power within the agencement. Opponents to wind turbines appear really active, they are extremely present in the social discourse through the medias and social medias. Those in favour of wind turbines however, are much less visible or active. The results are suggesting that the medias and social medias are hindering a clear public discourse and perception of reality towards the acceptation of onshore wind power. It is harming the communication between the different agencies as it creates a biased perception of the situation. Also, the results are suggesting a lack of appropriate tools to measure the actual public opinion of wind power.

Hence, there is a need to re-establish a proper balance in the visibility of both sides of the opinions. In order to make public acceptance visible in the agencement again, there a need for appropriate and active use of tools, such as the 20% ownership, the social medias, the creation of contextual dialogue between the different agencies, and more contextualised research (such as polls) about local public opinion.

Another former hypothesis is that the increase in number and in size were the cause of NIMBYism towards wind power projects. The results have shown that this theory is far too simplistic in comparison to reality. It seems that rather, the rise of public resistance is due to much more contextual factors. It is not merely the new materiality of wind turbines that disturbs the residents, but rather the issue that the artefacts are standing in the local areas, benefitting actors not undergoing the visual and sound impacts, whilst not bringing benefits to the ones undergoing the impacts. This discrepancy is new as, in the early stage of wind power development, wind projects were mainly community owned and the benefits fairly dispatched among the area. Today, the new configuration of the agencement (i.e. with low price of electricity, energy goals, financial interest, …) is in many cases beneficial to actors with greater resources. It is getting more and more arduous for actors with modest means to participate in wind development, and hence it creates an imbalance in the agencement which strengthens the public resistance' agency.

The results are thus indicating a need for greater collaboration between these new actors and the energy communities. Wind turbines can fulfil their purposes only if the configuration of the arrangement permits it, and therefore wind developers have to value appropriately the importance of public acceptance for a successful project implementation.

If the results indicate that wind developers are already aware of this need, they suggest an under and/or inappropriate estimation of its value. It seems that wind developers perceive financial interest as the only factor leading to public acceptance, whereas public acceptance is contextual and cannot be bought. Rather, the attempt of "buying acceptance" might even reinforced public resistance. Public resistance hence

must be understood in a flexible and contextual manner. Instead of saying to the residents what their needs are, wind projects developers must understand the actual needs of the residents; that might be financial compensation, co-ownership creation, or stabilised knowledge on wind turbines effects. Another understanding that wind developers might have to consider is the importance of the visual impacts from the turbines. If a community has issues with the height of the turbines, it might be a solution to consider the implementation of smaller ones so to decrease public resistance (if the unit cost of kWh remains feasible). Or, the other way around; a new study by the Danish Energy Association (Energiwatch, 2017) shows that four out of five onshore wind turbines in Denmark could currently be replaced by new and bigger turbines, hence enhancing the visual impacts.

Overall, the results indicate that communication and dialogue between the different key stakeholders of the agencement are one of the main criteria for a successful wind power project establishment.

To conclude, is it important to mention that the new size and materiality in general of the wind turbines is a major source of changes in the agencement. Nevertheless, it is not due to the new size that public resistance is increasing; rather, it is due to a lack of adjustments from the agencies to the new size that is the cause. It is also important to state that no generalities can be made about wind turbines implementation successes or fails, and that the lack of community ownership is only one of the multiple factors that generates the public resistance. Several recommendations can be made so to re-adjust the agencement and thus to permit an effective co-evolution of the agencies for reaching the ambitious climate goals; they are presented in the following section. The following table represents the three stages depicted along the report:

***Table 03**: Three stages of the conditions for wind power implementation: past, present, future.*

	1980s	*2010s*	*2020s*
Local participation and interest	Active, in resistance, enacting an alternative	Unknown by the Governance and wind developers	Understood as contextual to each wind power projects
Public acceptance beliefs	Reliance on positive polls	Reliance on the NIMBYism theory and polls	Contextualised situations, U-shape understanding

Financial sources	Communities	Large energy companies and mandatory 20% individual shares	Flexible cooperation between large energy companies and communities/individuals
Wind turbines size and costs	Low size, low investments, low visual and sound impacts	Large size, large investments, large visual and sound impacts	Flexible size, investment, and impacts
Medias and communication	Open and great dialogue between the different actors	Large influence from the medias, lack of contextualised communication between actors, unbalanced use of the medias and social medias	Contextualised communication between actors, great understanding of the different needs, active use of tools and new devices (social medias, 20%,…)
Governance	Emergent, supporting	EU and climate goals, current Government considering the energy transition too expensive	EU, climate goals, new calculative devices deployed by the Government, new driving force
Energy market structure	Not disturbed by wind power	Wind Power disturbing the market structure	Smart Energy System, integration of wind power and new market structure

6.2. Recommendations

In this section, recommendations for the different actors of the Danish wind power network are made. The recommendations are not exhaustive and are rather meant to provide ideas for practical implementation of solutions so to alleviate wind power establishment in Denmark.

Recommendations for national governance

- The Government should participate in the creation of a stable energy market with appropriate regulations so to transform the energy system into a Smart Energy System. For example, tax scheme for conversion technology should be alleviated, or for example incentives could be created so that wind producers would participate in the grid stability by stopping their turbines in times of high wind production.
- The Government should re-establish the registration of community owned wind turbines in order to re-create stabilised knowledge about their importance for the wind power development. Also, new adequate definitions of what *energy communities'* entails should be provided in order to permit thorough and relevant policy-making.

- The Government must realise that offshore wind power is still more expensive than onshore, and that the implementation of onshore wind power projects is only sometimes more complicated due to a current lack of adjustment of the different agencies. Hence, the Government should re-investigate the benefits from onshore wind power.
- Governance agencies must realise the importance of public participation and create a framework in which communities and actors with modest means have the opportunity to participate in wind power projects. For this, a flexible regulation framework must be developed. If the establishment of a tendering model is approved the 21st of February 2018, the model should permit smaller actors to be in the making in an appropriate manner. For example, more than the 6MW should be proposed to be without the tendering model.
- Municipalities could endorse a new role and steer the energy transition: incentives could be created for municipalities to have climate goals, or municipalities could gather for creating wind projects together and thus be able to compete if a tendering model is established in February 2018.
- Municipalities could approach companies to establish public-private partnership so to both establish competitive wind power projects and reach climate goals.
- Municipalities and wind developers should alleviate their dialogue along the projects, and incentives could be created so that municipalities would not stop a project at the last step. This could be made through the establishment of climate goals incentives, or financial compensations from the municipalities.
- Governance agencies and wind developers have to shift their paradigm: the notion of NIMBYism has biased the results of social acceptance and has mislead communication in wind projects. There is a need to understand that each case is specific, and that NIMBYism is an incomplete theory that cannot explain all the sources of public resistance.

Recommendations for wind project developers

- Wind project developers should alleviate their calculative devices in regards to the valuation of public acceptation. A contextual approach to each cases is needed and therefore, wind projects developers could consider hiring anthropologists or sociologists to understand local barriers. Industrial PhD might be an alternative to both create knowledge and help developing specific projects.
- Wind project developers must alleviate public acceptation by an active use of tools: they must consider using actively the 20% ownership and the social medias as part of each projects and in a very contextual manner. They might also consider realising small-scale surveys, or polls, previously to starting projects, in order to give a basis for contextualised communication.

- Communication and dialogue between wind developers and residents, as well as between wind developers and municipalities, must be ameliorated: social media platforms could be used to enhance communication and dialogue and to create stable knowledge on projects.
- A wide collaborative approach to the planning of the wind turbines should be establish as early as possible in the projects to ensure that the proposal meets the expectations of both the residents and the wind planners.

6.3. Limitations

For the purpose of this research thirteen interviewees have been reached. All the interviewees have an interest and will in developing onshore wind power. Therefore, a limitation of this research is that no actors against wind power projects have been interviewed. For greater research, insights of the public resistance agency could provide a better understanding of the dynamics lying behind the resistance.

Also, the results have indicated that successful wind power projects are not visible and in this report, only cases with controversies or failures have been used. For further research, cases with great social acceptance could provide deeper insights of the dynamics of the Danish wind power configuration.

Furthermore, the results have indicated the importance of the economic parameters when it comes to wind power project investments, that is for individuals, communities, or larger energy companies. The realisation of a business model establishing a collaboration between the three different agencies could permit to provide important details to understand how could the different agencies gather and share a business case. Such research could provide accurate recommendations for establishing projects with high public acceptance.

Moreover, throughout the report communication has appeared to be one major element influencing the perception of onshore wind power. Nevertheless, the research has not looked at the specifics communication processes between the actors when establishing wind power projects. If the goal is to generate knowledge about the specific ways to alleviate communication between the actors and to understand their dynamics, one could follow several wind projects implementation processes.

7. Conclusions

The Danish wind power socio-technical agencement has greatly evolved through time and has become more and more complex. Wind power was in the 1970s a vision developed by civil society and communities in reaction to a discourse favouring the development of nuclear power. Opposed to the trajectory offered by the Government, communities organised themselves and developed knowledge of another technology; wind turbines. The wind turbines became in the making when being connected for the first time to the grid – it is at that moment that the turbines shifted from an alternative vision to reality. At that time, the technology was "innocent", in the sense that it was not disruptive for the different actors (neither to the inhabitants, nor to the Government, nor to the grid).

Nonetheless, the large scale integration of wind power has changed these parameters. The turbines are today higher and have greater visual impacts, they are more expensive, more spread across the country, and represent also new challenges for the power market and for the grid.

From there, a complete new agencement can be perceived. New actors such as low price of electricity, medias, energy goals, or the importance of the EU have appeared. These new actors are the result of co-produced trajectories and co-shaping of agencies, and have led to the creation and strengthening of a new one: public resistance. This latter configuration of the agencement is much more complex than the first one analysed. In this one, the distribution of the different agencies is generating overflows that are leading to hot momentums. The actors of the network do not perceive the same reality as they are using different calculative devices to frame the world. It leads to misunderstandings, conflicts, and hence sometimes to halts of wind power projects implementation.

Overall, the new materiality of the wind turbines has led to significant shifts in the Danish wind power STA' configuration, and the different elements that compose the agencement are today lacking adjustment.

There is therefore a need to develop new and more appropriate calculative devices by, and for, the different actors of the agencement. This will permit to create stable knowledge about what the reality actually is, and thus to contribute to the finding of closures on the actual conflicts. Dialogue, active use of tools such as the social medias or the 20% of ownership, co-creation of wind power projects, new governance paradigm and policies, all are changes that have appeared to be essential so to move on from this stage increasing the public resistance.

Overall, re-adjusting the configuration of the Danish wind power agencement is essential so that wind power will to continue to thrive in the future.

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