The Valuation History of Danish Wind Power

The Ongoing Struggle of a Challenger Technology to Prove its Worth to Society

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BY

HENRIK BACH MORTENSEN

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AALBORG UNIVERSITY
DENMARK

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Image Credit: Peter Lyhne Højberg, 2017

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CV

Henrik Bach Mortensen (Viborg, Denmark, 1983) obtained his Master of Arts in International Business Communication from Aarhus University in 2011. He began his professional career in the Siemens Wind Power Graduate Program, working in a business support role in the R&D blades departments in Aalborg, Denmark and Boulder, Colorado. After completing the program in 2013, Henrik continued his work in Siemens Wind Power through the Business Development unit of the Technology Department. In the fall of 2014, Henrik moved to the Cost of Energy team, wherefrom he commenced on this industrial PhD-dissertation with Aalborg University. Henrik remains employed within Product Portfolio Management in the merged company that is today called Siemens Gamesa Renewable Energy.

English summary

This PhD-thesis analyzes the valuation history of wind power in Denmark, by studying the valuation devices that have been used to frame wind power as a worthwhile or not worthwhile investment to the Danish society. This is done through an analysis of key reports, calculations and public statements about the societal value of wind power. This is combined with interviews of key actors from the valuation history to create as complete a picture as possible. Drawing on Strategic Action Field Theory and Valuation Studies, I examine how the value of a challenger energy source, wind power, has been produced through various and competing framings. These framings consist of qualities that are inscribed into the object of wind power and make it more or less valuable as a societal investment. Furthermore, I examine the historical valuation drama between incumbent- and challenger-coalitions by focusing on particular critical moments of valuation.

The valuation history of Danish wind power can be seen as consisting of five periods, each with their dominant valuation frame and a corresponding network of human and material actors upholding it. In the 1970's and 1980's wind power was a Unique Supplement, which had a large future potential instead of nuclear energy, but was still confined to a peripheral role in the energy market. In the 1990's, wind power was framed as indispensable climate change mitigation solution, and a valuation network of enabling devices were enacted to stretch the market to accommodate wind power. This period was followed by a dramatic shift in valuation in the early 2000's, as new calculative centers frame wind power as a value-destroying market distortion. After five years of a stand-still and a disassembled valuation network, a new valuation network re-framed wind power as a worthwhile investment to society. A broad coalition of actors gathered around investments in wind power which could provide a global advantage for Denmark both in terms of mitigating climate change, gaining energy independence and growing an export industry. This seemingly broad consensus was, however, contested and partly broken in the fifth and final period. Even as wind power now was recognized as an industrial benefit to Denmark and the cheapest technology to build, Wind Power was temporarily framed as a subsidy burden to Danish society, through the taxes and subsidies which enabled its presence in the energy market. This most recent framing however turned out to be fragile going forward, as several powerful actors oppose this framing of wind power.

The study identifies 12 qualities which actor coalitions combine and rank in various ways to make up the competing frames of the valuation history of Danish wind power. These qualities are assembled throughout the above described periods by five coalitions, of which some overlap or emerge from others. These coalitions struggle

to assemble a strong enough valuation network to stabilize their framing of value through market frameworks, materiality and calculative devices.

It is my ambition that this study can contribute to the emerging field of valuation studies by providing an in-depth empirical analysis of the valuation frames and valuation networks that uphold them. By understanding which qualities have historically been used to frame wind power as worthwhile, the actors who represent wind power, can better challenge any entrenched meanings in the energy market. If the climate crisis it to be solved in time it is necessary for framings that recognize wind power as valuable to society and position it as the standard investment for the future.

Dansk resume

Denne PhD-afhandling analyserer historien om hvordan vindkraft blev værdisat i Danmark ved at studere de instrumenter der er blevet brugt til at frame vindkraft som værdifuld eller ej for det danske samfund. Dette gøres gennem en analysis af centrale rapporter, beregninger, og offentlige udtalelser om den samfundsmæssige værdi af vindkraft. Dette er kombineret med interviews af centrale aktører i historien om vindkraftens værdisætning for at give et så komplet som muligt billede af historien. Ved hjælp af Strategic Action Field Theory og Valuation Studies, undersøger jeg hvordan værdien af en *challenger* energikilde som vindkraft er blevet produceret gennem forskellige konkurrerende frames. Disse frames består af *qualities* eller karakteristika, som bliver indskrevet i det object man kalder vindkraft, og gør det mere eller mindre værdifuldt som en samfundsmæssig investering. Derudover undersøger jeg det historiske værdisætningsdama mellem koalitioner af etablerede aktører, *Incumbents*, og udfordrer-koalitioner, *Challengers*, ved at fokusere på de kritiske *Moments of valuation* i mødet mellem de to koalitioner.

Historien om værdisætningen af dansk vindkraft kan forstås som bestående af fem perioder, hver en med sin dominante *Valuation Frame* og et tilhørende netværk af mennesker og materialle aktører som opretholder den specifikke framing. I 1970 og 1980’erne var vindkraft framet som et unikt supplement med et stort potentiale istedet for atomkraft, men det var dog stadig begrænset til et periferært hjørne af energismarkedet. I 1990’erne blev vindkraft framed som en uundværligt løsning til at mitigere klimaforandringer, og et netværk af love og materialle forankringer blev opbygget for tilpasse energimarkedet til at akkomodere udbredningen af vindkraft. Denne periode blev efterfulgt af et dramatisk skift i værdisætning i de tidlige 2000’er, idet ned beregnings-centre framede vindkraft som en værdi-ødelæggende forstyrrelse af energimarkedet. Efter fem års stilstand og et ødelagt værdinetværk, et nyt netværk, som igen framede vindkraft som værdifuldt, blev langsomt opbygget. En bred koalition af aktører samlede omkring investeringer i vindkraft som en global fordel for Danmark idet det kunne mitigere klimaforandringer, give Danmark højere energi-uafhængighed samt skabe en voksende eksportindustri. Denne tilsyneladende brede konsensus ville imidlertid blive udfordret og delvis brudt i den femte og endelige periode. Selvom vindkraft var anerkendt som en erhversmæssig fordel for Danmark og den billigste teknologi man kunne bygge, ville vindkraft midlertidigt blive framed som en subsidie-byrde for det danske samfund gennem de afgifter og subsidier som muliggjorde vindkraften i energimarkedet. Denne seneste framing ville vise sig at være skrøbelig fremadrettet, da adskillige magtfulde aktører modsatte sig denne framing af vindkraft.

Studiet identificerer 12 karakteristika som aktører kombinerer og rangerer i forskellige konstellationer til at udgøre de konkurrerende frames som udgør værdisætningshistorien om vindkraft i Danmark. Disse karakteristika samles og kombineres af fem forskellige koalitioner af aktører, hvoraf nogle overlapper med

hinande og andre opstår fra tidligere koalitioner. Disse koalitioner kæmper for at skabe et værdisætnings netværk der er stærkt nok til at stabiliserer deres framing af værdi gennem regulering, material udbygning og kalkulative instrumenter.

Det er min ambition at dette studie kan bidrage til det fremvoksende teorifelt som er valuation studies, ved at levere en dybdegående empirisk analyses af *Valuation Frames* og de værdisætnings netværk der opretholder dem. Ved at forstå hvilke karakteristika der historisk er brugt til at frame vindkraft som værdifuldt kan vindkraft-aktører bedre udfordre gamle intuitive meninger i energi-markedet. Hvis klimakrisen skal løses i tide er det nødvendigt at skabe framings som producerer vindkraft som værdifuldt for samfundet og positioner det som fremtidens standard investering.

Preface & Acknowledgements

The cover of this thesis shows the image of a modern offshore wind turbine at the Danish Østerild Test center in 2017. This leviathan of steel, magnets, bolts, glass and wood is a symphony of engineering, which represents the materiality of Denmark’s continued investment in wind power. I have not been blessed with the technical skill to help make such a materiality come into being. But I have had the privilege to work with the great engineers, project managers and builders, who collectively can construct such an entity. Since 2011, I have seen the passion that goes into the gargantuan task of making real what matters, clean energy for generations to come. I am humble to stand on the shoulders of these giants.

First and foremost, I extend my deep gratitude to my two supervisors. Peter Karnøe had the vision to call Danish wind power an international success in 1991 and his prediction has only come truer since then. I thank him for his passionate guidance and unrelenting patience, whenever a young PhD-student has needed things explained another time around. Bent Christensen has guided me through the intricate details of Danish energy-history and given me insights I could never have read my way to. I thank him for his trust and unwavering support in this journey.

I am grateful to Siemens Gamesa Renewable Energy and the Danish Innovation Fund which made this multi-year research project possible. Peter Esmann has given priceless help through hundreds of spirited sparring hours, and hundreds of thorough reviews of my pages. My thanks also go out to Henrik, Aidan, Marton, Marianne and Mads for their encouragement, reviews and support.

Thank you to all of my amazing colleagues in the Special Interest Group on Valuation and Markets, who are an inspiration to work with. Jens Stissing Jensen has especially provided dedicated sparring, reviews and words of encouragement. Thank you to the SCANCOR organization and Danmark-Amerika Fondet for the opportunity to study at Stanford University, and to Marc Ventresca for opening his doors and teaching me the value of thoughtfulness in academic work. Thanks also go out to all the people who have been interviewed for this thesis.

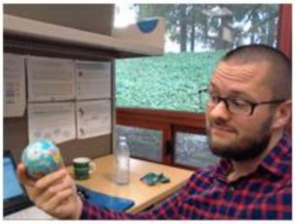
I thank my father and mother for teaching me the lessons of dedicated hard work and kindness to others. These are values I also see in my brother, sister and wonderful niece and nephews.

My deepest gratitude goes to Maria and Josefine. When the last months were hard, I could look to you two baking in the kitchen or join you for a walk in the woods, which gave purpose and inspiration to all other things. I now get more time back and look forward to discussing arts, cuisine, society and all other worldly things with Maria, and to play many more board games with Josefine. Thank you for your patience and love.

This thesis proves the saying that the more you learn, the more you realize how little you know. I have felt this way as I have navigated the many calculations and frameworks, but I have given it my all to assemble something valuable in all of these words and figures. Below are a few snapshots from the journey that brought this thesis to being. Bruno Latour jokingly once wrote that a 50.000 word thesis might be read or skimmed by half a dozen people, if the author was lucky. If the reader should be one of these people, I hope it brings her as much value as it brought me to write it. Thank you.

Henrik Bach Mortensen

March, 2018.

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Abbreviations

Terms	
Abbreviation	Description
(C)	Member of the The Conservative Party
(RV)	Member of the Danish Social Liberal Party
(S)	Member of the The Social Democrats
(V)	Member of the Left – Denmark's Liberal Party
ADAM	Annual Danish Aggregate Model
CC	Climate Change (Used in CC Mitigation quality)
COP	Conference of Parties
CS	Climate Solution Valuation Frame
DSO	Distribution Systems Operator (e.g. SEAS)
ED	Editorial in a newspaper
ES	Expensive Supplement Valuation Frame (historic)
ETS	Emissions Trading System
GA	Global Advantage Valuation Frame
GBA	Graph By Author *(Graph was made by H. B. Mortensen)*
GW	Gigawatt (equal to 1000 MW)
GWh	Gigawatt hour (equal to 10000 MWh)
kW	kilowatt
kWh	kilowatt hour (DK household/Year = ~4000 kWh)
LCOE	Levelized Cost of Energy
MD	Market Distortion Valuation Frame
MLP	The Multilevel Perspective (Geels)
MW	Megawatt (Equal to 1000 kW)
MWh	Megawatt hour (Equal to 1000 kWh)
Op-Ed	Opinion piece in a newspaper
SB	Subsidy Burden Valuation Frame
SWT	Siemens Wind Turbine
TSO	Transmission Systems Operator (e.g. Energinet)
TWh	Terawatt hour (equal to 1000 GWh)
US	Unique Supplement Valuation Frame

Organizations and People		
Abbreviation	Original Name	English Translation (When applicable)
AFR	Anders Fogh Rasmussen	
AKF	Amterne og Kommunernes Forskningsafdeling	The Research Unit of the regions and municipalities
ATV	Akademiet for Tekniske Videnskaber	The Adademy of Technical Sciences
AU	Aarhus Universitet	Aarhus University
BNEF	Bloomberg New Energy Finance	
CBS	Copenhagen Business School	
CEESA	Coherent Energy and Environmental System Analysis	
CEPOS	Center for Politiske Studier	Center for Political Studies
COP	Conference of Parties	
DDHA	Dansk Fjernvarme	The Danish District Heating Association
DE	Dansk Energi	Danish Energy (known as DEF until 2001)
DEA	Energistyrelsen	The Danish Energy Agency
DEC	De Økonomiske Råd	The Danish Economic Councils
DEF	Danske Elværkers Forening	The Danish Utilities Organization
DEFU	Danske Elværkers Forenings Udredningsenhed	The Danish Utilities Organization's Research Unit
DF	Dansk Folkeparti	The Danish Peoples Party
DI	Dansk Industri	Danish Industry
DKGOV	Den danske regering (bruges i nogle kildebetegnelser)	The Danish Government
DTU	Det danske Tekniske Universitet	
DWIA	Vindmølleindustrien	The Danish Wind Turbine Industry Association
DWOA	Danmarks Vindmølleforening	The Danish Wind Turbine Owners Association
EA	EA Energi Analyse	EA Energy Analysis
EFKM	Energi, Forsyning og Klima Ministeriet	The Ministry of Energy, Utilities and Climate
EK	EnergiKommissionen	The Energy Commission (2016-2017)
EU	The European Union	
EUC	The Commission of the European Union	
EWEA	European Wind Energy Association (WindEurope today)	
FT	Folketinget	The Danish Parliament
GWEC	Global Wind Energy Council	
IDA	Ingeniørforeningen	The Danish Engineering Society
IEA	The International Energy Agency	
IMV	Institut for MiljøVurdering	The Institute of Environmental evaluation
IPCC	The International Panel on Climate Change	
IRENA	The International Renewable Energy Agency	
JP	Jyllandsposten (Newspaper)	
L&F	Landbrug og Fødevarer	The Danish Agriculture & Food Council
LCL	Lars Christian Lilleholt	
LCOE	Levelized Cost of Energy	
NOAH	Naturhistoriske Onsdag Aftener	Nature Historic Wednesday Nights (DK Friends of the Earth)
OECD	Organisation for Economic Co-operation and Development	
OOA	Oplysning om Atomkraft	Information about Nuclear Power
OVE	Organisation for Vedvarende Energi	Organization for Renewable Energy
RW	Rockwool Fonden	Rockwool Foundation
SCANCOR	Scandinavian Consortium for Organizational Research	
SDU	Syddansk Universitet	The University of Southern Denmark
SEAS	Sydsjællands Elektricitets Aktieselskab (Idag: SEAS-NVE)	Southern-Zealand's Electricity Shareholders Company
SF	Socialistisk Folkeparti	The Danish Socialistic Peoples Party
SGRE	Siemens Gamesa Renewable Energy	
SR	Socialdemokratiet-Radikale Venstre regering	A Socialdemokratiet-Radikale Venstre Government
SRSF	Socialdemokratiet-Radikale Venstre og SF regering	A Socialdemokratiet-Radikale Venstre-SF Government
SWP	Siemens Wind Power A/S	
UN	The United Nations	
VK	Venstre-De Konservative regering	A Venstre-De Konservative Government
AAU	Aalborg Universitet	Aalborg University
AAU-CPH	Aalborg Universitet - København	Aalborg University - Copenhagen

1. INTRODUCTION

In accounts of the global transition to green energy, Denmark is lauded as a wind power pioneer. By successfully integrating large degrees of wind power while maintaining stable supply, the small country in Northern Europe has created an efficient energy sector that many experts view as a model for the rest of the world (IEA, 2017b; McKenna, 2016). Danish political leaders often highlight the success of the nation's energy policies on the international stage, and there appears to be consensus on the high value of wind power in completing Denmark's transformation into a green society by 2050. But did lawmakers and entrepreneurs in Denmark recognize the value of investing in wind power at a much earlier date and on a larger scale than those in most other countries? Did the key legislators in power all agree that wind power was a worthwhile investment, or is this apparent consensus an illusion? Did broad political agreement exist, and does it exist today? To answer these questions, it is important to examine Denmark's struggle to find the societal value of wind power.

During its 40-year history in Denmark, wind power has evolved from being a highly contested and marginal challenger energy source to becoming a central component in Denmark's future renewable energy system. In 2017, the equivalent of 43.4% of Danish electricity consumption was generated by wind power, and the 3-year rolling average for 2015–2017 was 41%—a world record high (EFKM, 2018; EnerginetDK, 2016a). Despite this global acclaim as a world leader and to the surprise of many, recent events in the Danish energy field have revealed an apparent lack of shared meaning or political consensus about the value of investing in wind power in Denmark.

Indeed, escalating debate in the media and political shifts in the energy policy in recent years reveal a surprisingly strong divide over the question of whether wind power is a worthwhile investment for Denmark. For example, claims such as "Wind powers subsidy costs are a too large burden on society" or "wind power is too unreliable to be more than a supplement to the energy system", that circulated widely when wind power was strongly subsidized in the 1980s, persist, even though the technology is significantly more advanced and much less subsidized per Kwh today. Recent calculative comparisons of electricity-generating technologies that Denmark could build even show that wind power is the cheapest available option to build. This conundrum is what sparks my interest as a researcher. Why is it that the value of wind power remains contested in the country where it is the cheapest to build and it gives the industrial benefit per capita? If the value and legitimacy of wind power cannot stabilize its own world and be considered valuable in Denmark, it would be difficult to achieve this in other countries.

An examination of the Danish energy sector in the 1970s and 1980s reveals how the anti-nuclear movement enabled the emergence of a sister movement advocating for renewable energy, in particular the challenger technologies wind and solar (Beuse, 2000; Karnøe, 1991). Following the 1973 energy crisis, proponents of wind power succeeded in obtaining a foothold despite strong protests from the incumbent utilities, which at the time were the authoritative "go-to" experts on the energy system. The uniqueness of the Denmark case is that wind power has evolved from being a highly contested challenger energy source to being a major component of Denmark's energy system and industry (EnerginetDK, 2016a; Karnøe & Jensen, 2016), supplying more than 40% of the nation's electricity, 4% of its total exports and 33,000 jobs (Damvad, 2016). Several negotiations around energy agreements led to this position, the most recent one being the 2012 Energy Act. This Act was considered a game-changer by many, as it appeared to stabilize the policy framework and conditions for wind power that would allow it to grow beyond its challenger technology status. The Energy Act mobilized a broad political coalition around shared ambitions, including wind power as an integral component towards a fossil-free energy system by 2050 (DEA, 2016b). The 2012 goal to be fossil free in 2050 appeared to have public support in surveys of the Danish population which showed that a majority agreed that a green transition is needed, and that associated costs are worth bearing (DKvind, 2014a). Thus, Denmark's green transition could on the surface appear to be built on a foundation of broad public acceptance of wind power and its associated costs of subsidies and grid investments.

However, wind power remains controversial after more than 40 years of implementation in Denmark, and continues to be a challenger energy source in the context of the long history of fossil fuels. Fossil fuels have been integral to the construction of modern society, and have had more than 150 years to become the incumbent energy sources of the western world technically, politically, and economically (Mitchell, 2009). Recently, it has become clear that agreement about Denmark's strategic direction was not as strong or enduring as the 2012 Energy Act seemed to indicate. Old controversies re-emerged in 2015 and 2016 that were driven by a new Danish government opposed to the perceived high cost of wind power. Recent events in the Danish energy field have revealed a lack of shared meaning and legitimacy in relation to so-called subsidy costs and ambitions for wind power in Denmark (Karnøe & Jensen, 2016), surprising many stakeholders who thought that the broad consensus from 2012 would hold. Indeed, escalating debate in the media and recent policy shifts have revealed a (surprisingly) strong divide over the country's energy strategy, with a media-public and political coalition fully supporting wind power on one side, and another media-public and political coalition only modestly, and at times reluctantly, supporting wind power on the other side. The latter group utilizes the opportunity of being in government to roll-back earlier policies while creating new uncertainties about current subsidy frameworks and agreements (Steel, 2016a). Entrenched beliefs such as "subsidy costs are a burden" or "wind power disturbs the energy system" seem to have taken hold and are now mobilized in the current debate about wind power's legitimacy in the Danish energy system. In addition, the claim that "wind power is expensive" persists despite recent calculative comparisons and material demonstrations showing wind power to be the cheapest available technology to build. This is a rather sudden destabilization of the conditions for wind power so shortly after the 2012 energy act.

Looking at wind power today, Denmark hosts the world's largest wind power manufacturers and developers in an industrial cluster which employs roughly 33,000 people (Damvad, 2016). Denmark is due to good wind conditions and a high interconnectivity with northern markets ideally positioned for wind to supply an even larger share of electricity demand than the current 43% (DWIA, 2016a). It is the country with the highest per capita share of wind power in the world and the fourth largest total offshore wind capacity, only surpassed by the UK, Germany and China (GWEC, 2017, p. 61)[1]. Building the infrastructure required to integrate wind power has not destabilized the Danish energy system, as Denmark ranks among the top 3 countries in Europe on all key metrics for energy security (i.e., power shortages, supply independence, etc.), while charging some of the lowest raw electricity prices in Europe (Quartz, 2015). In 2016, Denmark's energy system was ranked as the best in the world by the UN-accredited World Energy Council, with an especially high level of energy security earning it the top spot (WEC, 2016). Denmark also has the world's largest industrial per capita benefit of wind power exports with the industry comprising 4.1% of total exports and 6.9% of total goods exports in 2016 (DWIA, 2017b, p. 3).

Wind power as a technology should thus have favourable policy conditions in Denmark, but is by the sitting government still problematized as being too expensive, thereby increasing investor uncertainty and destabilizing the regulatory framework for the challenger industry. The resulting political uncertainty and high risk of market instability is delaying the transition to a sustainable energy system, and I find this instability highly interesting after 40 years of existence. Moreover, since Denmark is still ahead of other countries in terms of wind power infrastructure and integration, the International Energy Agency (2006) has described it as a "microcosm" for analysing some of the pathways and obstacles to a green transition. The challenges that Denmark has faced and will face in making wind power one of the central components of the low-carbon energy system are worth examining to reveal insights that may help other countries when they encounter similar challenges.

In this thesis, I analyze these present controversies in the context of the historical struggles of producing the challenger technology wind power as a worthwhile

[1] In 2007, Denmark had the 6th largest installed capacity of wind power in the world comprising about 3.3% of global installed capacity (GWEC, 2008, p. 8). Denmark had until then ranked number 1 in offshore wind power installations, but lost the first place to the UK in 2007 (GWEC, 2008, p. 63), and the second place to Germany in 2015 (GWEC, 2016, p. 49).

investment for society. One perspective would be to think that it is purely a matter of the technical performance of the technology. A second position would be that the economic characteristics are given by straightforward market prices or costs. A third could be that it is purely a matter of political meanings. But all of these perspectives neglect the question of how calculative instruments and methods intervene in the valuation of wind power. By contrast to these common positions, I examine the valuation work that has been used to frame wind power as valuable or not to the Danish society, in particular how calculative instruments and methods intervene in the meaning-making and valuation processes. This understanding has shaped the title of the thesis and its object of study, namely the valuation history of Danish wind power. Why is it an ongoing struggle and how can we understand this valuation history of wind power as a challenger technology seeking to demonstrate its worth to society?

1.1. PROBLEM STATEMENT AND RESEARCH QUESTIONS

In order to understand how meanings about societal value are formed, maintained and challenged, it is necessary to inquire into how devices, such as calculations, form statements and meanings that enable certain framings, and produce certain valuations of wind power. I therefore use the following overall problem statement to guide my inquiry:

What has been the historical role of valuation devices in producing wind power as a worthwhile investment for Danish society?

To answer this question, I examine existing theories on sustainable transition and how change occurs in otherwise locked-in fields such as the energy sector. The aim is to understand how a challenger energy source (e.g., wind power), comes to be valued by proponents, opponents and incumbents in the energy sector, and how a current dominant framing of value can be challenged by a coalition supporting a challenger energy source. The first Research question focuses on how power is enforced in the framing of wind power. Actors who are able to propose new framings can create new knowledge and meanings about the value of wind power, and thereby try to change the governance structures to favor their perspectives. To understand valuation devices, I draw on the emerging field of valuation studies, wherein it is acknowledged that the devices used to create meanings affect the value of the object being categorized. By examining the empirical field through this lens, I hope to cast light on an under-studied aspect of the emergence and development of wind power in Denmark—specifically, which political priorities and assumptions about the world affected the qualification of wind power as a worthwhile investment.

Research question 1: Which valuation frames and devices have dominated in the history of Danish wind power, and which key qualities were used to produce wind power as a valuable societal investment or not?

One cannot understand valuation frames without also analyzing the networks behind them. To analyze how the various actors have positioned themselves, I employ Neil Fligstein's work on field theory with a specific focus on his recent work on strategic action fields with Doug McAdam (Fligstein & McAdam, 2012). I use the terminology and understanding therein to show how challengers navigate the field of the Danish energy sector and specifically focus on the political governance of the field as well as the "rules of the game." Within the overall scope of analyzing the power struggle between incumbents and challengers, I shine my spotlight specifically on the valuation devices that incumbents and challengers use to create meanings about the societal value of investing in wind power. If wind power had followed the typical trajectory of a challenger energy source, its presence in the Danish energy sector today would constitute the size of an incumbent. I thus examine if wind power is considered an incumbent in the Danish energy sector, or if it is still considered a challenger energy source, which is associated with field instability. Once this research question has been answered I will look towards the future and a broadened context in research question 2.

Research Question 2: What can be learned from the valuation struggle of Danish wind power in terms of stabilizing a challenger energy source in energy fields in Denmark and Europe?

I conclude this dissertation with a forward-looking chapter in which I reflect on how insights from the Danish microcosm can be applied more broadly. Applying these analytical insights, I examine potential future energy system developments to propose how the value of wind power can be framed in both Denmark and the EU. It is worth exploring how a theoretical understanding of valuation frames and valuation networks can be used to build strong coalitions and challenge entrenched meanings about wind power both in and outside of Denmark.

1.2. STRUCTURE OF DISSERTATION

I will hereafter briefly go through the overall structure of the thesis that follows after this introduction chapter. In Chapter 2, I present the theoretical framework for this study and describe how I aim to contribute to the field. In the five empirical chapters that follow, I cover the valuation history of wind power, with a main focus on the 43 years from 1974 to 2017.

The empirical analysis starts in Chapter 3, where I briefly summarize relevant events prior to 1974, before focusing on categorization and valuation practices in the 1970s and 1980s. This includes the formation of actor-networks around the first valuation frames which enabled the emergence of wind power in Denmark, and the framed qualities which enabled wind power to evolve from being a grassroots movement darling to a small industrial cluster. In Chapter 4, I examine how wind power expanded in a reshaped market during the 1990s, when it was framed as a necessary solution to mitigate climate change. In Chapter 5, I describe the dramatic shift in valuation that occurred in the early 2000s, whereby new actors disassembled the previous valuation frame and instead framed wind power as a distortive factor within a perceived "natural market." In Chapter 6, I examine the slow re-emergence of wind power from 2007 to 2014 as wind power was framed as a global advantage for Denmark with support from a broad valuation network. In Chapter 7, I turn the analysis to the most recent events since 2015, a period where a paradoxical mix of low technology costs and a strong focus on subsidy costs have been salient at the same time. The frameworks that enable wind power have been disassembled, and uncertainty has increased in a field that in the previous period had appeared to be stable.

Following the five empirical chapters will be three chapters, where I present my findings and build on these insights to look forward and draw conclusions. In Chapter 8, I discuss findings that emerged through empirical analysis, primarily focusing on qualities and framings that enabled wind power to be viewed as valuable to society. Doing so reveals insights about the compositions of the valuation networks that constituted the framings and how they changed over time. In Chapter 9, I apply insights from Chapter 8 to propose how wind power proponents can constructively engage in valuation struggle going forward. Finally, in Chapter 10, I present overall conclusions based on my findings. The structure of this dissertation is visualized in Figure 1 on the next page.

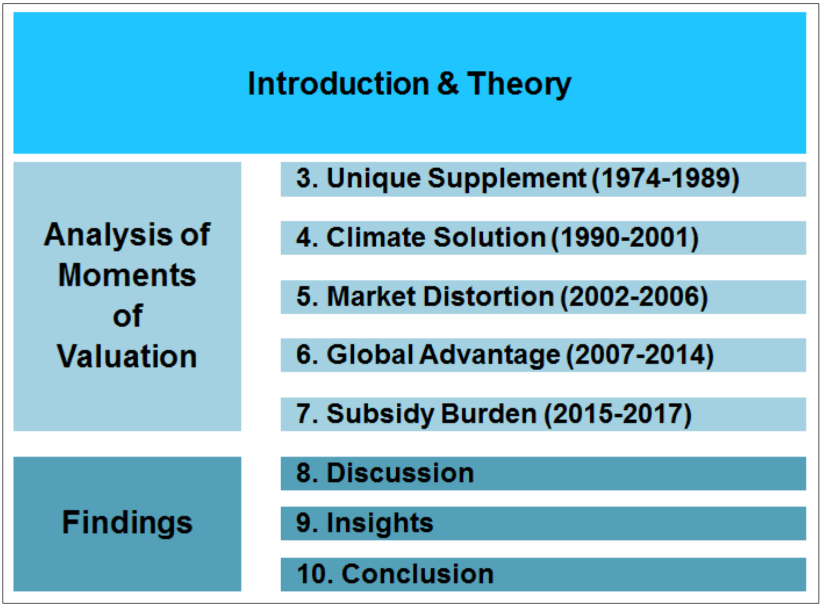

Figure 1: Dissertation structure

1.3. PHD PROJECT INFORMATION

In this section, I provide a short overview of the activities undertaken in the process of writing this dissertation to fulfill the requirements of my PhD. I have completed the activities in Table 1 to accumulate 30.25 ECTS points for the project.

Table 1: PhD-Courses and Conferences

Date	Course	Institution	ECTS
10.02.15	Introduction to PhD	AAU	1
27.02.15	Industrial PhD Course	DTU	7.5
28.04.15	Writing Scientific Papers	AAU	3.75
07.05.15	Organizing Agents and Institutions	CBS	5
04.06.15	Science and Technology Studies	AAU-CPH	5
07.04.16	6th Latin American and European Group of Organizational Studies	EGOS	4
06.07.17	33rd European Group of Organizational Studies (EGOS)	EGOS	4
			30.25

In collaboration with my supervisor, Peter Karnøe, I co-authored and submitted two conference papers which were accepted and presented at the conferences listed in Table 1. The EGOS conference paper "Never mind your numbers" was presented in July 2017, and thereafter expanded and submitted to the *Journal of Cultural Economy* in the fall of 2017. The paper is currently in "revise and resubmit" status (H. B. Mortensen & Karnøe, 2018 Forthcoming). These papers are however not part of the Monograph.

From July 2016 to December 2016, I studied at the Scandinavian Consortium for Organizational Research (SCANCOR) at Stanford University. SCANCOR enables Scandinavian PhDs, post-docs and professors to collaboratively work on research and interact with academic faculty at Stanford University. In addition to gaining valuable inspiration at various lectures at SCANCOR and the campus in general, I made two SCANCOR-presentations about my PhD work during the stay. As a PhD candidate, my teaching activity at Aalborg University has been limited to a few undergraduate classes on energy economics related to the Bachelor-education in City, Energy and Environment. I have continued to work on projects related to market design and energy production costs in my daily work at Siemens Gamesa Renewable Energy. Specifically, I have interacted with members of the field through my work in the Cost of Energy team, which provides input for industry reports published by agencies such as the World Energy Council, IRENA and BVG Associates. Additionally, I have attended a number of industry events and conferences, including the Wind-Europe 2015 Offshore Conference (Copenhagen) and the Wind-Europe 2015 Annual Conference (Paris). It should however be noted that any opinions expressed in the thesis do not in any way reflect the views of Siemens Gamesa Renewable Energy, but solely that of the author.

1.4. METHODOLOGY

In this section, I present my approach to knowledge and explain how I conducted my empirical inquiry in the field. This is thus the framework for how I aim to produce answers to the two research questions posed in the previous sub-chapter.

1.4.1 Ontological Approach

No researcher acts independently of his or her research community (I. Andersen, Borum, Kristensen, & Karnøe, 1992, p. 162). I am a member of the Special Interest Group on Valuation and Markets at Aalborg University in Copenhagen, and a contributor to the Innovative Remaking of Energy Markets and Business Models (IREMB) research project. Thus, I draw my methodological approaches from these research networks, and approach my study in accordance with similar valuation studies in the short history of the emerging field (Antal, Hutter, & Stark, 2015; Helgesson & Muniesa, 2013). In valuation studies, scholars reject both methodological individualism (i.e., all individuals decide value) and methodological institutionalism (i.e., individuals are insignificant because they are ruled by structures) in favor of methodological situationalism (Antal et al., 2015, p. 3). This means that valuation is a “spatially and temporally localized” process requiring certain technologies and devices which are recognizable to the attentive observer (Antal et al., 2015, p. 4).

I approached my analysis as a study of moments of valuation, as proposed by Antal, Hutter and Stark (2015, p. 4), who viewed valuation as an outcome of such moments that form a valuation process build on sites and methods which can be described as ‘historic, contingent and disputable’ (Muniesa, Millo, & Callon, 2007, p. 3). This choice also equates a particular approach to an understanding of power. I focus my analysis on the actors which acquire the skills and techniques to produce and codify information to function as an organized power that can facilitate control at a distance (Cooper, 1992; Reed, 1999, p. 31). Ontologically, I adopt what is known as the pragmatic approach originally described by Charles S. Peirce and William James, and refined by John Dewey (Bernstein, 2010, p. 4). The original pragmatic idea was a departure from previous conceptions of the positivists, who believe a “given” truth is out there to be discovered. Pragmatists instead propose the notion that reality is effectuation and significance is an act (Muniesa, 2014, p. 17). Under pragmatism, beliefs are understood as rules for actions; the ways in which individuals conceive and enact qualities of an object become the full conception of the object (Bernstein, 2010, p. 4). This original principle of pragmatism can be exemplified by the object of water. As an object, water is inscribed with many different signs and qualities depending on the purpose and device being considered (e.g., to sail over the North Pole, keep a nuclear reactor cool, or foster a salmon population in a river). The same word, “water,” is a sign for objects that come into existence through work and interests, where actors conceive of the object in terms of the qualities relevant to that specific site.

Dewey’s conception of pragmatism is especially well suited to studying valuation. He was philosophically opposed to the classic realistic/idealistic dualism on the meaning of value. To realists, value is inherent to an object and thus attached to something independent of an observer. To idealists, however, value is a characteristic which a thing gets by its relation to the consciousness of an organic being. Dewey counter argued that there is no such thing as value, only the process of valuation (Muniesa, 2011, p. 25). The value of an object is affected by the subject valuing it, but this does not mean that all valuation is merely subjective:

> "Value is "objective," but it is such in an active or practical situation, not apart from it. To deny the possibility of such a view, is to reduce the objectivity of every tool and machine to the physical ingredients that compose it, and to treat a distinctive "plow" character as merely subjective". (Dewey, 1915, p. 516 in; Muniesa, 2011, p. 26)

Dewey described a theory of inquiry, wherein a given problem would be transformed into a determined situation in which the inquirer would acquire new knowledge within the situated environment. Dewey understood inquiry as the struggle to replace doubt and ideas with settled belief. The notion that inquiry can be doubtful does not mean it is subjective, since even nature is an environment only when an observer is able to conceive it as such (Dewey, 1938, p. 2). Dewey sought to draw a connection between how conceptions of the world shape not only how individuals inquire about objects, but also how inquiry shapes future actions:

> "Thoughts that result in belief have an importance attached to them which leads to reflective thought, to conscious inquiry into the nature, conditions, and a bearing of the belief…to think of the world as flat is to ascribe a quality to a real thing as its real property. This conclusion denotes a connection among things and hence is not, like imaginative thought, plastic to our mood. Belief in the world's flatness commits him who holds it to thinking in certain specific ways of other objects, such as the heavenly bodies, antipodes, the possibility of navigation. It prescribes to him actions in accordance with his conception of these objects". (Dewey, 1910, p. 2)

Thus, I argue that a study of valuation fits well with the pragmatic tradition. When an actor "ascribes a quality" to something, he or she "commits" to attaining alignment with other objects in the world.[2] Dewey used the ancient belief that the world is flat to illustrate his idea. It was a belief that was thought to be fact "because people had not the energy or the courage to question" what seemed to be "confirmed by obvious sensible facts" (Dewey, 1910, p. 2). Just as believing the world is flat significantly impacts a traveler's "possibilities of navigation," the act of ascribing certain qualities to the components of an energy system impacts its builders' future possibilities of navigation. Extending this parallel to modern times, the topic of

[2] Dewey went on to quote Locke's text, *On the Conduct of Understanding*, published two years after his death, wherein Locke described what Dewey would call qualities as "images" which govern human minds: "But in truth the ideas and images in human minds are the invisible powers that constantly govern them, and to these they all, universally, pay a ready submission. It is therefore of the highest concernment that great care should be taken of the understanding, to conduct it aright in the search of knowledge and in the judgments it makes" (John Locke in Dewey, 1910, p. 6).

climate change is causing the world's scholars to question how to act in a world where science is politicized in an unprecedented way (Latour, 2011). If one acknowledges man-made climate change as an existential threat to mankind, it would in Dewey's words "prescribe" one's other actions in accordance with this conception. In the case of coal, the negative impact of burning it (i.e., the acceleration of climate change) would have to be included in its valuation. On the other hand, if one does not acknowledge climate change as an existential threat, beliefs about coal being the cheapest available energy source could remain uncontested. For an ecological issue on the scale of climate change, no single institution can oversee the scope of the task, and act as an authority to determine whether moral action is "right" or "wrong." As a solution, Latour suggested that society should stop attempting to separate the worlds of science and politics:

> "Facts and opinions are already mixed up and they will be even more mixed up in the future. What we need is not to try isolating once again the world of science and the world of politics…Since it is now the worlds that are in question, let's compare cosmologies with one another. Instead of trying to distinguish what can no longer be distinguished, ask these key questions: what world is it that you are assembling, with which people do you align yourselves, with what entities are you proposing to live?" (Latour, 2011, p. 7)

This thesis will not go deeply into climate change science and will only briefly touch upon the moral discussion of mitigating climate change. But it is worth highlighting why it is important to ask the key questions that Latour states above. Several researchers have begun to use the term "Anthropocene" to define the epoch we are living in as one where humankind is the driving geological factor of the world. Our actions and plans affect the existence of all other species on the planet, and our one species thus have considerable impacts on the biological systems that enable all species' existence (Bonneuil & Fressoz, 2016, p. 7). However, as will be seen in the analysis, calculative agencies attempt to ascribe a cost to CO2 emissions, and to ascribe a reasonable monetary cost to build mitigations to Climate change, such as wind turbines. An interesting question then becomes whether the Anthropocene epoch actually calls for an urgency imposed by nature that overrule the man-made rules of economic doctrines. Instead of ascribing monetary values to actions in attempts to incentives actions to mitigate climate change, it could be decided that an urgent exit strategy for coal was necessary. This may appear politically impossible, but as I will show later (Chapter 9: Insights), it is certainly not technically impossible. How various actors approach such questions related to climate change appears exactly to define what Latour called "the world that you are assembling". Dewey's notion that ascribing qualities to something commits one to a specific course of action is important to keep in mind as I make my way through the analysis. This is especially relevant to how wind powers value through its ability mitigate climate change is commensurated (Espeland & Stevens, 1998) and weighed against other qualities to assess whether it is valuable or not. As Latour stated in the quote above, it is important to ask: With “which people” and “what entities” does one align?[3] To me, this phrasing shows the importance of understanding which actors are assembling the networks that uphold certain valuations. To understand the assumptions behind a given valuation’s frame, one must sometimes aim to understand the broader assumptions held by the frame makers.

1.4.2 Approach to Empirical Analysis: Selecting the Empirical Material

To explain how different actors in Denmark have categorized and valued wind power, I used actor-network theory (ANT) to trace associations. ANT provides a framework with the necessary breadth to learn how a given societal path has been altered. To answer my first research question, I adhered to ANT scholars’ recommendations to follow the trail of associations (Latour, 2005, pp. 3–5). Instead of trying to map relevant actors a priori, as would be done in traditional “sociology of the social” (Latour, 2005, p. 52), I began my investigation with the first valuation struggle. Struggles over the societal value of wind power are at the center of my research, and I focused on the decisive moments of valuation. Similar to the many moments of which time, skills, human motivations and assumptions go into constructing a building that may stand for decades or centuries (Latour, 2005, p. 89), there is much to be learned from understanding the moments wherein frames, that may determine the value of an energy source for years or decades, are constructed.

Data Collection Tools

A central component of this research is a qualitative content analysis of how the value of wind power has been framed through devices such as calculations and statements. I focused on identifying the devices which are used to frame whether wind is a worthwhile investment for Danish society. This occurs in moments where a calculation or statement upholds or challenges the dominant framing of the societal value of investing in wind power. I supplemented these calculations with historical and biographical literature to track the actors’ personal historical accounts combined

[3] It is especially difficult to claim objectivity when studying topics with large implications for the societal distribution of value, as Latour elaborated in a 2017 interview: “To have common facts, you need a common reality…Science has never been immune to political bias. On issues with huge policy implications, you cannot produce unbiased data. That does not mean you cannot produce good science, but scientists should explicitly state their interests, their values, and what sort of proof will make them change their mind” (Vrieze, 2017).

with public statements made at the time. Instruments of valuations, such as government energy plans and calculative reports are supplemented with framings by public actors in the media, as well as interviews with key actors. I collected the data presented in the empirical chapters by combining a "follow the actors" methodology with document mapping. For this purpose, I used Denmark's largest and most trusted database for archival news texts, Infomedia. By searching for key terms, I was able to retrieve texts that reveal the qualities of wind power as they emerged[4]. In addition, I triangulated with historical accounts to identify major energy plans and legislative changes relevant to wind power. Doing so enabled me to create targeted searches focused on the valuation struggle leading up to a given change, or following a new major calculative report or energy plan. In Figure 2 (GBA), I present examples the three pillars of data analyzed in each empirical chapter.

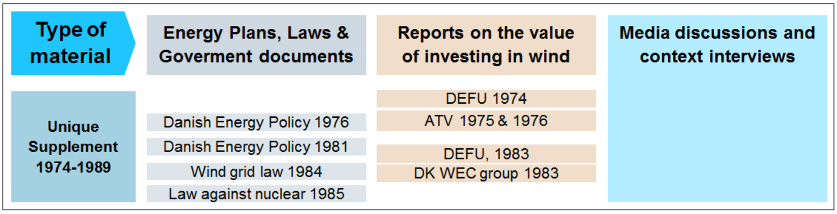

Figure 2: The three pillars of data analyzed in the empirical chapters.

Prioritizing analytical breadth inherently requires sacrifices in terms of depth. Since this dissertation is an endeavor to examine how calculative devices, valuation frames and valuation networks change over long periods of time, limited space exists to cover each year's events and discussions. This is not a thesis in history and it will therefore not comprise an empirically-exhaustive historical account of Danish wind power, but instead focus on the key calculations created throughout the historical trajectory. The thesis is within valuation and use moments of valuation to exemplify how calculative devices and concepts have been used to frame wind power as valuable or not. Since this is an analysis of the political negotiation over the societal value of investing in wind power, I address other interesting topics such as innovation or industrial policies only briefly. Readers who are eager to gain more insights into the emergence of the growth and success of the Danish wind turbine cluster can find additional information in several academic (Garud & Karnøe, 2003; Karnøe, 1991; Karnøe & Jensen, 2016; Karnøe, Kristensen, & Andersen, 1999; K. H. Nielsen, 2001; Pallesen, 2013), and historic publications (Beuse, 2000; I. K. Jensen, 2015).

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[4] Some articles in the reference-section have a code after their line, and I will also use the journalists name in the reference-section when available. This is so I can more easily track the article in the Infomedia database for further research. I hope the reader can accept the few extra lines in the references section.

Throughout the analyzed periods, wind power has expanded, as roughly shown in the graph on top of Figure 3 (GBA). In this study, I attempt to unpack both the actor networks involved in the valuation struggles and the enacted framing. This process is visualized through framings (large Squares) drawing on various qualities and their corresponding points of reference (small boxes) in the bottom part of Figure 3 (GBA). These points of reference are part of the associations of heterogeneous elements – such as humans, calculation methods, technologies, documents - which form a network upholding the frame.

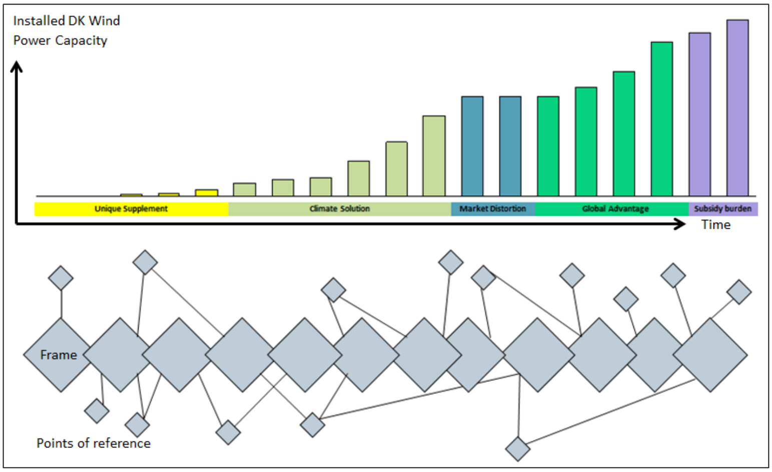

Figure 3: Frames and points of reference

Throughout the five empirical chapters, the level of detail increases, reflecting the number of available documents and coverage of actors' movements. My descriptions of valuation struggles in Chapters 3 and 4 therefore rely more on historical documents and actor interviews, whereas descriptions in the chapters 5, 6 and 7 are based on a larger set of available documents and media-sources.

1.4.3 Following and Identifying the Trail of Claims for or against Wind Power

In an examination of a field with a rich history like Danish wind power history, certain elements are highlighted, while others must be left out of the analysis. Since I view the empirical field as moments of valuation, the relevant trail of documents and statements pertain to the valuation struggle over wind power as a worthwhile investment for Danish society.

Many accounts of Danish wind power history exist, a technology-industry history (Karnøe, 1991) a network history of politics and technology (K. H. Nielsen, 2001), a collection of first-hand actor experiences (Beuse, 2000), an interview-based narration of the key struggles (I. K. Jensen, 2015), making it impossible to capture all aspects of the emergence of this energy source and industry, even in 300 pages. In this thesis I take yet another perspective and address an issue that has been overlooked as a distinct theme. Drawing inspiration from valuation studies, I focus on the political struggles over what wind power is worth to society. Doing so has enabled me to construct a different account where the valuation approach reveals new aspects of the history of wind power in Denmark. This account will include the various calculative devices involved in shaping the valuation and the stabilizing or destabilizing effects that new meanings and framings entails for the challenger technology of wind power. However, like all studies, this approach also have limitations in that it does not yield in-depth accounts of technical developments, the growth and re-structuring of utilities and turbine manufacturers, and the construction of the Danish energy market. Instead, I have chosen to focus on instruments of valuation and on those policymakers and actors with sufficient authority to make statements about the societal value of wind power. Nevertheless, since no lens ever captures the full picture, there is ample opportunity to extend this analysis to include more actors and an even more fine-grained set of qualities.

I acknowledge that for several qualities, one could argue for the necessity of some sort of an impact threshold to be included in the analysis. In order to make sense of "the messy practices of relationality and materiality" (Law, 2007, p. 2), assessments must be made, and perhaps discussed. One of the most difficult tasks of this analysis was organizing and weighing the many different types of qualities, and the authoritative importance of actors against each other. My earlier approach to the thesis was to examine calculative reports almost exclusively, and then compare their framings in that specific calculative approach. That was a less messy world, as these reports typically translated qualities into numbers. From there on it was a matter of checking which points of reference had been used to draw up the value of the different qualities, and how this weighed to form the final framing. However, in a SCANCOR seminar during my semester abroad at Stanford, Professor Mitchell Stevens challenged the notion that I could deduce something about the negotiations over wind power from the reports alone. The reports revealed nothing about the contexts, the networks that used them, and the underlying debates leading to their creation. Some qualities may have an impact on a framing even though it is rarely calculated in the central documents of the period.

Being Aware of My Position as an Observer

Since I am studying valuation struggles in a policy field, a natural question has probably already crossed the reader's mind. Is the author too embedded in the field to accurately describe and interpret it? However, according to Alvesson (2003, p.

189), an observer position with a risk of being too involved in the field (i.e., going native), can also be a valuable resource for understanding it. I believe my access to resources and key actors has been of great benefit to this study, and that I have sufficiently managed these risks by spending several years working with scholars at Aalborg University in Copenhagen, and 6 months working with scholars at SCANCOR at Stanford University in the United States. Nearly all of the empirical data (i.e., interviews and archival materials) relate to the history of wind power in Denmark, and are not directly related to Siemens Gamesa Renewable Energy.

However, I believe that the strong engineering tradition of Siemens Gamesa Renewable Energy has forced me to reflect deeply about how this thesis can function for two audiences. The difference between the two audiences became especially clear when I was interviewing a sociologist who authored one of the theories used in this thesis. He advised me to shift my focus away from the technical details of who built what and at which time to the political negotiations over the value of wind power. Having spent three years in an engineering-focused company, this struck me as profoundly incomplete. How could I possibly describe various experts' attempts to translate qualities into the object of wind power without providing a short description of the material properties of wind power and its interacting systems? I have thus attempted to write for both a sociological audience and a technical audience. If I have accomplished my task, the sociologist will find the various changes in counted qualities and the changing actor constellations of interest. An engineer who is purely interested in technology may find it interesting to learn what was known at a given time about wind power technology, CO2 quotas, etc. As originally identified by Kuhn (1962), much tacit knowledge is built on experience gained through repeated practices in the field, which cannot be accurately mapped at the outset of research. I therefore believe that being a member of both the university research networks and Siemens Gamesa Renewable Energy has helped me be more reflective about my own inquiry. As recently stated in the new journal of valuation studies, it is acceptable for researchers to deliver qualified interpretations of the valuation processes they observe:

> "It is possible to examine and make discussable the social practices of valuation while not being impartial to what is being studied. Open and blatant critiques of a particular valuation practice may bring greater force to discussions through the independent assessment (whatever this means) of the merits and demerits of what a certain valuation practice renders visible and invisible. There is indeed much to be said about the importance of, and even need for, critique within constructivist analyses...It is a perfectly acceptable academic (and not just political) point to say that a specific metric has strong limits and problematic consequences" (Doganova et al., 2014, p. 90).

Where necessary, I use my field experience to provide background information about both the specific metrics and points of reference used in a given framing. If elements are black-boxed and remain black-boxed today, it is the responsibility of the analyst to raise awareness of this in his study. Otherwise, we end up merely "telling interesting stories" as John Law once described one of the purposes of ANT (Law, 2007, p. 2). To be fair, Law also argued that researchers should possibly interfere in these stories, as he does not interpret material semiotics as a grand theory, but rather as a toolkit for telling said stories about "the messy practices of relationality and materiality of the world" (Law, 2007, p. 2). When I provide background information, I do so out of the conviction that the reader will benefit more from this than from merely learning that "A claimed X and then B contested claim X."

This concludes my methodology section and I hereafter leave it to the reader to judge whether I have managed to "be close and avoid closure" (Alvesson, 2003, p. 190).

2. THEORY

In this chapter, I introduce the theoretical framework for my thesis “The Valuation History of Danish Wind Power”. For the sake of brevity, I provide a basic overview of the theories instead of unfolding their many nuances and complexities. I focus on new technologies that emerged during transitions, how incumbents and challengers fought over stability or change in fields, and power relationships in terms of how knowledge of valuation is created. Thus, my primary aim in this chapter is to show why valuation studies can help reveal the political struggle of the valuation work that occurs during energy sector transitions. The theoretical toolset presented in this chapter enabled me to understand how meanings about wind power’s societal value are produced through calculative technologies and connected to political action, which in turn is linked to capacity expansion decisions. Just as new meanings about wind power can affect political action and capacity expansion, it also can work the other way, where the materiality of previous expansion initiatives or legislative system changes affect future political actions and meanings about the value of wind power.

When faced with the existential threat of climate change, it is intuitively tempting to expect that global society will make a technological leap when it is most needed. The designs of current energy technologies may appear obvious; it would be easy to assume that they would have been invented independent of political priorities and economic arrangements. But as will be revealed in the empirical chapters on the adaption of wind power in Denmark, innovation and political priorities are inherently intertwined. Hughes (1983) showed that the energy system we have today did not naturally evolve from rational technical choices, but was built through a complex web of intertwined technical, economic and political concerns. This is also empirically shown by studies of entities that today are described as “conventional” energy sources such as coal and oil (Mitchell, 2009; Unruh, 2000), which have gone from being false heroes to villains in a matter of a few years. Unruh (2000) and Mitchell (2009) have documented how fossil fuel extraction largely drove the proliferation of modern Western society and is an underlying component to many locked in societal structures. Today, it has become clear that the companies which have benefited the most from fossil fuel extraction have also delayed being perceived as villains. Since the 1960s, the American Petroleum Institute and several large oil companies have been aware that climate change would at some point reveal fossil fuel extractors as villains and not as heroes (Oreskes & Conway, 2010).

The idea that the technical, political and economic spheres are intertwined is at the core of science and technology studies. Technologies “reproduce and embody the complex interplay of professional, technical, economic, and political factors” (Law & Bijker, 1992, p. 3), and thus mirror the societies we live in. Any account of a technical trajectory would be comprised of “messy networks” across the spheres

(Law & Bijker, 1992, p. 8,12); moreover, since all framings are imperfect, overflows should be thought of as the norm and not the exception (Callon, 1998). When studying sustainable transitions through this lens, calculative devices become central in producing ultimate value. This is exemplified by Mackenzie when it comes to economic models that shape financial markets (MacKenzie, 2009b, pp. 3–4), and by Fourcade when it comes to calculating environmental damages or oil spills (Fourcade, 2011, p. 1727).

2.1. THE MULTILEVEL PERSPECTIVE

The multilevel perspective (MLP) framework is among the oldest and most widespread within sustainable transition studies, making it a natural starting point for my thesis (Geels, 2005, 2011). The central point of the MLP framework is to study transitions as resulting from "the interaction between processes at different levels:" niche, regime and landscape (Geels, 2011, p. 29). From Geels' perspective, an existing energy sector is a socio-technical regime, which is stabilized through a combination of technical, social, political and economic performance criteria, such as sunk investments and infrastructure restraints (Geels, 2011, p. 25). The concepts of niches (i.e., where radical innovations happen) and landscapes (i.e., broader contexts that may influence regimes) are derived from the studied regimes. Regimes represent established practices and associated rules that can change at the interplay between larger societal changes at the landscape level, and R&D innovations developed at the niche level (Geels, 2014, p. 23). Niches will be the areas where new challenger technologies emerge to change the existing dominant regime. The MLP framework is beneficial for mapping exogenous events and niche actors involved in challenging a given regime (Smith, Voß, & Grin, 2010). However, like the other sustainable transition frameworks, its utility for analyzing political agency in power struggles is underdeveloped (Hess, 2014; Meadowcroft, 2011).

> "From the outset sustainable development was understood as a political project, because the operation of social institutions does not spontaneously generate a sustainable development trajectory…To put this another way: markets may drive the uptake of the iPhone (with a lot of help from a favorable regulatory environment), but they will not produce a carbon emission-free energy system—at least on a time frame relevant to avoiding dangerous interference with the climate system….So whatever else they may be, sustainability transitions are inherently political". (Meadowcroft, 2011, p. 71)

This notion aligns well with Nobel-prize winning economist Nicholas Stern's description of climate change as "the greatest and widest-ranging market failure ever seen" (Stern, 2006, p. i). If institutions in the MLP framework do not adequately mitigate climate change, the sustainable transition landscape becomes inherently more political, as the time element eventually requires lawmakers to make difficult choices through climate change mitigation policies (Meadowcroft, 2011, p. 72).

> "The politics of sustainability transitions requires a redefinition of societal interests and this implies political engagement to build reform coalitions, create new centers of power, buy off powerful lobbies, isolate die-hards, compensate losers, and so on….It is therefore important to develop an understanding of how political actors (understood broadly) can construct linkages between economic, social and environmental reform agendas;…what resistance strategies are most popular with transition opponents, how they can be countered by proponents; and so on". (Meadowcroft, 2011, p. 73)

According to Meadowcroft, the struggle between various incumbent actors and their strategies of resistance must be further developed in the MLP framework. This call for more focus on agency aligns well with Geels' later work, wherein he described regime stability as an outcome of "active resistance by incumbent actors," and encouraged scholars to "understand and enact the destabilization of fossil fuel-based regimes" (Geels, 2014, pp. 23, 25). In Geels' 2014 paper on regime resistance, he highlighted a "core regime alliance" between incumbent firms and policymakers:

> "I suggest there are, at least, three ways in which firms influence policymakers. First, dependency leads to relational networks and close contacts between big business and senior policymakers, which provide policy access to firms….Second, frequent contacts may lead policymakers to internalize the ideas and interests of industries, which is a more subtle mechanism of influence…Third, firms use "corporate political strategies" to influence policymakers, which may contain information strategies, financial incentives strategy, organized pressure strategies, direct lobbying strategy, and confrontational strategies such as litigation…In sum, one way to introduce power and politics into the MLP is to conceptualize relations between policymakers and incumbent firms as a core regime level alliance, which often resists fundamental change". (Geels, 2014, pp. 26–27)

Recent efforts to include a more political element have improved the MLP framework. Incumbents are seen as exerting influence through frequent interactions in relational networks, whereby policymakers “internalize the ideas and interests” of the incumbent industries. I agree with Geels on the importance of the networks between incumbent actors and policymakers. Building on Snow and Benford’s (1988) original frame concept, Geels proposed three different framing dimensions of regime resistance—namely, diagnostic framing, prognostic framing and motivation framing. Geels explained that incumbents use their political power to frame which problems should be addressed (diagnostic framing), how they should be solved (prognostic framing), and which actions actors should pursue (motivation framing) (Geels, 2014, p. 29).

Although Geels stated that challengers must propose alternatives to existing dominant frames, he did not explore the valuation work underpinning the creation of new frames. In the next section, I briefly discuss other branches of sustainable transition studies that have also dealt with this question of power in framing processes.

2.2. SUSTAINABLE TRANSITION STUDIES

Beyond the MLP framework, a number of other theories have emerged within sustainable transition studies that are worth touching upon. In a comprehensive literature review, Markard, Raven and Truffer (2012, p. 959) defined sustainable transition studies as “the analysis of the institutional, organizational, technical, social, and political aspects of far-reaching changes in existing socio-technical systems (e.g., transportation and energy supply), which are related to more sustainable or environmentally friendly modes of production and consumption”. They identified four major frameworks: MLP, transition management, strategic niche management, and technological innovation systems. In addition to MLP, strategic niche management and technological information systems are relevant to the context of this study.[5]

Smith and Raven (2012, p. 1027) explained how the strategic niche management framework distinguishes between a “formative phase,” wherein actors engage in experiments within a “protected space” phase, and a “growth phase” that typically follows characterized by system expansion and diffusion. Although Smith and Raven (2012, p. 1029) recognized that actors perform “intermediating work” to

[5] The exception is the transition management framework, which draws on the early works of evolutionary approaches to propose an “instrumental, practice-oriented model” to manage technological innovation (Markard et al., 2012, p. 958). This has not yet been developed on a national level, so although the framework has some applicability at the municipal- and city-level, it is not relevant to explore further in this context.

create robust knowledge networks, they contended that it remains "unclear precisely how niches compete and transform incumbent regimes" (Smith, 2007; Smith & Raven, 2012, p. 1030). So although both Geels and Smith and Raven designate niches as the place where challengers emerge, the interaction with the incumbent regime appears to have potential for further development.

Drawing from Smith and Raven (2012), Lauber and Jacobsson (2016) has deployed the Technological Innovation Systems (TIS) framework to examine the German Energiewende. Specifically they aimed to analyze how various legislative acts function from two different perspectives. They found that when the "fit and conform" perspective is adopted, the value of renewables is framed based on short-term cost competitiveness under current system configurations. When the "stretch and transform" perspective is adopted, however, modifications to the existing system are considered to accommodate renewables (Lauber & Jacobsson, 2016, p. 148)[6]. Although this study shows that TIS can include the political struggles in a transition to some degree, one of the original critiques—namely, that it does not sufficiently map the processual dynamics of agency—still stands (Markard, Hekkert, & Jacobsson, 2015, p. 82). Lauber and Jacobsson (2016, p. 261) argued that achieving a greater understanding of the "politics of policy" in the green transition requires an approach that is even more interdisciplinary than Geels' (2011, 2014) MLP framework. Proponents of the technological innovation systems (TIS) framework have acknowledged that their approach "does not address the decline of (incumbent) socio-technical systems, nor has it paid much attention to interaction of multiple technologies;" nonetheless, developing this branch of the framework is considered a worthwhile endeavor (Markard et al., 2015, p. 80). According to Markard, Raven and Truffer, all branches of sustainable transition studies have neglected the political aspect of transitions:

> "At a more conceptual level, issues of power and politics had originally been somewhat neglected…transition research has mostly focused on meso-level contexts, such as innovation systems and sociotechnical regimes. Therefore, the field might benefit from more in-depth studies on how system and regime structures are created and changed through the strategic interplay of different types of actors" (Markard et al., 2012, p. 962).

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[6] The authors show an emerging focus among especially the business wing of De Konservative on the 'affordability' of energy in the mid-2000s, and a warning from the four major utilities that expanding capacity for renewables could cause 'grid destabilization and increased blackout risks' (Lauber & Jacobsson, 2016, p. 151). Lauber and Jacobsson (2016, p. 160) concluded that the fit and conform discourse is currently dominant in Germany, which in part stems from an initial law from the 1990s which framed renewables as 'an additional source, probably marginal', and in part from a post-2009 backlash to the 2000 EEG law. They highlighted the high degree of controversy over the stretch and transform notion that market formation is 'essential to reducing initially high costs' (Lauber & Jacobsson, 2016, p. 160).

Although progress has been made in the six years since the four major frameworks were mapped, scholars in the field of sustainable transition studies still have “much to learn from…neo-institutional theory, actor-network theory, political and policy sciences” (Markard et al., 2012, p. 962).

2.2.1 Smith and Raven’s Empowerment Framework

Smith and Raven (2012) proposed an approach to analyze how actor networks seek to empower niche technologies by further developing the “fit and conform” and “stretch and transform” perspectives, now called empowerments. The fit and conform empowerment involves niche technologies trying to become competitive within “conventional, regime criteria,” whereas the stretch and transform empowerment involves an attempt to “convince the wider social world that the rules of the game need to be changed” (Smith & Raven, 2012, p. 1033). When the stretch and transform empowerment is enacted, the coalitions advocating for the niche technology attempt to justify system change by arguing that the niche technology presents a “realistic resolution to instabilities, conflicts and tensions” in the current market or system. This proposed framing of the world must be accepted by a “sufficiently powerful coalition” for it to translate into a system change (Smith & Raven, 2012, p. 1030).

To achieve power, coalitions use three types of narratives to “reshape perspectives” and possibly enable desired market-changing reforms (Smith & Raven, 2012, p. 1032). The first narrative focuses on future performance improvements that will justify investing in the niche today; these can include promises about future reductions in technology costs or more reliable output. The second narrative advocates for present day reforms to make the niche competitive, for example, by promoting job growth in the renewables sector. The third narrative involves reframing the past by challenging prevailing understandings of priorities, for example, by reframing which energy sources are considered to provide energy security. This elaborated understanding of niche technologies provides a “more networked and discursively argued way” (Smith & Raven, 2012, p. 1031) to empower a niche technology, which is “far from an orderly, singularly rational management task” (Smith & Raven, 2012, p. 1034) According to Smith and Raven, in-depth empirical work is required to determine whether their proposed framework captures these processes. The approach to understanding how niche advocates mobilize evidence and construct narratives represents a significant advancement compared to previous approaches, but is still very broadly defined.

Their focus on the “mobilization of material and nonmaterial resources” (Smith & Raven, 2012, p. 1031) to shape norms and standards also reveals an awareness of the interplay between human and material actors. Especially during attempts to stretch and transform, coalitions must "create capabilities and attract resources that empower participation in political debates" (Smith & Raven, 2012, p. 1031). Nevertheless, the three narratives fail to address the role of mobilizing actors and calculating value.

Although these significant contributions from Geels (2011, 2014) and Smith and Raven (2012), have provided valuable tools that recognize the political struggles involved in energy transitions, it is necessary to obtain an even deeper understanding of the exact power struggles between incumbents and challengers, and how interactions between incumbents and policymakers are central in defining the rules of the game and maintaining stability in the field. But these interactions also need to account for the instruments that are at play when value is calculated, for example when future performance is framed to justify political action. It is necessary to know more about the role of calculative devices and methods and how they impact the robustness of a given framing. It is thus important to explore how these frameworks can be "theoretically enriched by mobilizing insights from other theories" (Geels, 2011, p. 31).

2.3. STRATEGIC ACTION FIELD THEORY

Strategic action field theory (Fligstein & McAdam, 2012) and Fligstein's (1996, 2001, 2008, 2013, 2014) corresponding work on markets as fields is suitable for analyzing how actors maintain stability in a socially constructed arena such as an energy market. Since it especially facilitates extensive consideration of the interplay between state and market fields, this framework is suitable for a study of wind power[7].

Fligstein and McAdam characterized fields as "constructed social orders that define an area within which a set of consensually defined and mutually attuned actors vie for advantage" (Fligstein & McAdam, 2012, p. 64), wherein strategic action fields are "the constructed mesolevel social orders" wherein actors interact with each other on the basis of shared understandings about purpose, relationships and governing rules (Fligstein & McAdam, 2012, p. 9). In strategic action field theory, value is determined within a field when actors fight over how to split resources, which affects the rules of the game. This can be exemplified by current capitalist markets, which only exist because nation-states "create the institutional conditions for

[7] I will hereafter refer to Fligstein's body of work as Strategic Action Field Theory, although I am aware that the major piece on this is written with Doug McAdam and some text on market architecture are also written in collaboration with other authors. This is not too take anything away from these other authors, but it is needed to have some sort of common reference point for the large theoretical framework, which mainly draws on Fligstein's papers.

markets to be stable," so that these markets can "create and maintain stable worlds" for market actors (Fligstein, 1996, pp. 657–658). A market is just one of many ways for a society to allocate resources as there is no "single set of social and political institutions that produce the most efficient allocation of resources" (Fligstein, 2001, p. 23). The difficulty in this is especially apparent when it comes to natural resources or pollution, as exemplified by carbon markets (Callon, 2009; MacKenzie, 2009a), the value of nature in a market arrangement (Fourcade, 2011), and climate change mitigation as a collective concern (Pallesen, 2013).

2.3.1 Incumbents and Challengers Determine Stability in a Field

As in other sustainable transition theories, Fligstein distinguished two groups of market actors: incumbents and challengers (Fligstein, 1996, p. 663). As the dominant actors in a given market, incumbents frame their actions to create or negotiate stability in the market amongst themselves and government entities. Challengers try to gain a foothold in a market, and experience market institutions as factors beyond their control. As long as the market remains stable, they must frame their actions according to the rules established by incumbents. However, when a crisis emerges, the roles of incumbents and challengers can change significantly. This perspective challenges static views of lock-ins, as market fields may be characterized by cracks and heterogeneity, as opposed to a single dominant understanding. Both challenger and incumbent actors thus can be viewed as "constantly making adjustments" in a field that is "continuously contested and constantly oscillating between greater or lesser stability and order" (Fligstein & McAdam, 2012, p. 12). Ensuring the success of markets as institutional projects is inherently a political endeavor (Fligstein, 1996, p. 664). The valuation of goods depends on a number of constructed assessment methods that have been shaped and accepted by dominant players in industry and society over time (Fligstein & Dauter, 2007; Fligstein & McAdam, 2011). A dispute over the value of a given good constitutes a struggle for market control (e.g., which actors should deliver electricity)[8]. State actors typically do not change the rules governing interactions unless dominant actors are under pressure.

[8] The energy market has an additional layer of complexity, as indirect and direct subsidies from state budgets play a significant role in shaping the market. If the valuation struggles of wind power are to be analyzed, interactions between incumbent firms and policymakers are important. Fligstein's theory on markets and their enabling institutions is therefore highly relevant. One example of how costs become a target in itself is the alleged "Energy Trilemma:" affordability, energy security and decarbonization. The Energy Trilemma had been proposed in 2008 by UK branch of the German utility EON back in 2008 (Boston, 2013). But it was not highly salient as a device until it was re-introduced at a 2013 conference as an 'old' way of seeing things by a British industry lobbyist. It depicts three energy system qualities, decarbonization, energy security and affordability, wherein a step in one direction could not be done without losing something on

2.3.2 Conceptions of Control and relation between State- and Incumbent Actors

Fligstein identified four types of rules which produce market stability: property rights, governance structures, rules of exchange, and conceptions of control (Fligstein, 2001, p. 32). Property rights distinguish where risks and rewards are allocated, and thus make firms in a market distinguishable from one another. Governance structures constitute the laws and practices which define how firms compete and cooperate. Rules of exchange also regulate the market by governing how transactions are performed (i.e., legally constituted health and safety obligations). Conceptions of control is the fourth and most interesting rule to study, as it relates to hierarchies in the internal organization of a given market that constitute a shared worldview among incumbent actors, which enables them to interpret others' actions relative to "how things work" in their market.

> "Market structures involve both cognitive understandings and concrete social relations...specific understandings about the way a particular market works. These specific understandings structure the interactions between competitors but also allow actors to make sense of their competitors' actions". (Fligstein, 2001, p. 32)

Fligstein emphasized that the laws and rules governing such political projects as markets are never neutral; rather, they favor certain groups of actors. States do not seek to change such rules unless dominant groups or the state experience an economic crisis, which precipitates demands for change (Fligstein, 2001). For example, the oil crisis of 1973 sparked demands for change and played a role in enabling the emergence of wind power. Although Fligstein and McAdam suggested that challengers who act independently encounter great difficulties in changing current market arrangements during periods of stability, they recognized the ongoing contestations during these periods and the skills deployed by "agents of change" to "resist other actors' power" (Fligstein & McAdam, 2012, p. 7).

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another parameter (CB, 2013). The World Energy Council (WEC) would then a few years later start producing Trilemma reports based on almost the same phrasing, namely Environmental impact mitigation, energy security and social equity (WEC, 2016). To bring "affordability" up to as high a status as sustainability and energy security limits the discussion about what it is worth to solve or mitigate the two large challenges in the trilemma. If "affordability" is mentioned as a goal in itself, the goal of having "cheap" energy becomes a purpose on its own. But "cheap" coal power is only cheap because we are not pricing the climate change damages it does.

2.3.3 The Work of Actors is Ongoing

Fligstein's theories show the importance of bridging the gap between what used to be divided into the two spheres of "rational" economics and "intimate" sociology (Zelizer, 2007). Fligstein generally rejected such a division, as well as the idea of dividing the world into macro- and micro-levels; instead, he described society as consisting of millions of "densely interconnected" fields (Fligstein, 2014, p. 2). These fields are defined by ongoing changes (Fligstein, 2013, p. 43), and order can only be achieved through "interaction with other actors where something is at stake" (Fligstein, 2014, p. 1). Fligstein distanced himself from what he described as the sociological version of new institutional theory, which "tends to underestimate power, conflict and the degree to which there exists hierarchy within fields (Fligstein, 2014, p. 2). As such, even when a field appears stable, it is not due to some inherited script from history that powerless actors must follow, but because incumbent actors constantly make adjustments to maintain a stable world (Fligstein, 2013, p. 43). All fields are "embedded in complex webs" of other proximate fields (with strong ties where actions routinely impact each other) and distant fields (with weak ties or virtually no ties) (Fligstein, 2013, p. 44). Although Fligstein recognized intra-field hierarchies, no macro-order field exists in the traditional institutionalist sense. Societies interpret new crises from "the current dominant perspective" (Fligstein, 2001, p. 36), but such a dominant perspective is just another network, which represents a source of information (Fligstein, 2013, p. 48).

2.3.4 Incumbents Determine the Value of Products and Realistic Pathways

Fligstein and Calder (2015) considered the qualities of a given product, but only in the context of initial market creation. Before a product enters the market, market and state actors define what qualities to ascribe, and the rules governing exchange:

> "For example, in the early stage of a market's development, a product's qualities need to be defined. Governments, firms, and customers have input into the question of what count as safe food products, useful telecommunications standards, or tradable financial securities. ...Institutional theory stresses not only how states set rules and enforce sanctions, but also how they define what types of products are appropriate for exchange". (Fligstein & Calder, 2015, p. 3)

Moreover, market actors rely on "institutional architecture, formal and informal rule systems" to mediate problems related to the exchange of goods (Fligstein & Dioun, 2015, p. 71). Therefore, this framework accounts for how interactions between state and private actors determine a given product's qualities in order to define the rules governing its exchange. Although Fligstein did not engage further with ongoing valuation work, the above quote reveals an awareness that valuation work occurs.

Apart from its compatibility with valuation studies, this theoretical framework is useful for mapping how incumbents can influence what is considered a realistic technological pathway. Stirling used Fligstein's framework to analyze how incumbent actors in European energy markets influence which technological pathways are considered realistic (Stirling, 2014, p. 86). This is critical to examine, since the various technological pathways for creating a low-carbon energy system are so disparate that they cannot be optimized simultaneously (Awerbuch, Stirling, Jansen, & Beurskens, 2006, pp. 202–222). Since any discussion of future energy pathways occurs in a context characterized by system lock-ins creating entrenched vested interests (Unruh, 2000, 2009), there is a need to understand the actors who get to frame the value of energy sources (Stirling, 2014, p. 85) [9]. One example of powerful actors working to re-categorize the energy source they support, is the work of the nuclear lobby to categorize nuclear power as emission-free so it could be associated as part of the same group as the renewable energy sources of wind and solar power in 'low-carbon energy policy frameworks' (Garud, Gehman, & Karnøe, 2010). Professor Anna-Marie Mol has also developed relevant considerations of power in relation to healthcare. But if one imagines the words "patient" and "healthcare" replaced with "energy" in the following quotes, it has some relevance for the analysis to come. Mol asks whether an administrator decides between options on behalf of a "patient-customer making choices between discrete goods on a market, or should it be a patient-citizen trying to organize the healthcare system for the benefit of all" (Mol, 1999, p. 86). Mol's point about how powerful actors frame those they claim to speak on behalf of, is something I also think can be applied to the energy market.

Fligstein's field theory is well-suited to studying transitions in contested fields, particularly due to its strong focus on agency. I use Fligstein's conceptualization of incumbents and challengers, and of how incumbents and state actors collectively establish the rules of the game. I also highlight which technological pathways are deemed "realistic" by incumbents in the analysis. In the next section, I shift my focus to valuation studies, which can reveal how qualities come to form framings of value.

[9] One could, of course, argue that a locked-in infrastructure that favors a certain technology has a type of power; importantly, material conditions could also serve as beneficial reference points for a given coalition, even though they are not viewed as a controlled power resource. Fligstein (2013, p. 43) recognized networks as representing sources of information, resource dependence and trust, since power is exercised through access to knowledge. He discussed how "material resources" can be used as a "powerful weapon" to shape "contours of the emerging field" (Fligstein, 2013, p. 45), herein understood in the sense of Bourdieu's (1986) types of capital, which can be exchanged for power. Just as Fligstein mainly interpreted materials as resources which are leveraged for power to enforce a given framing, scholars in the field of valuation studies view materiality (e.g., infrastructure) as a quality to be leveraged in a proposed frame.

2.4. VALUATION STUDIES

Like sustainable transition studies, the field of valuation studies is rooted in the science and technology studies tradition, but compared to sustainable transition studies valuation studies is occupied with how value is calculated and framed. Valuation studies breaks down Parson's Pact, which had set up a barrier between economic calculations and societal values and priorities (Çalışkan & Callon, 2010).[10] Value is not seen as something that is determined in some unobservable equilibrium, but rather as something that can be studied within sociology. When calculations frame the world, some elements become visible while others are unconsciously or consciously neglected. The editorial board of the Valuation Studies journal therefore deemed it worthwhile to pursue more studies that make "the social practices of valuation discussable and, possibly, thereby also accountable" (Doganova et al., 2014, p. 88).

Valuation studies scholars such as Kjellberg et. al. (2013) follow Dewey's (1939) pragmatic perspective that objects do not have pre-determined qualities, but become valued as an outcome of active and ongoing effort (Muniesa, 2011, 2014; Stark, 2009). Valuation is a fundamental mechanism by which economic reality is "actionized" through various instruments (Çalışkan & Callon, 2009), and valuation studies focus on these instruments and the situated work involved in valuation (Heuts & Mol, 2013; Sjögren & Helgesson, 2007). Valuation is understood as an ongoing process, and an object's valuation is thus never determined once and for all. Antal et al. (2015) aptly described how valuation can be understood as a configuration of sites and moments:

> "The sites of valuation are often spatially marked: the dining hall, the court room, and spaces for professional meetings all have their material characteristics. They are sites for collective gatherings. Each one is equipped with certain technologies and devices…Moments of valuation are also temporally marked. In most of the case studies they have a recognizable beginning and end. They are identified as sessions, or trials, or experiments. They could consist of a sequence of meetings or of an era of changing evaluation standards, only recognized in hindsight". (Antal et al., 2015, p. 4)

Examples of valuation processes may be found in all areas of production, use and consumption, regulation, public management, as well as by food and art critics (Heuts & Mol, 2013; Sjögren & Helgesson, 2007). While scholars have explored

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[10] Parson's Pact was the informal agreement made between sociologist Talcott Parson and his economist colleagues at Columbia University in the 1960s that economists would study value, and sociologists would study values (Stark, 2009).

how actors develop capacities to evaluate economic and non-economic characteristics of objects (Beckert & Aspers, 2011; Çalışkan & Callon, 2009, 2010; Callon, Méadel, & Rabeharisoa, 2002; Stark, 2009), so far, few have focused on how new valuations are proposed by actors.

When analyzing the different devices that constitute a given market, it is critical to pay attention to material and discursive assemblages which shape understandings over time (Muniesa et al., 2007, p. 2). For an entity to be "economic" and calculable in monetary terms, it must have been formulated during a series of events and trajectories that qualify it as a product in a given market arrangement (Muniesa et al., 2007, pp. 4–5).

> "Calculation is neither a universally homogeneous attribute of humankind nor an anthropological fiction. It is the concrete result of social and technical arrangements. Likewise, the qualities of goods and services are the output of complex operations of qualification, of framing and reframing, or attachment and detachment". (Muniesa et al., 2007, p. 5)

As Muniesa explained, value is framed through complex operations whereby actors attach and detach certain qualities to a good. Likewise, Callon et al. (2002) described how a good's qualities emerge within a system of "differences and similarities" of "distinct yet connected categories" (Callon et al., 2002, p. 198), which are revealed through trials:

> "First, these properties are not observed; they are 'revealed' through tests or trials which involve interactions between agents (teams) and the goods to be qualified….The characteristics of a good are not properties which already exist and on which information simply has to be produced so that everyone can be aware of them. Their definition or, in other words, their objectification, implies specific metrological work and heavy investments in measuring equipment. The consequence is that agreement on the characteristics is sometimes, in fact often, difficult to achieve. Not only may the list of characteristics be controversial (which characteristics ought to be taken into consideration?) but so also, above all, is the value to be given to each of them". (Callon et al., 2002, pp. 198–199)

The notion that trials frame value based on various qualities[11] is a key idea within valuation studies. When a good is qualified, it is revealed. But this is not understood

[11] As shown in the quotes, Callon also referred to qualities as "properties" and "characteristics;" in this thesis, the term "quality" encompasses both of the other two terms.

as a discovery process, whereby a scientist lifts a rock and discovers more information about hidden value. It is an “objectification”, which requires “heavy investment in measuring equipment”. The work of qualifying an object can be difficult; the prioritization and value ascribed to an object’s qualities can be controversial because qualification trials depend greatly on the devices used and the actors using them.

> “All quality is obtained at the end of a process of qualification, and all qualification aims to establish a constellation of characteristics, stabilized at least for a while, which are attached to the product and transform it temporarily into a tradable good in the market. A good is defined by the qualities attributed to it during qualification trials. These qualities are therefore twofold. They are intrinsic: the good is engaged in the qualification trial and the result obviously depends on the good in question. But they are also extrinsic: not only are the qualities shaped by the device used to frame the good (and therefore depend on the choice and characteristics of that device) but their formulation and explanation also generate evaluations and judgements which vary from one agent to the next”. (Callon et al., 2002, p. 199)

Callon et al. emphasized that a quality of a given object depends on both the materiality of the object and the device used to frame its value. A quality is understood as something that is inscribed into an entity to give it meaning as either valuable or not valuable.

Empirically, scholars in the field of valuation studies continue to focus on identifying similarities across studies to create a more coherent framework (Kjellberg et al., 2013, p. 15; Lamont, 2012, p. 21.4). One of the more relevant cases to this study is Sjögren and Helgesson’s (2007), analysis of the Swedish Pharmaceutical Benefits Board, responsible for determining which medicines qualify for the public pharmaceutical benefits scheme. The board enacted “a space of calculability”, wherein economic calculation became the overshadowing form of qualification of medicine (Sjögren & Helgesson, 2007, p. 216). Board members argued that goods are considered part of the same market if buyers regard them as possible substitutes for each other. Therefore, they had to assign monetary values to various health benefits and side effects to qualify certain medicines for public funding (Sjögren & Helgesson, 2007, p. 219). Their paper shows how a calculative center plays a critical role in qualifying widely different goods.

In another interesting study, Heuts and Mol (2013) demonstrated that the qualities which make a given good (tomatoes) valuable, differ based on the site of valuation.

> “That qualities are not fixed characteristics of the object qualified does not imply that they depend on the eyes of the beholder. Instead they rather depend on the active contributions of the experts, be they developers, growers, processers, buyers, cooks or eaters”. (Heuts & Mol, 2013, p. 136)

The tomato case is a good example of valuation viewed from the perspective of methodological situationalism. According to Heuts and Mol, a tomato’s value is not just a matter of taste, unique to each new “beholder;” neither is it completely determined by structures that the actors are powerless to change. Instead, value is performed in sites of active groups of experts specific to a given field, in this case, tomato experts.

2.4.1 Valuation Studies and Power

Çalışkan and Callon (2010) revealed confrontations between the “things” to be valued and the “agencies” capable of calculating and prioritizing their value. In such confrontations, asymmetries in calculative competencies exist; due to these asymmetries, the most powerful agencies are “able to impose their valuations on others,” and establish a frame wherein they determine the terms of the exchange (Çalışkan & Callon, 2010, p. 13). A network then forms around a particular configuration that makes an object exchangeable:

> “The meaning of what it is to be “economic” is precisely the outcome of a process of “economization,” a process that is historical, contingent and disputable. It seems undeniable that, in so-called advanced liberal societies, “economic” often refers to the establishing of valuation networks that is, to pricing and to the construction of circuits of commerce that render things economically commensurable and exchangeable; but “economic” can also be said of a particular configuration that aims at “economizing” in the sense of saving or rationing. The fact that an institution, an action, an actor or an object can be considered as being economic is precisely the result of this process of economization. And the historical contingency of this process does not call its reality into question. The reality of this process is as hard as the trials it imposes and the resistance that it triggers”. (Muniesa et al., 2007, p. 3)

Muniesa et al. (2007) established an important link between a commensurated and exchangeable object, and a specific valuation network. This network upholds the object’s value, which is never final but only as solidified as the “trial it imposes” (Muniesa et al., 2007, p. 3). When something has been exchanged at a given value for a long period of time, it is easy to think that this is an undisputed fact, but as Muniesa et al. (2007, p. 3) pointed out, all valuations are “contingent and disputable.” Valuation networks are formed to produce frames through various valuation devices, and new connections to reference points can be drawn to re-categorize an object as valuable or not valuable.

To understand how a given configuration such as a calculation maintains or changes, scholars in the field of valuation studies view a calculation as a literary inscription within a network which is linked to political claims about an object’s value to society (Callon, 1991, p. 135). If enough micro-actors subscribe to a given calculation, this can become a black box which no longer needs to be reconsidered (Callon, 1986, p. 284). Black boxing also occurs through materiality, and is a prerequisite for eliminating the need for human society to renegotiate everything all the time. This is shown through the effects of material devices on human society in Callon and Latour’s (1981) groundbreaking piece, “Unscrewing the big Leviathan”. By comparing baboon society to human society, they illustrated how material devices shape power relations. Researchers who studied baboons found that the primates maintain and fortify alliances through hierarchies, which are constantly negotiated through verbal and non-verbal signs. Callon and Latour (Callon & Latour, 1981, p. 283) argued that baboon societies teach us what a human society would look like if a number of “human instruments” such as walls, contracts and uniforms were not available as signals of power, which can extend further than the interactions initially involved in forming them. They used the term *translation* to refer to how actors can grow powerful by acting and speaking on behalf of other actors. Calculations are one of the ways to gain authority through translation:

> “By translation, we understand all the negotiations, intrigues, calculations, acts of persuasion and violence, thanks to which an actor or force takes, or causes to be conferred on itself, authority to speak or act on behalf of another actor or force”. (Callon & Latour, 1981, p. 279)

Calculations, buildings and laws are examples of how human societies enable translations to last longer than the interactions that formed them: This is different than the baboons who only have their bodies acting upon other bodies. This is explained in the quote on the next page.

> "But they [baboons] are social too, in that they can maintain and fortify their alliances, links and partitions only with the tools and procedures that ethnomethodologists grant us to repair indexicality. They are constantly stabilizing the links between bodies by acting on other bodies....Although in order to stabilize society, everyone—monkeys as well as men—need to bring into play associations that last longer than the interactions that formed them, the strategies and resources may vary between societies of baboons or of men". (Callon & Latour, 1981, p. 283)

A large, unbroken chain of heterogeneous material and non-material actors thus becomes a Leviathan of "greatness and longevity" (Callon & Latour, 1981, p. 284)[12]. The focus on materiality in valuation is important, because although the materiality of a given object does not solely determine the assumptions of its value, it exercises a number of constraints on how its value can be calculated (Çalışkan & Callon, 2009, p. 384;388)[13]. For the most part, these constraints are needed to ensure the coordination of human societies, as actors "would be incapable of coordination if they shared nothing more than judgments or (cognitive) calculative capacities" (Çalışkan & Callon, 2009, p. 379).

2.4.2 Valuation Studies with the other theoretical literatures

Valuation studies scholars are occupied with the specific practice of valuing "things", and with the agencies capable of calculating and prioritizing their value. The practice of valuing is not understood as something inherent to an object; rather, it is understood as an active framing process. By definition, framing is "incomplete and imperfect," since it involves selection and exclusion (Helgesson & Muniesa, 2013, p. 8). Valuation studies scholars thus do not focus on determining the most objective framing or calculation, but on critically analyzing a given frame to expose the assumptions behind it. Once assumptions and points of reference are made

[12] Full quote: "But if you transform the state of nature, replacing unsettled alliances as much as you can with walls and written contracts, the ranks with uniforms and tattoos and reversible friendships with names and signs, then you will obtain a Leviathan….A difference in relative size is obtained when a micro-actor can, in addition to enlisting bodies, also enlist the greatest number of durable materials. He or she thus creates greatness and longevity, making the others small and provisional in comparison. The secret of the difference between micro-actors and macro-actors lies precisely in what analysis often neglects to consider. The primatologists omit to say that to stabilize their world, the baboons do not have at their disposal any of the human instruments manipulated by the observer."

[13] For example, it is impossible for humans to cognitively calculate that wind turbines will produce energy when the wind does not blow, because their materiality rejects this translation.

transparent, it is possible to have a political discussion about the envisioned world emerging from such assumptions.

> "The study of valuation is, at its core, about making the social practices of valuation discussable and, possibly, thereby also accountable. It is about turning the establishment, assessment, and negotiation of values into topics for conversation". (Doganova et al., 2014, p. 88)

Only by revealing how an object's inscribed qualities were selected and prioritized, and how their values were calculated, can the valuation network behind it be held accountable. Valuation studies should thus help reveal the social practices of valuation, and thereby reveal the assumptions of a given valuation network.

Moments of valuation often involve a struggle over assumptions in the assembled framing, but in the cases where key assumptions remain black-boxed, it is acceptable for a scholar of valuation to highlight limits or problematic consequences for a given framing:

> "It is a perfectly acceptable academic (and not just political) point to say that a specific metric has strong limits and problematic consequences…What would happen to our humanness if we imagined that we could completely leave our hearts and morals behind us? Objectivity? Nihilism? Amorality?...Thus, the positions that 1) it could have been otherwise, 2) it is otherwise, or 3) it should be otherwise, are positions that are merely different in terms of analytic strategy. For all positions, it is (always) a question of how and where we do the valuation work—and what gets shown". (Doganova et al., 2014, pp. 90–91)

This "missing link," what Doganova et al. (2014, p. 91) described as "how and where we do the valuation work―and what gets shown", is what valuation studies can help illuminate. Valuation studies reveal the sites and instruments that enable valuation from the perspective of methodological situationalism.

Collectively, sustainable transition studies, the MLP framework and strategic action field theory reveal the existence of struggles over value in a given field. Clearly, power is at play, and actors have access to different resources. Yet the devices involved in framing value and produce meanings about a given object have not been analyzed. Valuation studies provide this needed framework for questioning whether the valuation of an object "could have been otherwise."

2.5. VALUATION FRAMES AND VALUATION NETWORKS

In this section, I define the two terms used to map my analysis of the valuation struggle of wind power in Denmark. First, I explain the origins of the term *valuation frame*, which I use to visualize the selected and prioritized qualities that make wind power valuable or non-valuable as a societal investment. Second, I define the term *valuation network*, which was briefly mentioned in section 2.4 and refers to a network of actors which maintain, challenge or exercise power through a given valuation frame.

2.5.1 From Calculative Frame to Valuation Frame

My definition of a frame originates from Michel Callon's (1998, p. 4) understanding of a frame as something that "establishes a boundary" which enables actors to determine the significance and content of the interactions within the framing. The frame determines what counts and how it is counted (Bruszt & Stark, 2003), and is a necessary, yet often unnoticed exercise when the values of new and unknown objects are calculated.

Beunza and Garud (2007) identified the challenge of ascribing value to an unknown good before valuation studies formed as an independent field of study. Since the emergence of the so-called Knightian challenge (named after economist Frank Knight), economists have divided themselves into two opposite positions. One position is based on the claim that calculations are straightforward, while the other position is based on the claim that a high level of uncertainty causes analysts to act like lemmings who merely follow colleagues' predictions (Beunza & Garud, 2007). Beunza and Garud challenged this division when they illustrated the valuation process of internet retailer Amazon. They argued that financial analysts should be viewed neither as passive information processors nor as imitators, but as critics who value objects by establishing calculative frames (Beunza & Garud, 2007, pp. 15–17).

> "We denote by calculative frame the internally consistent network of association, including (among others) categories, metrics and analogies, that yield the necessary estimates which go into the valuation of a company". (Beunza & Garud, 2007, p. 27)

Beunza and Garud (2007, p. 27) used the framework shown in Figure 4 to analyze how financial analysts ascribed value to an unknown entity (in this case, the internet retailer Amazon in December 1998). Two highly competent analysts issued very different valuations of Amazon: Jonathan Cohen assigned a value of USD 50, while Henry Blodget valued it eight times higher at USD 400 (Beunza & Garud, 2007, p. 22). The dramatic difference in the estimated stock value can be explained by differences in the metrics (profits vs. revenue growth), categorization (Book seller vs. Internet retailer) and comparators (Barnes and Noble vs. Dell). These elements were used to perform the valuation work, which yielded two widely divergent framings of Amazon's value. Figure 4 is a remake of Beunza and Garud's calculative frames (2007, p. 27) with the text added by the author.

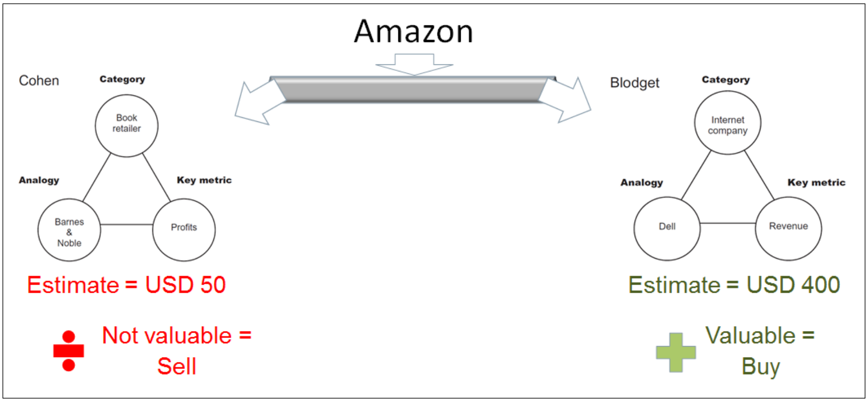

Figure 4: Beunza and Garud's Calculative Frames

The calculative frames presented by Beunza and Garud show how entities are valued using different metrics, while residing in the same domain. The authors concluded that "analysts tend to persist in their positions due to perseverance in their frames" in what they referred to as "framing controversies" (Beunza & Garud, 2007, p. 29). This is similar to the previously described "moments of valuation" (Antal et al., 2015) whereby assumptions are challenged and emerging new frames and overflows become observable within otherwise black-boxed frames.

The concept of calculative frames is useful, as it shows the connection between how a given entity is characterized and the key metric that frames its value. Calculative frames produce the valuation of an object; in framing controversies, there is a struggle over which framing will dominate. However, scholars have not yet examined how economic and technical analysts ascribe value to different energy source choices for a society.

This study is about how valuation of wind power occurs at the sites where active work is performed to produce knowledge about the societal value of wind power. But the valuation work also enacts qualities in wind power which are not always calculated into a monetary value, but still affect its final framing. The calculative frame concept therefore needs to be expanded to the notion of a *valuation frame*, drawing inspiration from Doganova and Karnøe's (2012) initial use of the term:

> "The notion of "valuation frame" helps to understand how market actors qualify goods and calculate their worth. It refers to the boundary established between the qualities of a product or service that will be taken into account in the calculation of its worth, and those that will be left unconsidered (Callon, 1998). This boundary is taken for granted and hardly noticed in everyday economic exchanges, but it becomes visible when "market rebels" (Rao, 2009) shed new light on qualities that lie within or beyond it. The mobilization of "concerned groups" (Callon & Rabeharisoa, 2008) can reveal "externalities"—that is, qualities external to the dominant valuation frame—and shift the ranking of qualities that induce market participants to take them into account". (Doganova & Karnøe, 2012, p. 18)

A valuation frame is equivalent to the calculative frame in that it tracks the network of associations among categories, metrics and analogies, but also includes associations of non-economic elements by prioritizing qualities in matter of importance (Callon et al., 2002, pp. 197–198). A framing can be likened to a formula that enacts an object's description by combining and ranking both economic and non-economic qualities:

> "Combining and ranking "economic value" and "social values" is not an easy task (Stark, 2009). Not only do they have idiosyncratic logics of valuation, but their management has generally been delegated to different actors: economic value falls into the realm of companies and markets, while social values pertain to norms, government, and regulation. This separation left social values and disutilities outside markets, and the boundary was seen as "natural state of markets". (Doganova & Karnøe, 2012, p. 17)

By substituting the words "value" and "values" with "quality" and "qualities," it becomes possible to analyze how a given framing came to produce the result it did. I propose to expand the notion of calculative frame to include non-counted, but prioritized qualities. In line with Doganova and Karnøe's (2012) initial use of the term, I propose that a valuation frame is a mixture of more or less crystallized claims evidenced by qualities which have positive or negative impacts on the framed value of an object (Callon, 1991, p. 135). These qualities are attached to the object while stabilized and are understood as both intrinsic and extrinsic. They depend on the materiality of the given object, but are also “shaped by the device” used in the given framing (Callon et al., 2002, p. 199).

The ranking and possible quantification of qualities form valuation frames (Doganova & Karnøe, 2012, 2015), which in this thesis are understood as “material and discursive assemblages that intervene in the construction of markets” (Muniesa et al., 2007, p. 2). A valuation frame’s qualities draw on points of reference to produce meanings about wind power’s value to society. Those meanings can then be mobilized via political action, which in turn affects not only the expansion of wind power capacity, but also helps constitute the very market architecture into which wind power is incorporated.

Valuation frames enable researchers to reveal the qualities that count, thereby enabling debate. The combination and prioritization of qualities can be visualized and connected to a valuation network. Different networks frame value in different ways, and their calculations enable alliances to form around a given valuation frame. I employ the previously described notion of qualities to describe how wind power’s value is determined through framings that render certain qualities highly salient and deprioritize or neglect others.

2.5.2 Relationship between Valuation Frames and Valuation Networks

In this section, I discuss the relationship between valuation frames and valuation networks. A valuation frame is constructed through the active use of devices by experts who have obtained authority to make statements about a given entity. Such groups join with other material and non-material actors to form a valuation network, as described in a previously used quote by Muniesa, Millo and Callon:

> “The meaning of what it is to be “economic” is precisely the outcome of a process of “economization,” a process that is historical, contingent and disputable. It seems undeniable that, in so-called advanced liberal societies, “economic” often refers to the establishing of valuation networks, that is, to pricing and to the construction of circuits of commerce that render things economically commensurable and exchangeable…the historical contingency of this process does not call its reality into question. The reality of this process is as hard as the trials it imposes and the resistance that it triggers”. (Muniesa et al., 2007, p. 3)

I build on Muniesa, Millo and Callon's (2007) understanding of this relationship by viewing valuation frames and valuation networks as intrinsically linked. The valuation frames formed by valuation networks do not occur at random, but are developed through active contributions at sites of valuation, which I aim to identify and study. A given framing is "as hard as the trials it imposes and the resistance that it triggers," and valuation frames that appear highly stabilized and irreversible, are so because a valuation network upholds a specific framing of qualities to make the object in question "commensurable and exchangeable."

Figure 5 (GBA) is visualization of typical differences between strong and weak valuation networks. Strong networks usually are comprised of several heterogeneous actors with privileged access to make authoritative claims about value. Weaker networks usually are more homogenous and dependent on one or few actors, of which just one or two detachments can weaken the network significantly.

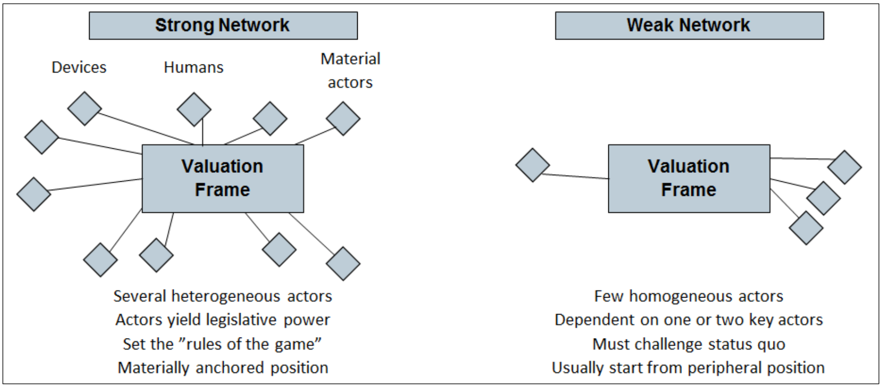

Figure 5: Strong and weak Valuation Networks.

A valuation network is understood as the network of actors who either maintain an existing valuation frame or construct new frames to challenge dominant conceptions. In addition to the usually studied coalitions of human actors, such network also comprises the materiality of laws and physical structures. This concept is thus understood as the enabling network of humans, materials and texts involved in shaping the framings in the field. It is important to keep in mind that these actors do not have to be consciously coordinated to support or contribute to a shared valuation frame. The groups of actors in a valuation network can pursue different goals while holding roughly equivalent views of the value of an object.

2.5.3 Frames and Networks in Relation to Political Power

Before moving to the analysis, I will draw some reference points to how framing of value is related to understanding political power. In the context of knowledge controversies, calculations and framings of value are understood as "instruments used to generate evidence" about a given matter of concern (Barry, 2013, p. 8,12). If a given framing makes sense to a number of significantly powerful actors, it can be black-boxed, whereas weaker framings can be turned into political matters of concern, by actors pursuing "advantages in a longer-term struggle for power" (Barry, 2013, p. 10). Objects can become subject to political contestation (Marres & Lezaun, 2011, p. 491) once their value is performed through a given frame, wherein problematized issues are pre-set. Sub-politics can be inscribed in objects and disappear from the public eye, to later reappear in a changed and generalized form (Beck, 1992, 1997, p. 52). One example of this is how fossil fuel energy sources have become materially anchored in modern Western societies, and through lock-in effects have dominated conceptions of value (Mitchell, 2009; Unruh, 2000).

During some controversies, political actors draw a line between what needs to be solved legislatively, and what can be delegated to the current market arrangement (Callon, 2010, p. 164). From this perspective, a market is framed to work satisfactorily as long as it complies with the preferences of the actors upholding it (Callon, 2010, p. 166). Thus, when the framing of an object's value is altered, it is considered a political activity. It is, however, also a political activity to delegate to the current market architecture, which essentially amounts to delegating to the incumbent actors. One way to impose a current valuation frame is to state that a given concern should be "left to the market to solve". An actor making this statement is either satisfied with the current dominant framing of value or views the price in a given market architecture as "naturally created". Such an actor may perceive himself as staying out of a struggle, when in fact he is actively upholding the current dominant framing in that market architecture. Valuation frames reflect tradeoffs and priorities with societal implications, and therefore also reflect judgments of who something should be valuable for (Corvellec & Hultman, 2014, p. 354).

In relation to power, it is important to stress that there will always exist asymmetries in calculative competencies. Such asymmetries enable the most powerful agencies "to impose their valuations on others", and establish frames wherein they determine the "distribution of value" (Çalışkan & Callon, 2010, p. 11). Power is most effectively applied when key decisions are shifted to sites where they do not seem like decisions, but facts (Mol, 1999, p. 80). All markets are constructed architectures that act as boundaries to determine which interests should be included and which should be excluded:

> "They (Regulatory institutions) establish mandatory rules about which diverse interests and values should count within a given domain of activity; often implicitly more than explicitly, they also rule on what interests and value frameworks should or can be excluded". (Bruszt & Stark, 2003, p. 75)

Once something is left to the market, the market arrangement is what Beck (1992, 1997, p. 52) defined as "sub-politics" that have disappeared from the public eye and reappeared in a changed and generalized form. Beck (1997, p. 52) specifically used the example of ecological transition as an element which challenges fundamental convictions: "technocracy ends when alternatives erupt in the techno-economic process and polarize it". He went on to explain how "the environmental issue penetrates into all occupational fields and becomes concrete and manifest in substantive controversies regarding methods, orientations, calculation procedures, objectives, standards, plans, routines and so on" (Beck, 1997, p. 58). According to Beck (1997, p. 60), these controversies eventually lead to significant changes in today's markets, as "losers generate winners. As industry loses its ecological innocence, other business sectors build up their 'greening' livelihood".

A given set of sub-politics can appear as a 'definition of reality' whereby the level of dominance is not determined by its legitimators' theoretical genius, but rather by their power (Beck, 1997, p. 58; Berger & Luckmann, 1966, p. 116)[14]. The actors in power thus can exercise indirect influence, which is not easily observable:

> "Of course, power is exercised when A participates in the making of decisions that affect B. But power is also exercised when A devotes his energies to creating or reinforcing social and political values and institutional practices that limit the scope of the political process to public consideration of only those issues, which are comparatively innocuous to A". (Bachrach & Baratz, 1962; R. A. Dahl, 1961, p. 59; in Lowery, 2013, p. 7)

Successfully exercised power can be ingrained in values and practices, which constitute the status quo and over time become taken for granted. This is what Callon (1991) would refer to as actors being 'completely translated' to follow the interest of the translator and thus not aware that power is being exercised through

[14] MacKenzie (2009a) revealed this element of sub-politics in relation to EU carbon markets.

them. Incumbent interest can then "condition wider social expectations" of what counts as realistic and unrealistic pathways or speeds for technological change (Stirling, 2014, p. 86). A dispute over the value of a given good constitutes a power struggle for control of a market, and state actors do usually not change the rules governing interactions between actors, unless dominant groups are under pressure (Fligstein & Dauter, 2007; Fligstein & McAdam, 2011).

In my study, it is especially interesting to follow the actors who are able to make calculations and statements about whether wind power is a worthwhile investment or not. Power is exercised when certain interests and values are accommodated, and over time these can seem to be "naturally given" facts. A valuation frame is, however, still the outcome of numerous decisions on the distribution of value and the inclusion and exclusion of particular qualities. I will seek out the ongoing work of creating meanings about wind power's value in the moments of valuation happening in the struggles between dominant frames and challenger frames.

2.5.4 My Tool for Mapping Valuation Frames

My theoretical foundation is based primarily on a combination of Strategic Action field theory and the emerging theory-field of valuation studies. I use this framework to investigate my original problem statement:

What has been the historical role of valuation devices in producing wind power as a worthwhile investment for the Danish society?

In the empirical analysis, I focus on how challengers representing wind power attempt to stabilize their world and challenge the dominant incumbent framings of wind power. I analyze these framings by examining which qualities historically have been inscribed into the object of wind power, and how they impact the meaning of its value. In figure 6 (GBA) I depict the mapping machinery, I use to visualize the most dominant qualities that make up a valuation frame in each period.

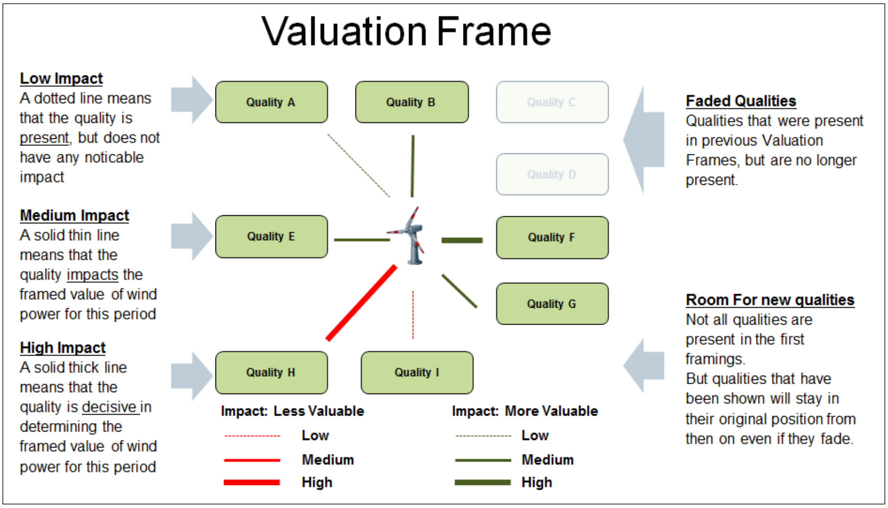

Figure 6: The Valuation Frame methodology

I study the relationships between the qualities of a given valuation frame, and the valuation network which constructs or maintains the given framing. Shifting qualities can lead to changes in actors' network positions and vice versa. At the end of each empirical chapter, I will introduce the qualities that emerged. When I thereafter point to a quality during the analysis it will be marked with a Capital starting letter and written in italic[15].

The understood relationship between valuation frames and valuation networks is visualized by the author in Figure 7 (GBA). This visualization is not used in the empirical chapters, but is included here to put an image to the connections I aim to follow. The realities of the empirical field are, of course, significantly messier; hopefully my synthesis of the literature and accompanying visualizations helps explain the lens I have used to analyze the field.

[15] There are three Valuation Frames and corresponding periods, which will be named after a quality which highly defines these frames and periods. The names of the periods and frames will however not be in italic. I know there is a risk this overlap can become confusing, but I estimated that it still worked better that the names of the frames and periods closely correspond to the central qualities. It is my hope that the connection between the frames and their qualities become more intuitive and easier to remember this way.

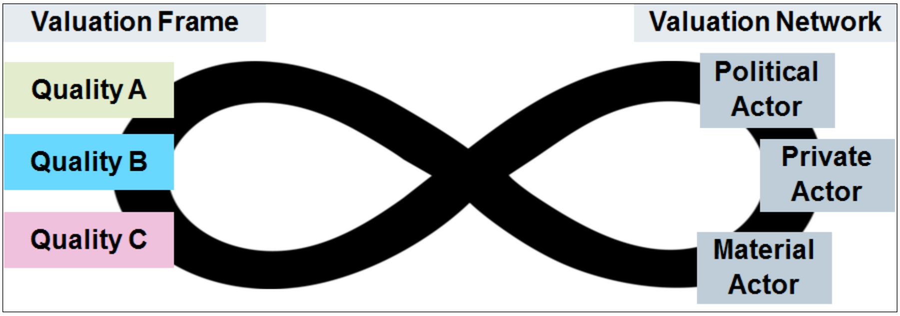

Figure 7: Valuation Frames and Valuation Networks.

In the end of each chapter will also be an overview of the valuation networks at plays, herein both the human actor coalition and the material build-out and the regulatory framework.

Throughout the five empirical chapters that are coming I have identified more than 40 different types of actors. These can roughly be divided into political parties, private or public actors that are not political parties, calculative agencies (which practice the various calculative methods) and media outlets. These actors will be presented as they appear in the analysis. There is however a focus on the political negotiation of the value of investing in wind power. I therefore have a special focus on the four political parties that all serve in governments at some point in time during these chapters[16]. These four parties are Radikale Venstre / The Danish Social Liberal Party, Socialdemokratiet / The Social Democrats, Venstre / Left – Denmark's Liberal Party and Det Konservative Folkeparti or commonly known as De Konservative / The Conservative Party. Because most of my readers will likely be Danish I will in the text refer to these parties by the shortest version of their Danish names. This also allows me to use a short abbreviation that corresponds to their Danish initials or their party letter in the parliamentary system. Radikale Venstre (RV), Socialdemokratiet (S), Venstre (V) and De Konservative (C).

In addition to these four political parties there is one private actor organisations which will also be mentioned frequently throughout the analysis. This is the Danske Elværkers Forening / Danish Utilities Organization, which is the organization representing the interests of the Danish utilities. In 2001, the organization changed its name to Dansk Energi / Danish Energy. It will therefore be referred to as the Danish Utilities Organization (DEF) in the first two empirical chapters, where after it will be referred to as Danish Energy (DE). The empirical analysis will follow hereafter.

[16] I will especially be analyzing the statements and actions of energy ministers. I have therefore placed an overview of who served in these ministries in Appendix A7.

3. EARLY VALUATION VISIONS OF A UNIQUE SUPPLEMENT

In this chapter, I will cover the early developments in Danish wind turbine history. This chapter will thus span from the first Danish turbine, Gedsermoellen, in 1957 and up to the 1973 oil crisis. Prior to this crisis, energy was not something considered to be within the political regime, but instead a matter left to the utilities who operated steam-power plants, mainly burning coal and oil for power (80% oil by the early 1970's) (DKGOV, 1990, p. 28). Denmark's first energy law was made in 1907 (Staerkstroemsloven), and among other things it prohibited the establishment of any new utility companies in an area which already had one. For the more than six decades up to the oil crisis, the Danish energy system was dictated by these local utilities that had monopoly in each their area. They set the price of production for their local customers, which in turn owned the utility through the municipality or local cooperatives (Frederiksen, 2012). The limited political interaction with this sector was in terms of setting up research programs and the few laws to set the rules of interactions, Apart from that the utilities were left to purchase the cheapest possible fuel and import this to run in the plants. The first dominant coalition within matters of energy policy and therein wind power valuation will therefore be referred to as the Fuel-coalition. It had the utilities at the center and the major political parties in agreement with the direction taken.

3.1. DENMARKS FIRST SMALL ELECTRICITY PRODUCING TURBINES (1891-1957)

Poul La Cour was a physicist by trade and today known as Denmark's first great inventor of wind power. He was known as Denmarks Edison, and had a dream to build wind turbines that eventually could mechanize the numerous manual labor hours involved in farming (Karnøe, 1991, p. 161). He had seen the first conventional steam-power plants come to Denmark in 1891, and he was worried by the risk that Denmark had to import large amounts of fuel for these plants. In January 1891, he applied for a grant to build a wind turbine and turn the electricity into hydrogen through electrolysis. As La Cour was known as a competent inventor, he was awarded 4000 DKK (Roughly 250.000 DKK/34.000 Euros in 2016), to build his first turbine, which would be erected already in May 1891 (PLCMV, 2004, p. 1). His work would continue with several constructions and inventions, and six years later (1897) he would receive funding to build a larger turbine. Towards 1910, La Cour would sell hundreds of small wind turbines (3-30 KW) to danish farms, mechanical shops and small villages (Karnøe, 1991, p. 162). La Cour would also start training Denmark's first wind-engineers from his positions at one of Denmark highest respected boarding schools, Askov Hoejskole (Wittrup, 2016a). In 1904, a young pupil named Johannes Juul started in Poul La Cour's school of wind-turbine engineers at the age of 17 although the application limit was 18. Below is to the left a picture of Poul La Cour's 1904 class of wind turbine engineers. The third person in the back row from the right is the young Johannes Juul. To the right is a picture of Johannes Juul many years later as an experienced wind power engineer[17].

Figure 8: Left: Poul La Cour's 1904 class & Right: Johannes Juul.

There were other early inventors of electricity producing wind turbines around the time of Poul La Cour, most notably James Blyth (1888) and Charles Brush (1888).

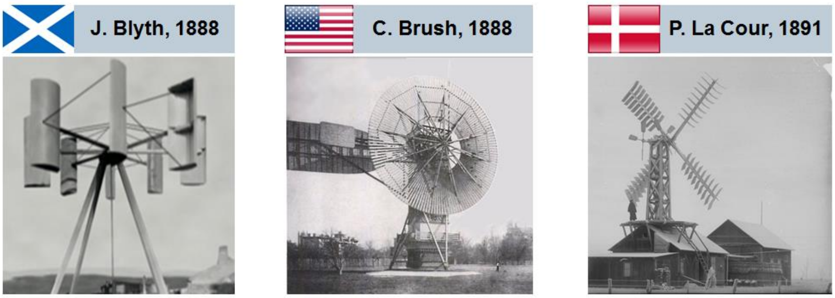

Figure 9: The first known wind turbine designs.

[17] The picture to left in Figure 8 is used with permission from the Poul La Cour Museum, while the picture on the right of Johannes Juul is used with permission from EnergiMuseet.

Danish wind power was despite La Cour's efforts still in limited to a few self-built wind turbines on local farms, which were still not incorporated to the grid. The impact that La Cour had on the technological development of modern wind power would however come to be seen everywhere in Danish society and cannot be overstated. Part of his legacy would be seen several decades later (1957), as his student Johannes Juul build the turbine that is today known as the father of 'the Danish concept' (Elmuseet, 1998, p. 9; EnerginetDK, 2009, p. 8).

3.2. GEDSER TURBINE OPENING SETS EARLY CATEGORIZATION (1957-1967)

The second large step in the early history of Danish wind power was a government-funded, but this time utility-led research program, the 200 KW Gedser Turbine from 1957 (DEA, 2016b). This turbine exhibits what is today known as the Danish concept (three-bladed horizontal-axis rotor), and is widely regarded as one of the major technical milestones for the later developments in wind turbines technology such as the Riisager, Tvind and Herborg turbines. After a long career in the energy sector, Johannes Juul demanded of his employer SEAS (Sydsjællands Elektricitets Aktieselskab / Southern-Zealand's Electricity Shareholders Company), to be allowed to develop a number of large prototype wind turbines (Meyer, 2000, p. 82; K. H. Nielsen, 2010, p. 192). Juul had worked as an electrical engineer in SEAS since 1928, and in 1947 he would be set in charge of a research program into wind turbines. This was immediately after the Second World War and the prospect of developing an energy source, which left the country less exposed to disruptions in fuel imports, was worth exploring. As the head of this project Juul was looking into a world where the energy system was predominately based on oil and coal, as the "atoms for peace" notion, which would introduce nuclear energy as an energy source, was not initiated until 1953. Juul was thus encouraged by SEAS in the onset of the project, as he would try out several different models, hereamong two and four-bladed turbines, before he in the mid-1950's found his optimal design (Karnøe, 1991, p. 168). This resulted in a 1954 exploration project on wind power, which was funded by the ministry of Public works, and supported by the Marshall aid, for a total of 0.3 mio DKK (~4.6 mio. DKK in 2017-Real) (Arhenkiel, 2015, pp. 8–12; Karnøe, 1991, p. 170).

One of the conditions for the public funding was that the project was conducted under supervision of the Danish utilities organization (DEF). Their president Robert Henriksen, who since 1955 had served as vice-president of the Danish governments "nuclear energy commission", led by Niels Bohr, gave the probably first recorded speech on Danish wind power at the inauguration of the Gedser Turbine on the 26th of July 1957. In this speech he gave the utilities view of what this new energy source was and what could be expected of it. This would initiate the first public traces of a framing contest, as Henriksen would qualify what type of an object wind power was to be considered as.

> "Today, we are not inaugurating a Calder Hall Plant (Britain's first nuclear power plant – later named Sellafield, ed.). This test plant represents no new sensational way of utilizing a sensational hitherto unknown source of energy…The wind power plant can only be used as a supplement to other energy sources, which are independent of the weather and the wind….In order for a wind power plant to be competitive, its maintenance costs, interests and repayment must not exceed the savings on fuel expenses on the power plant with which it is cooperating…today nobody can predict with certainty the future importance of wind power utilization for Danish households and Danish trade, perhaps in the form of wind power plant exports". (ET, 1957 in; K. H. Nielsen, 2001, pp. 2–3)

At the inauguration of the Gedser Turbine, nuclear energy was by many experts within the energy field framed as the new obvious energy alternative to oil, and it was thus not an uncommon statement Robert Henriksen made[18]. This opinion was shared by the Minister of Public Works, Kai Lindberg (S), who later during the inauguration dinner, announced that he sympathized with Henriksen's framing that wind power should at most play a supplementary role in the electricity system (ET, 1957, p. 305).

Wind power was framed as "a supplement", because it is dependent on the wind and thus unreliable. Continuing along this logic, Henriksen defines the wind power plants as unconventional to the existing electricity system by comparing them to nuclear power plants, which are centralized, like the existing coal and oil plants at the time. Henriksen configured the metric which wind power was to be framed by, as to how much fuel it can save from the power plant it supports. Robert Henriksen mentioned one potential benefit to pursuing an exploratory research project within wind power. Namely, the economic benefits to the Danish economy in terms of the *Industrial* quality of higher exports of wind power technology. As wind power could help replace some of the jobs that were lost in other sectors, it did have the quality of being an *Industrial* advantage, through the possible venue for exports and job creation in Denmark. Wind power is thus in this early qualification defined by its

[18] It should however be noted that Robert Henriksen had concerns about whether the government would create a big publicly funded nuclear plant, which would push DEF out of their hold. In 1963, DEF stated in an editorial that it at the current time was not economically beneficial to build a test nuclear facility in Denmark, but instead wait for nuclear to become price-competitive and then build a full-scale nuclear plant (K. H. Nielsen, Nielsen, Nielsen, & Jensen, 2015, p. 59).

ability to be a *Fuel Supplement* to a conventional power plant, and to a minor extent create some exports for Denmark.

Included in the funding to build the Gedser turbine was funding for an assessment report to judge whether wind power was competitive with existing steam power plants and thus valuable to society as a *Fuel Supplement*. This is the more solidified calculative device, which was used to qualify wind power based on Juul's Gedser turbine. The committee who wrote this report was headed by the CEO of the major utility company SEAS, S.M. Buhl and had Per Poulsen-Hansen, an employee in Danish Energy, as secretary and main writer (K. H. Nielsen, 2001, p. 14; Vindkraftudvalget, 1962b, pp. 72–73). The framing compared the cost of steam power to wind power. The committee added 4% transmission losses to wind power and a grid costs to supplement worth 15 DKK/MWh (152 DKK/MWh in 2017-R). DEFU ended at an equation that concluded wind power would only be competitive if steam power generated electricity would cost 17-19DKK/gigacalorie. Since current fuel prices at the time were around 8-9 DKK/gigacalorie, the framing led to the conclusion that building new wind turbines would cost approximately double of the fuel savings in the supplemented the steam plants (K. H. Nielsen, 2001, p. 10; 14; Vindkraftudvalget, 1962b, pp. 72–73). The value of wind power was calculated on the basis of whether fuel savings exceed the system costs of adding an energy source that was 'not available' as electricity demand needed it, as seen in the report quote below.

> "If there is only built wind turbines to a limited extent to supply steam power plants, there will be no savings to be had on the steam power plants in terms of capital costs, maintenance or salaries. The Wind Power electricity can therefore only be paid with the savings in fuel, with an added cost for transmission losses…That wind power is not available 'at the same pace' as the electricity demand does hardly need any further evidence, as long as one remembers, that the weather can be completely calm for days in a row". (Vindkraftudvalget, 1962b, p. 72)

The report's conclusion was summarized in an article in the engineer's magazine, wherein the wind power Committee explains their reasoning. The committee employs the *Fuel Supplement* quality to categorize wind power as too expensive to deploy on a large scale, just as was done in Robert Henriksen's 1957 Inauguration remarks, as seen in the below quote from the article.

> “Very substantial price movements are necessary before wind power can be fitted profitably into the economy of Danish utilities. However, Danish industry stands a good chance of building upon the experiences acquired. There is a very large and well known demand for wind power plants in a number of developing countries”. (Vindkraftudvalget, 1962a, p. 213)

This conclusion was supported by all members of the Wind power Committee with the exception of Johannes Juul, who would challenge this framing with his own alternative calculation only a month later. Johannes Juuls challenged the Wind Power Committee’s framing on the point of technological advancement possibilities and current integration costs. The first point was related to the fact that Juul believed the Gedser turbine design could be optimized much more than assumed in the committees report. Secondly, Juul envisioned wind power in a larger energy system, where production was spread out over more wind farms and combined with hydropower in Norway and Sweden. Juul argued that the Danish energy system could be adapted to wind power, instead of wind power having to adapt to the system. Juuls third challenge concerned the fact that the Committee had not included any grid system expenses for the current steam power electricity in their calculations. Juul argued that if they only considered the electricity supply system as a way to transport steam powered electricity, they also had to include the substation and transmission line costs (K. H. Nielsen, 2001, p. 19). Juul’s alternative calculation reached the conclusion that the cost price of wind power was 3.8 Oere/Kwh (45 Oere/KWh in R-2017), which was about half of what the Committee had reached at 6.4 Oere/Kwh (75 Oere/kwh in R-2017) (Juul, 1962, pp. 326–330; K. H. Nielsen, 2001, p. 19). The Wind Power Committees framing omitted system integration matters, and this led Juul to argue that the utilities only saw wind power as an export item, and therefore would not consider adapting the system to integrate wind power.

> “It looks as if the utilities and, perhaps the places in which future nuclear power plants are being projected think of wind power plants as competitors instead of collaborators and would prefer to see wind power plants exported to the developing countries. But this is hardly feasible unless there is a domestic utilization to refer to…I believe that we cannot afford not to build and utilize wind power plants as mediator of our only significant domestic source of power, i.e., the wind”. (Juul, 1962, p. 329 in; K. H. Nielsen, 2001, p. 20)

If one was to pinpoint a birth of the wind power framing contest, it could be this framing competition. On one side, the government-established and utility-led Committee saw wind power as a *Fuel Supplement*, which might pose an export opportunity, but could not be a viable alternative energy source in Denmark. Juul challenges this framing and especially argued that two world wars should have shown Denmark, that relying on imported oil and coal would leave the country vulnerable to external forces. Juul advocated this point in his contribution to the 1961 UN Conference on alternative energy sources (B. Sørensen, 1977, p. 65), and on several other occasions (I. K. Jensen, 2015, p. 45). Juul was as well as his teacher Poul Lad Cour motivated by the quality *Energy Independence*, of which wind power could contribute to the Danish energy system.

The impact that the Danish Electricity Foundation (DEF) had in the early categorization of wind power cannot be understated. It is first seen in Robert Henriksen's inaugural statements and 5 years later re-confirmed in the 1962 Wind Power Committee report. Wind power is framed an expensive and non-conventional addition to the existing Danish energy system, but could have potential as an export good. When Johannes Juul designed the Gedser turbine in 1957, he was breaking new ground. In 1962, he tried to make sense of how this new entity was a worthwhile investment to Denmark, and his perception differed from the rest of the Wind power Committee's. Their metric for success was whether or not this new entity, wind power, could displace the cost of fuel to a steam power plant. In their calculation of whether a wind turbine would be valuable, the system cost for adding the turbine was added to the turbines costs, while transmission grid costs were not added when calculating the cost of current infrastructure, in the form of the steam power plants.

As successful as Juul was within his technical endeavors, he was not able to break the dominant framing established in 1962, namely that wind power could only be a supplement to the conventional power plants. Although Juul laid the critically important material bricks for future wind turbine developments, he was not able to mobilize sufficiently strong allies to his framing. The fuel shortages in the 1940s and 50s that had caused the initiation of the Gedser turbine research project had in the 1960's been replaced by record low levels of coal and oil prices. So within the Fuel-coalitions Valuation Frame "Expensive Supplement" the value of wind power was to be framed by the fuel it could displace. When seen through this frame, it became true that "substantial price movements" would be necessary for wind power to be a viable energy alternative in Denmark. Wind power research was not only deemed invaluable due to its high cost compared to low oil and coal prices. It was also an unfitting match for the energy system compared to another emerging energy source, Nuclear Energy. Nuclear Energy represented centralized power plants which fitted the current system set-up, and research was supported in Denmark through the Risoe nuclear institute, headed by Niels Bohr. The Risoe centre received 140 mn. DKK (1.5 bn. DKK in 2017) between 1955-1963, and built up to employ more than 700 people by 1955-1963 (H. Nielsen & Nielsen, 2006, pp. 29–30). Over the same period, research spending for wind power was at 0.5 mn. DKK (5.9 mn. DKK in 2017) less than 0.25% of that of nuclear (Arhenkiel, 2015, pp. 8–12). So after a modest examination of wind power through the Gedser Turbine project, Denmark turned it research focus to nuclear in the 1960's. The Danish government's council on the topic would in 1963 conclude that "the production of wind turbines was probably best left to private initiatives" and to a large extent set public exploration and discussion of wind power on hold. After running without maintenance for 10 years, the Gedser turbine suffered a malfunction in 1967, and was stopped with no immediate plan for reparation. Two years later, Johannes Juul passed away at an age of 82. With Denmark's leading pioneer on wind power gone, the framing contest of wind would fall silent (Schultz & Dahlberg, 2013). Before we move on to the start of a larger valuation network, which would work for the re-emergence of wind power, I will just summarize the first three qualities we have observed so far.

3.3. THE FIRST THREE QUALITIES TO DEFINE WIND POWER

This overture will not include valuation frames or actor overviews, but before moving on to the first of the five analyzed periods, I will outline the first qualities that were invoked in the categorization of wind power.

Quality: Fuel Supplement (Technical)

The quality of *Fuel Supplement* represents the quality that a given object has in supplementing an already established energy source. This is especially seen through the metric of a break-even price, wherein wind power is considered valuable when it is a cheaper supplement to build than to purchase the equivalent amount of energy through imported oil, coal or gas. The difference between *Technology Cost* and *Fuel Supplement* is that *Technology Cost* has a metric measuring wind power as a stand-alone energy source, whereas *Fuel Supplement* is a quality that rates the value of an object based on how it supplements incumbent energy sources. This is how wind power is introduced at the inauguration of the Gedser turbine, and it is not examined in detail how much potential wind has or how it can function as a stand-alone energy source. It is instead considered a minor supplement to existing fossil fuel capacity.

Quality: Industrial (Societal)

Industrial is the value of having a wind turbine industry in the country, and represents the economic value of getting exports and taxes from both the domestic companies and their employees. Simply put, if Denmark bought its turbines from Germany and had no local content, this quality would not exist in the valuation of wind power. This is mentioned by both DEF and Juul as a salient quality, that wind power can create jobs and be something that Denmark might be able to export to less developed countries later on.

Quality: Energy Independence (Societal)

The quality of *Energy Independence* refers to the value of being independent of foreign fossil fuel imports. This quality thus both refers to perceived savings of importing fossil fuels, but also to the value of being less exposed to geopolitical tensions and the risk of being cut-off from supplies. Additionally, it covers the value of not funding potentially dangerous states by buying fuel from them. It was already first conceived in the thoughts of Poul La Cour as he feared the many steam plants being built would lead to huge imports of fuel. His student, Johannes Juul, would also keep this focus as one of the key reasons for supporting wind power, as the only domestic source of fuel that Denmark had in abundance was the wind[19]. Johannes Juul was alone with seeing the value of *Energy Independence* at the time, and must be said to have been quite ahead of his time. As a quality it will prove hard to calculate into a monetary value, but is still central in several of the coming energy reports and plans.

3.4. WIND POWER RE-EMERGES AFTER OIL CRISIS (1968-1979)

It is beneficial to summarize the situation following the first valuation struggle between Johannes Juul and the Fuel-coalition. The default option for electricity, transportation and heating in Denmark is at this point oil, with some coal in the system as well. Denmark has no official energy policy and the sitting governments have all left the utilities to manage their separate parts of the grid, and to purchase oil and coal at the cheapest possible price. The negotiation over what price Maersk-Mckinney Moeller should be allowed to buy the extraction rights to the north sea oil and gas fields occupy the trade ministry and the utilities were discussing if, when and how Denmark should build nuclear plants (T. B. Olesen, 2017, pp. 182–184).

[19] This is stated in the 1960's while North Sea oil and gas exploration was still at very early stages and Denmark imported practically all of its fuels.

The dominant valuation frame of wind power is the one proposed by the Fuel-coalition in 1957 and 1962, namely that it is a supplement which may be useful for some export purposes, but which is still too expensive to be an alternative to the existing oil and coal power plants. This fuel-coalition is made up of the utilities as represented by DEF and have general acceptance from all of the major political parties in parliament. Energy is something that is left to the utilities to handle as long as they buy the fuel for good cheap prices and keep a stable supply. But in the late 1960's a unique coalition of actors would begin to gather and come to challenge the dominant incumbent framing of wind power.

3.4.1 Anti-nuclear grassroots

Although the wind power valuation struggle was not as visible in the late 1960's, there was a rise of a highly interconnected network of environmental and anti-nuclear groups. The environmental group "Naturhistoriske Onsdag Aftener / Nature historic Wednesday nights" (NOAH) was formed in 1969 by students and teachers, who held political discussion nights at Copenhagen University (NOAH, 2016). The first NOAH gatherings on Avernakø were enabled by the Minister of Culture in 1970, Kristen Helveg Petersen (RV), and the following gatherings would also serve as a vehicle for collaboration and showcasing of small-scale constructions wind turbines and solar panels (Grove-Nielsen, 2016; Skardhamar, 2010), with participation from Danish politicians from the left wing, but also the centre-right party Radikale Venstre (Beuse, 2000, p. 14). The unity around protecting the environment is evident in one of the NOAH organization's first published books from 1970:

> "We are not fond of organizations. Yet, we work together, because we can learn from each other's experiences. Because we are stronger, the more we are…The only thing we agree on in NOAH is that the pollution must be stopped. The individual groups may have different political views and ways of working. Difference in rhetoric is not as important as cooperation towards common goals in practice". (Grove-Nielsen, 2016; NOAH, 1970, p. 130).

The NOAH Group and the Aeroe (Ærø) camps would grow their network considerably following the 1973 oil crisis, wherein oil prices would rise from a level of 22$ in December 1973 to 51$ in January 1974 (Macrotrends, 2017). This sudden 132% increase in prices led to substantial heating- and electricity price increases, and a rationing of gasoline resulting in car-free Sundays. Energy became a central concern and the Fuel-coalition interpreted the crisis as a need to construct nuclear power plant. But the members of the NOAH network were adamant that nuclear energy should not be the default choice of the government. In 1974, NOAH expanded to an anti-nuclear organization called "Oplysning Om Atomkraft / Information about Nuclear Power (OOA)", which in February 1975 would span into a sister organization promoting renewable energy, "Organisation for Vedvarende Energi / Organization for renewable energy" (OVE).

These three organizations, NOAH, OOA and OVE, were throughout the late 70's strongly intertwined through many camps and gatherings (Beuse, 2000, p. 55;111). Their cooperation would also sustain an extensive network of energy offices around the country, which would hold courses and trainings on building renewable energy technologies such as wind turbines (Beuse, 2000, pp. 59–60). OOA member Ole Terney was together with Lars Albertsen a main driving force in building the new OVE organization. He collected addresses of manufacturers and technicians relevant to renewable energy and published this important networking information in two books in 1975 and 1977[20]. The book also included information from Economist Frede Hvelplund and Professor Bent Soerensen, who were part of an academic group that would construct the first alternative to DEF's view of valuation frame of wind power.

3.4.2 The ATV Academics

In addition to the academics Hvelplund and Soerensen, the young physics professor Niels I. Meyer would also play an important role in the new valuation network. Niels I. Meyer was an openly declared opponent to nuclear energy, who had spoken actively against it at the Rebild conference in 1974 an authored the pro-renewables side of a major state-funded information campaign that was meant to compare nuclear energy and the alternatives in 1975 (Meyer, 2000, p. 87, 2004, p. 108,149). Meyer was highly occupied with environmental concerns, through his involvement with the researchers behind the 1972 Club of Rome Report "Limits to Growth" (Meyer, 2004, p. 142). In the service of that research community, Meyer had in 1973 arranged a seminar in Denmark, where Dennis Meadows, Co-author of the 1972 Limits to Growth report, would speak for a crowd of 500, here among a number of leading Radikale Venstre politicians (Meyer, 2004, p. 145)[21]. Meyer's strong academic record and his network within academics and the politics meant that he was put in charge of forming "The Wind power Council of the Academy of

[20] Several publications which enabled knowledge sharing and agreement on common goals would come out in this period, including monthly magazines from OVE, contact lists for manufacturers, and technical safety manuals for small-scale turbine construction (Grove-Nielsen, 2016).

[21] Kristen Helveg Petersen was a personal friend of Niels I. Meyer, and the two would later go on to write two political books, in 1978 and 1982.

Technical Sciences" (ATV) in October 1974, with the declared task of "investigating the opportunities and needs for increased exploration of wind power in Denmark" (Meyer, 2000, p. 82). Meyer was at the time President of the Academy of the Technical Sciences, which hosted the Wind Power Committee. This formation of a wind power committee, by a declared nuclear opponent was not uncontroversial, and several attempts to remove Meyer as president of ATV were made up to the formation of the Wind power committee[22]. Meyer persisted with his beliefs intact, and saw the need for a different way of calculating from the 1962 and 1974 Danish Energy reports, as explained below[23].

> "The official Denmark wanted to bet on coal and nuclear, and that was industry, utilities and political parties, almost everyone. The idea of suggesting to bet on renewable energy was pretty original in the public debate. But because it was ATV that did it together with the grassroots, the grassroots could draw an advantage from our prestige". (Interview 2: Meyer, quote 1).

The composition of the ATV wind power committee and the prestige that it could lend to the grassroots movement is important to highlight. The ATV wind power committee saw themselves as representing a challenger view against the 'official Denmark' comprising not only the utilities, but also industry and most political parties in parliament, what I earlier have dubbed the Fuel-coalition. Niels Meyer, the ATV lead author, explains below how there initially was significant opposition to him leading the ATV, especially due to his interest in wind power.

> "I did not have the entire ATV behind me, as they tried to have me removed as president of ATV. They did not believe you could have an ATV president who was "anti-technology". But I did however succeed in convincing them that there also was much technology in wind power". (Interview 2: Meyer, quote 2)

[22] Elsam, which was among the largest Energy utilities at the time, advocated for the removal of Meyer on the grounds that it was not possible to have an "anti-technology" president of the ATV (Interview 2: Meyer quote 2), whereas Conglomerate Magnate, Maersk McKinney Moeller, made efforts to convince Meyer of the role of nuclear power in Danish energy policy (Meyer, 2004, pp. 108–109).

[23] Niels I. Meyer also contributed to the energy ministry under both Jens Bilgrav Nielsen, the liberal Anne-Birgitte Lundholt and under the socialdemocratic Svend Auken (K. H. Nielsen, 2001, p. 305).

When Meyer can be considered “anti-technology” due to his outspoken preference for wind power, it appears that wind power was still considered a peripheral energy supplement in a possible future mix. But despite this opposition, there was now a strong enough network to challenge the dominant framing. Where Johannes Juul did not have strong allies in his alternative calculations, the ATV Wind Power Committee consisted of a highly aligned and yet diversified group of engineers and economics from businesses, universities and the grassroots movements[24]. Their alternative valuation frame would first be presented in the 1975 report “Wind Power”, which was a response to the Fuel-coalitions way of calculating. The new framing would be continued through a more elaborate 1976 follow-up report “Wind-Power 2”, and a series of alternative energy plans during the early 1980’s. I will hereafter refer to this set of actors challenging the incumbents as the “Unique-coalition”. It was a uniquely broad collection of new actors to the energy-field who all shared the view that wind power represented a unique future opportunity. Before going into the Unique-coalitions’ challenger frame, I will briefly summarize a 1974 report, authored by another DEF-led committee. This report followed the same Fuel-coalition logic from 1962 and enforced the still dominant framing of wind power as an expensive supplement to existing coal plants.

3.4.3 DEFU 1974 report on Wind Power

The challenges that Denmark faced following the 1973 oil crisis, resulted in a re-evaluation of the earlier lack of energy policy. The Danish government and the utilities would initiate a substantial overhaul of the current supply picture[25]. The first time DEF re-visited wind power valuation since 1962, was in the 1974 taken report “the utilization of wind power for electricity production” (Johansson, 1974). This report was written in collaboration between the sitting Danish government and DEF’s research unit, led by DEF’s lead engineer on renewables, Mogens Johansson. The report built on the framing established in the 1962 DEFU report, as wind power was qualified by how much fuel it could displace from a conventional power plant. Fuel prices were in 1974 quoted as 30 DKK per gigacalorie, and wind power was

[24] The head of the council was Jean Fischer, the CEO of Cement production- and engineering company, F.L. Schmidt, which in 1974 had created a technical business-report wherein they declared wind power as a viable alternative (Beuse, 2000, p. 115;116). Frede Hvelplund, Economist who in the early 1970’s was among the first to calculate the economics of wind power in Denmark (Moeller, 1978, p. 8). Bent Soerensen, lector at the Niels Bohr Institute, who prior to the 1975 report had predicted that Denmark could have a 100% renewable energy society by 2050 (Terney & Maegaard, 2000, p. 28) . Niels O. Gram, was the official Government representative in the trade ministry, and would in 1990’s go on to serve as head of Danish Industry, one of the most powerful lobby organization in Denmark (Bang & Hjoellund, 2015).

[25] Firstly through a conversion of the many combined heat/power plants from oil to coal, and secondly a preparation for a comprehensive government-funded build-out of gas-pipes for heating (DEA, 2016b, p. 13). Denmark thus reduced its use of oil in the electricity and heating sector with 92% in the 18 years from 1972-1990 (DE, 2015).

calculated to be competitive only at 44-50 DKK per gigacalorie. Thus, the report repeated the dominant framing that the cost of building wind turbines overtook the benefits by 60%, but did acknowledge that some export potential existed (Johansson, 1974; K. H. Nielsen, 2001, pp. 85–86). Although the *Industrial* quality was still mentioned and one line was dedicated to the *Environment* quality through possible air quality benefits, it was the quality *Fuel Supplement* that determined that wind power was still not valuable to society.

3.4.4 ATV 1975 report

The Unique-Coalitions first report was simply called "Wind Power" and was released in May 1975. It continued the core methodology of the incumbent Fuel Coalitions 1962 and 1974 reports of calculating wind power as a *Fuel Supplement* through a break-even price. This standard way of quantifying the price of where wind becomes valuable against the price of coal is used throughout the report and has a major role in the categorization of wind as a supplement. It can however be seen that the authors note that wind power is not "ascribed any effect value, as long as it is only calculated as a supplement" (ATV, 1975, p. 16), thereby indicating a reflection that it could have been calculated as something more[26].

While the Unique-coalition shared the same metric as the Fuel-coalition, fuel savings, it was their focus on the *Future Potential* of wind turbines which made the report stand out from DEF 1974. There are four central points of reference about *Future Potential* quality that allow the Unique-coalition to frame wind power as a worthwhile investment.

1. The first is the uses of wind measurements at sites that do not currently have wind turbines erected, but would theoretically be optimal are used. The authors themselves state a clear emphasis for "open landscapes and good wind conditions in all directions" (ATV, 1975, p. 11)[27].

[26] The value of wind power is expressed in the percentage-wise savings compared to importing fossil fuels (ATV, 1975, p. 29), something which the ATV authors explicitly reflected on: *"The plant-price for the coal/oil based plants is on the contrary not part of the calculations, as the wind power production as mentioned is only considered a supplement to the conventional production (ATV, 1975, p. 17)."* The authors have thus been aware that a comparison of a new-build cost of a coal-plant would have been a different calculation. They do however still calculate towards a break-even price in order to have a document that can be compared to Danish Energy's 1974 report.

[27] When it comes to wind resources, Denmark is among the absolute top tier countries in Europe (EEA, 2009, p. 22) due to high average wind speeds of 5.8 meters per second (M/S) (DMI, 2016), and the near-absence of low-wind areas (EEA, 2009, p. 51)[27]. The good onshore wind resources are especially found on the western coast, wherefrom the western wind belt generates more than 25% of the winds over Denmark (TV2, 2004). The largest potential for offshore wind power deployment in Europe is also found in the two major seas surrounding Denmark, namely the Northern and the

2. The ATV authors combine the good wind condition with unnamed sources stating that 35 % efficiency (understood as capacity factor, ed.) can be achieved with “simple construction improvements without substantial changes in price”. This is a very substantial assumption which appears several places in the report (ATV, 1975, p. 18,20,26). It is however stated that the efficiency of their reference turbine, the Gedser Turbine, was only 24 %. The “simple construction improvements” that the ATV authors cite as proof that 35% can be expected in the future, is explained as something that has been “pointed out from different sides” (ATV, 1975, p. 26). The ATV has had close contact with many of the individual builders of wind turbines at the time, so it has likely been estimates from people with experience in building wind turbines that have led to the 35% estimate. It would however be many years before onshore wind turbines would come near 35% capacity factor performance. The average European onshore fleet had a capacity factor of 24% in 2015, but modern turbines installed in 2017 and 2018 are sold with an expected capacity factor around 35 %[28]. The fact that the value of this quality was overestimated was a large factor in enabling the number that they reached.
3. The third assumption is that turbines will have a lifetime of 25 years, which is 5 years more than what was assumed in the DEFU 1974 report. This is not an overestimate as the capacity factor, since onshore wind turbines fairly quickly became sold with lifetime of 25 years. It was however still higher than the Fuel-coalitions assumptions and also made wind power be calculated as more valuable[29].
4. The fourth assumption is the discount rate, which is set at 3%. The lower the discount rate is set, the more valuable long-term investments such as wind turbines will be. The ATV discount rate was significantly lower than

Baltic Sea (EEA, 2009, p. 27). The reference point of Denmark as an optimum site for wind power has since the 1975 report become well-established, and Denmark is by some foreign scholars today referred to as the wind capital of the world (DR, 2016).

[28] The average capacity factor for onshore wind as reported by the European wind industry is today exactly 24%, Denmark coming in slightly higher than this (VE, 2014, p. 2; WindEurope, 2016a). In the US, where they have better wind resources, they are closer to ATV’s estimate, with an the average installed fleet capacity factor of 32% in 2015 (EIA, 2016, p. 159). Denmark has good wind resources and it is expected that newly constructed turbines in 2017 are expected to be able to deliver a 35% capacity factor over their lifetime (Energinet.dk, 2015, p. 10). Therefore it is reasonable to assume that the average capacity factor of the fleet installed in Denmark will in 2030, 55 years later, have reached the goal set out by the ATV authors. To this it must be noted, that the ATV authors did not state when they expected the level of 35% to be reached.

[29] Most wind turbines today are certified to last 20 years and the most common assumption is that they can last all the way up to 25 -30 years with the right maintenance (IEA, 2016a). Many of the smaller wind turbines that were erected in the late 1970’s and 1980’s were taken down during the 1990’s. This was however not because they were broken, but primarily because it made more economic sense to replace them with larger and more efficient turbines.

in the Danish Energy report, and also lower than the rate used by the Danish government, which in 2013 was lowered to its historic lowest point at 4% (DKGOV, 2016).

The above four assumptions about the *Future Potential* of wind power are decisive for reaching an estimated break-even price for a turbine of 2150 DKK/M2 for a coastal position and 1400 DKK/M2 for an inland turbine[30]. They estimate a 'larger electricity producing plant' by the coast to be within the somewhat broad price-range of 1000-2500 DKK/M2 (4800-12000 DKK/M2 in 2017-Real), which is then compared to the Gedser Turbine price-range of 1700 DKK/M2 (8100 DKK/M2 in 2017-Real), to argue that the range is not unrealistic (ATV, 1975, p. 20). In a graph the authors would show wind power's "annual costs"[31] at 8.5 Oere/KWh (40 oere/KWh in 2017-Real), and thus below their estimate for fossil fuels at 11 Oere/KWh (52 Oere/KWh in 2017-Real) (ATV, 1975, p. 27). These specific cost estimates were then calculated into an estimate of how much cost and fuel savings Denmark as a society would have if 5% of the electricity was to be supplied by wind power.

The ATV report would in addition to this also cover qualities such as *Energy Independence* and *Industrial*, while it briefly touched upon the qualities *Environment* and *Aesthetics*. On *Energy Independence*, wind power was framed as being able to improve on the current situation where energy production 'practically is completely dependent on fuel supplies from abroad'. The authors argue that wind power on the other hand would be "almost completely independent" of supplies from abroad (ATV, 1975, p. 14). They also combine this with an advantage of not having inflation rise once the price of extractable resources such as coal, oil and uranium would go up in the future (ATV, 1975, p. 15).

Secondly, the Unique-coalition drew on knowledge from Juul's construction and own calculations to conclude that at least 70% of investments in wind turbines go to wages, which correlated to 8-12 man-years (jobs for a year) per million DKK invested (ATV, 1975, p. 13). Hereof "tower production, foundation and erection" was highlighted as being a likely source of employment in the less populated areas of Denmark (ATV, 1975, p. 15). Although these numbers did not go into the final conclusion of 1% fuel imports savings, they provided concrete figures on the *Industrial* effects of building wind turbines. This was an element, which had only been briefly mentioned in the DEFU 1974 report, but not calculated.

[30] The term DKK/M2 is Danish kroner per square meter of swept area of the rotor. The number quoted is the average of the low and high point of the two ranges quoted in the report (ATV, 1975, p. 20).

[31] The term Levelized Cost of energy was not as such officially coined and known until the NREL and IEA started using it in the 1980's, but this "annual cost" part of the calculation bears the early marks of the methodology.

The ATV authors do also discuss that wind power will help avoid a “number of environmental disadvantages” that would have followed from the power being produced by coal and oil, exemplified through having reduced air pollution (ATV, 1975, p. 14). Although the ATV-academics were aware of the early works of how CO2 emissions constituted a problem at the time of writing, it is still only the quality *Environment* that is inscribed into wind power valuation, and the concurrent example of mitigating air pollution is not quantified into a number. In the same bearing, the authors touch upon *Aesthetics* concerns of wind power. The authors concluded that the problem of noise from the turbines was “expected to be technically solvable”, while visual pollution is a disadvantage that could arise from wind power deployment (ATV, 1975, p. 14). The visual pollution element is not discussed further, and it thus is an example of a mention to ensure that it wasn’t forgotten. The *Environment* and *Aesthetics* qualities are not part of the conclusion or used in any calculations.

The main takeaway was that Denmark could integrate wind power to cover 5-10% of Denmark’s electricity use in the future, and if Denmark reached 5% it would save 1 bn. DKK in fuel imports (4.2 bn. DKK in 2014 prices) (ATV, 1975, pp. 28–29). The impact of producing a number like 5-10 % for possible wind power build-out turned out to have a large impact, as will be seen in comparison to the energy plants. To summarize, the ATV report used the same quality of *Fuel Supplement* to make a comparable number to the DEFU report, but reflected on whether it could be calculated differently. They then calculated a strong positive impact from the quality of *Future Potential*. Herein two points of reference are especially important to this quality’s impact. The first is the assumption that “simple construction improvement” would make onshore wind turbines reach a capacity factor of 35% in the near future, something which would not happen until the 2010’s. Secondly, the discount rate which was set at 3%, significantly below both DEF’s and the Danish governments assumptions. This meant that in ATV’s calculations long-term investments were move favorable than they were in official government calculations of infrastructure investments.

<u>3.4.5 Follow-up Publication in 1976 and Alternative Energy Plans</u>

In 1976, the ATV would publish a second report, “Wind Power 2”, which served to lay out a research and development plan that the Danish government could follow. In the second report ATV increased their claim of *Future Potential* to be that Denmark could have 10% of its electricity come from wind power (ATV, 1976, p. 5; Beuse, 2000, p. 82; K. H. Nielsen, 2001, p. 111). This was unprecedented at a time where the many small wind turbines across the land still only constituted less than 0.1% of capacity, and none of them were connected to the grid. The *Future Potential* is still the most important salient quality together with delivering *Energy*

Independence, wherein wind power is shown as a solution to the still recent 1973 oil crisis. Although they do individual calculations, The ATV still uses the incumbent Fuel-coalitions method of calculation for the final framing for wind powers value, the Break-even price. The ATV authors also only mention the *Environment* effects but without calculating them. It can thus be seen that this challenger coalition still tried to influence through the "rules of the game" set forth by the Incumbents in the 1962 and 1974 reports.

The 1976 Energy Plan "Dansk Energipolitik" would only mention wind power as an option with other peripheral energy source which could possibly provide 3% of Denmark's energy demand in 1995 (DKGOV, 1976, p. 58). The plan was highly focused on the major ongoing shift from oil to coal in the current fleet of steam-power plants (1976, p. 28), a recently passed law expanding the use of natural gas (1976, p. 8)[32], and a comprehensive 20-year nuclear build-out plan to have nuclear energy supply two-thirds of Denmark's electricity by 1995 (1976, p. 39)[33]. But although wind power was peripheral it was mentioned as contributing to the one of the main goals of the plan, namely to decrease vulnerability of supply security (DKGOV, 1976, p. 17). The 1975 ATV report have in historical accounts of the time been connected as inspiration point for the Danish government's decision to at least include the option of wind power in the first Danish Energy plan (Meyer, 2000, p. 78). The Unique-coalition would respond to the government 1976 energy plan with an "Alternative Energy plan", which envisioned the possibility of having 12% wind power in the Danish energy mix by 1995, which was four times more than the government's projections (Beuse, 2000, pp. 79–80). This Alternative Energy Plan was not supported by a public institution but created media attention and showed that there was a clear countermovement to the nuclear option[34].

[32] The plan also outlined a needed public "capital injection" of 3-4 bn. DKK (13-17 bn. DKK in 2015) to build out "production facilities, offshore-pipes, transmission- and distribution-grid" to enable extraction of natural gas in the North Sea and potential other later sites (DKGOV, 1976, pp. 110–111). In comparison, the 1976 plan dedicated no more than 25 mn. DKK (108 mn. DKK) over 5 years to wind power research (DKGOV, 1976, p. 102).

[33] The nuclear power deployment plan entailed having the first commercial nuclear power plant in operation by 1985, and having a total of five nuclear plants (4,9 GW of capacity delivering 25 TWh) producing two-thirds of all Denmark's electricity by 1995 (DKGOV, 1976, p. 39). This was thus clearly the main road taken, while wind power was envisioned a peripheral role with 3% of the energy supply in 1995.

[34] A second alternative energy plan would be created in 1983 (Illum, 1983), and these plans would come to function as rallying devices for the grassroots movements. The alternative Energiplan 1983 called "Energy for the future" was two years underway as a reaction to the governments' "energyplan81" (Beuse, 2000, pp. 79–80)

3.4.6 An important overlapping actor between DEF and ATV

Even more interesting than the qualities prevalent in the 1974 report, was the author responsible for compiling the report, DEF's lead engineer on renewable energy, Mogens Johansson. He would also be appointed as a member of the wind power committee that would write the ATV 1975 report. Johansson was a pragmatic representative for the utilities, the incumbents, in the group. As such the ATV committee's report gained a high level of credibility from the diversity of the actors it comprised. Johansson noted that there was a significantly different motivation between the two groups of authors and especially highlights the discount rate, notably how the future development should be valued, as a main point of difference.

> "This was different people. You had Bent Soerensen who pulled very much in the direction that it should be doable, and Niels Meyer as well...Where we (DEF) probably used 4-5% (Discount rate), he (Bent Soerensen, ed.), was arguing that it should be down to almost zero. In that way he skewed it.". (Interview 1: Johansson, quote 1)

Despite the difference between the two groups, Johansson was among those within the utilities who saw export potential in researching wind power. He had participated in a 1977 delegation to the U.S. to raise awareness of Danish wind power, and the government committed funds to reestablish and showcase the Gedser turbine in 1977 (Arhenkiel, 2015, p. 14; Johansson, 1974). The three quotes below show how the collaboration between the Unique-coalition and Johansson led to a funding success for the wind-power program.

> "But then the ATV and Niels Meyer took initiative for "Wind Power 1", which I was a part of… it lead to the wind power 2 committee, which was about the question 'what should we do, because there might be something in this'. And that turned into a program (the proposed program in "Wind Power 2" report, ed.), which there was no money for". (Interview 1: Johansson, quote 2).

> "I proposed to the utilities, ELSAM and Power import, that we should set something up and make a plan, but they did not want to do this. ...But then sometime during the summer of 1976, the government set aside money for energy research in connection with the employment-stimulating efforts, 42 mn. DKK i believe. Niels Gram had been secretary in Wind Power 1 (the first ATV report, ed.), and had studied

> together with me, so I knew him quite well. He was in the trade ministry, and then he called and asked us, if we had any suggestions about what could be done to improve employment. We had such a thing right there in the drawer. That suggestion did not become reality, it was actually a bit larger. They (the government) would give us 11 mn. DKK and the utilities would then also come with 3 mn. DKK, so we had 14 mn. DKK in total". (61 mn. DKK in 2017-Real, ed.). (Interview 1: Johansson, quote 3)

> "I actually got in touch with a Dane who worked in a utility in one of the New England area states. He had read the report (DEFU 1974) and wrote me...Travelling to the U.S. At that time was expensive and troublesome, so there had to be something to travel for...It came to four visits for a combined 8-10 days I was over there. DEFU was always well-consolidated, so it was not an economic limitation. It was more a matter of how much it was considered reasonable to spend on it". (Interview 1, Johansson, quote 3)

Johansson's network and one of committee members, Niels O. Gram, would help secure government funding for a research program, which would help the many local turbine-builders around the country. These builders were closely intertwined with the previously described grassroots organization, and had in the mid and late 1970's yet to form an industry. I will hereafter briefly cover this part of the challenger coalition.

3.4.7 Local turbine-builders begin to form industry in late 1970's

Although the turbine-builders were not as directly involved in producing valuation devices, such as the examined reports and energy plants, they were still intertwined with the country-wide network of knowledge-sharing happening in the OVE organization. While the anti-nuclear movement and the local turbine-builders are not a homogenous group, historical accounts show a high degree of consensus between anti-nuclear groups and the wind turbines builders. One early example of the bottom-up organization was the collection of wind turbines output numbers for all of Denmark. This task was performed by way of all wind turbine owners sending their power output data by post-card to two turbine-builders in Western Jutland, as explained by wind power entrepreneur Henrik Stiesdal in the quote hereafter.

> "At one point (during the early 1980's), we came up to 0.1% of Denmark's electricity consumption, and we thought that was fantastic. It was a motivation to people that it could now be compared, and you could compete a little". (Interview 3: Stiesdal, Quote 1)

There was a strong overlap between the grassroots movements and the turbine-builders who would come to organize and build the Danish wind turbine industry throughout the late 1970's and early 1980's. The local builders started from very simple construction and moved to industrialization. Below is a narration of how one of the country's early wind entrepreneurs Henrik Stiesdal constructed his first turbines in the late 1970's:

> "Even though I still had money left from my work months the years before, there was not enough to build a turbine with an adequate performance from new components, and as many other turbine-builders I had to turn to recycled components….I found most components at local junkyards and one could get excited upon standing in a corner among all sorts of scrap and spotting a suitable object which could serve as a part of one of the turbines many part-systems – Brakes, Yaw-system and such. The price at the junkyard was almost always steady at 1 DKK per kg, so the price of a turbine-builders turbine could usually be established with good accuracy, by merely weighing it". (Beuse, 2000, p. 168)

The early turbine-builders, who worked with what they could find, would come to form the core of the emerging industry. They would bring their entrepreneurship to the companies, but would also with time professionalize their operations. Figure 10 is a selection of pictures showing what wind turbine construction was like in the 1970s. The two pictures on the left depict the construction of a 15 kW turbine in 1978 by H. Stiesdal, while the middle and right picture is the Herborg Vindkraft 22 kW turbine (1978) by K. E. Joergensen and H. Stiesdal. Both pictures are used with permission by Henrik Stiesdal.

Figure 10: Wind turbine construction in 1978.

One of the first entrepreneurs to establish a company was Christian Riisager, who in 1975 decided to connect a self-built turbine to the electric grid before receiving permission. Apart from Riisager's own electric meter suddenly running backwards, the neighbors reported no problems and Riisager had shown that wind turbines could be part of the electricity grid (Garud, Kumaraswamy, & Karnøe, 2010). Where the Tvind-collective turbine is often mentioned as showing that wind power could be large-scale, the Riisager turbine is in historical accounts considered as the turbine which showed that the technology could be economically sound (Beuse, 2000)[35]. Shortly after the grid-connection maneuver, Riisager started production and sold his first commercial turbine to Torgny Moeller, a journalist from the newspaper Information (Grove-Nielsen, 2016). Torgny Moeller used the turbine to run his house, from which he could write two sustainable-energy powered Magazines about wind power, Naturlig Energy (in Danish), and Wind Power Monthly (NE, 2016)[36]. In 1978, Torgny Moeller called for the first general assembly for the Danish wind turbine owners association (Danmarks vindmølleforening) to all owners or shareholders of wind turbines, which were mainly the Riisager turbines at this time. The opposition and difference of interests to the Danish utilities were explicitly stated in the invitation which Torgny Moeller sent out:

[35] Christian Riisager was quite possibly the first Danish entrepreneur to go into series production as he sold more than 50 turbines between the sizes of 10-45 KW, before selling the production rights to WindMatic in 1979 (Grove-Nielsen, 2016). He was strongly influenced by Johannes Juul's design and translated this from a prototype design to a grid connected electricity device, that could be ordered and installed for any land-owner with 50.000DKK (~200.000 DKK in 2017-Real).

[36] Both of these magazines are in 2018 still in existence and Naturlig Energi is still run by Torgny Moeller.

> "The invitation applies, as it will be known to some of you, all people who today have a grid-connected wind turbines or is about to have one. It does not apply to the utilities among us, as they will have pay-off interests which are in conflict with ours. The purpose of the association is a certain joint maintenance of our interests with regards to the utilities, authorities etc., as well as a more unified appearance externally, to secure a more serious information on the real opportunities of wind power". (Grove-Nielsen, 2016)

The invitation-text shows that Torgny saw wind power through the same framing as the Unique-coalition and sought it necessary that wind turbine owners organized, if they were to challenge the dominant valuation network of DEF. The need to persuade politicians to perceive wind power as a unique future possibility can also be seen in Torgny Moellers 1978 book, "Vinden Vender":

> "How can a small turbine, as this book is about, have a greater societal significance? It can so because it expresses something which in reality has very little to do with energy….It is indirectly about unemployment, trade balance, pollution, scarce resources and our society's dependence on foreign nations". (Moeller, 1978, p. 47)[37]

Torgny Moeller and the Wind turbine Owners association managed to organize themselves in the late 1970's before Vestas or Bonus were founded as companies. As with Torgny Moellers magazine, the Wind turbine Owners organization (DWOA) is still in existence and represents 32.000 wind turbine stakeholders (DVF, 2016).

In the five years between 1979 and 1983 the turbine-builders turned into a regular industry (Karnøe, 1991). The need for a public framework and certifying body to ensure the buyers' safety was met with the decision to make Risoe into Denmark's official wind power test center. It became an official certifying body, which approved projects for a 30 % establishment subsidy agreed to in the 1979 law "Lov

[37] Torgny Moeller elaborated on his broad view of wind power later in the same book: "The Operational economy will likely still be disputable….Nonetheless when it comes to macro-economics, there are problems that are as big as the economics. Unemployment is one of them…wind power is not just a way of retrieving energy, it is way to reduce unemployment. Trade balance is no less interesting. One point is that wind power can save money on purchase of oil and uranium. Another is that Danish produced wind turbines can become an export item in a time where falling exports is one of the major societal problems (Moeller, 1978, p. 49).

om fremme af vedvarende energy" (Beuse, 2000). Following this was the entrance of today's defining manufacturers for the Danish wind industry, Vestas, Nordtank and Bonus, who in 1981 organized themselves in what is today known as The Danish Wind Turbines Manufacturers, known today as "the Danish Wind Industry Association (DWIA)[38]. In historical accounts of the Danish wind turbine industry, the importance of the Californian demand for Danish wind turbines must not be underestimated as a significant factor in ensuring revenue, while generating technical and commercial experience for the industry (Karnøe, 1991, p. 20). Below is a graph of the installed capacity in each year throughout the 1980's in the Danish and the U.S. market, combined with a pie-chart showing a split of where the worlds wind power capacity was installed at the end of 1990. Thereafter follows a picture of the Tehachapi Valley, wherein many Danish turbines were installed and still stand today. The marked turbine is the first 30 kW Bonus turbine installed in the U.S. in 1982. Figure 11 is by the author (GBA), while the Tehachapi valley picture in Figure 12 is used with permission from H. Stiesdal.

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[38] As the industry grew, some people within the grassroots and turbine-builders would begin to differ on the approach taken, as Henrik Stiesdal notes hereafter:
"The people I came to know in the environment, where for the most part driven by this opposition to nuclear power,..(some) objected to the first onshore wind farm Vestas was set to build in Ringkoebing. Wind power was supposed to be implemented through craftsmanship and not based on an industrial approach….From thereon I noticed that we differed too much on this topic (Interview 3: Stiesdal, Quote 2)."
Although differences emerged throughout the 1980's, the turbine-builders and grassroots were still combined a network, which were able to get attention to the topic.

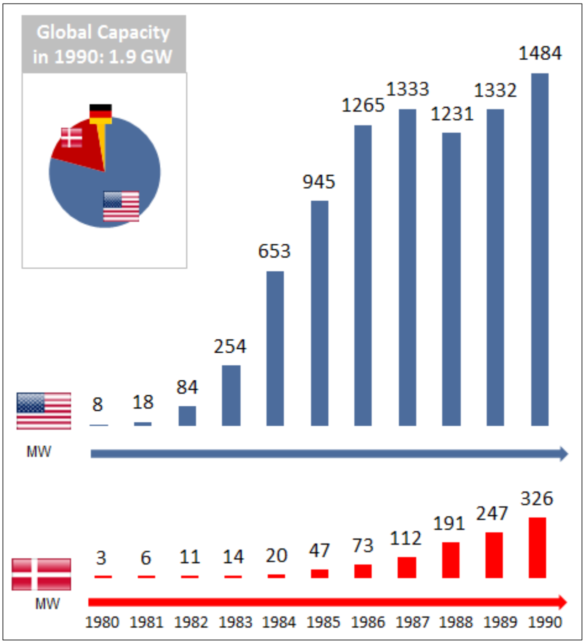

Figure 11: DK and U.S. capacity build-out in 1980-1990.

Figure 12: Tehachapi Valley and the first Bonus 30 kW turbine.

The recognition that Danish wind turbine design received abroad helped the wind turbine industry position itself as an industry which created jobs and improved the trade balance[39]. The emerging industry was an important part of the challenger coalition, as they were the source that the Alternative energy plan could reference to as proof that wind power created jobs and provided exports.

3.5. WIND POWER BECOMES A VALUABLE INDUSTRIAL SUPPLEMENT (1980-1989)

By the mid-1980's, the U.S. market for wind turbines was booming and as the Unique-coalition had grown since its emergence in 1974, DEF sought to rid an image of being against wind power. The export push was paying off and by 1984-1985 it was clear that Denmark was not going to build nuclear, DEF started to consider a future where wind power had to be integrated in a smart way. DEF would in 1984 sign a 10 year agreement on grid-usage terms with The Danish Wind Turbines Owners' organization. New DEF CEO, Jacob L. Hansen, labelled the agreement as an "electricity-historical occasion" DEF spokeswoman Ulla Röttger, urged that the agreement would change "the widespread opinion of the press and many politicians" that the utilities were against renewable energy (K. H. Nielsen, 2001, p. 275) . This change towards a more accepting stance of domestic wind power did however come slowly and started with the emergence of small renewable organizational units within the utilities, who worked on demonstration projects such as the Nibe and Tjaereborg turbines. How this slowly would cause a change, is explained in the below quote from Bent Christensen, Project- and General Manager in Elsam Projects from 1986-2000.

> "There is a transition from when you are forced to do something, to when you have an organization in which it is a fun work-day which gives purpose. At that point, other forces start to push within the company". (Interview 4: Christensen, quote 1)

[39] On an international scale it also showed the international banks that there was money to be made on wind power when applied in the scale, and that the robust turbines from Denmark were able to withstand even harsh weather conditions. An example of such an endorsement of Danish wind turbine manufacturers was given by CEO of Calwind[39], Douglas Lewitt, at an announced frame-agreement purchase of 138 Nordtank wind turbines: *"The Danish machines are more reliable and technically ahead of the American ones. In Denmark you have done your research and development in wind turbines for a longer period of time than we in the USA have because, right after the oil crisis, the Danish government funded the development of renewable energy* (K. H. Nielsen, 2001, p. 255)".

Although there were engineers in the utilities who were interested in wind power, the top management of the utilities still mostly saw wind power as a disturbance to the system. DEF's position to the system-challenges was communicated in a 1983 Utility newsletter by then DEF-CEO Kresten Leth Jarnoe.

> "It is not the task of the utilities to support the Danish wind turbine owners….If the utilities shall benefit from wind turbines, we have to develop them, to make them better. Besides, there are fine export possibilities within this industry". (DEFU, 1983a; K. H. Nielsen, 2001, p. 274)

But between the disputes such as how to count generated electricity, or who could own wind-turbines, the utilities had to engage more with the turbine-builders. Below is a combination of quotes, which form the recollection of one such meeting between these local builders and the utilities leadership, as seen through the eyes of wind power entrepreneur Henrik Stiesdal.

> "I had long hair and wooden clogs, and met these older men, a bit set in their ways. At meetings, there would be this characteristic cigar-plate, wherefrom you could get cigars, cheroots, cigarettes, often accompanied by a shot of fine spirits. When I visited ELSAM during the 1980's, it would always start with a "Gammel Dansk" (A Danish Schnapps-like spirit, ed.). They often saw us as noise, and seem to think 'why should we take these people seriously, what is the logic of it'…It had been hinted at the utilities that they should engage…I do not think they cared much about the economics of it (wind turbines, ed.). It was a completely regulated system….They did not politicize on the employee-level, but they politicized a lot on the managerial level. They wanted nuclear power, it should be central, it should be big. We started as noise and then we became a threat". (Interview 3, Stiesdal, Quote 3)

The above quote shows that the turbine-builders and the numerous small turbines they were erecting around the country-side were seen as a peripheral supplement which 'stole' away at the utilities' business model, leading some managers to informally refer to wind-turbines as "three-armed thieves" (Bülow, 2009). The electricity system was a 'rest in itself' system, where costs would be priced into the consumer, and added reinforcement costs would thus not be paid by the utilities, but instead be borne by the consumers. There were some challenges to the many decentralized wind turbines coming on the grid as they were not very flexible. This is explained below by Bent Christensen, Project- and General Manager in Elsam Projects from 1986-2000.

> “At that time, a wind turbine was a bit "dumb" compared to today. Today a turbine can be expected to actively help in keeping grid-stability, which they could not do earlier...the toughest challenge was that all distribution-grids and local-grids were designed and dimensioned from the idea that the power only ran one way (From central power stations to users, ed.). Now the power started to run the other way, and it required a lot to upgrade the grid to handle that unpredictability”. (Interview 4, Christensen, Quote 2)

The electricity system had however also prior to the introduction of wind power, experienced several break-downs. Long-time engineer at ELSAM, Paul-Frederik Bach, refer to the 1960’s as a time where the build-out of power plants happened so fast that it at times could be “pure lottery to run the 1960’s thermal system”. This period posed “large and unpredictable demands towards the grid” as the utilities experienced “many failures, which could occur in the most unreasonable combinations” (P.-F. Bach, 2007, p. 14). This highlight the point that *Black-out Risk* and challenges in energy system management also existed before wind power entered the system. The energy system already needed back-up capacity and the ability to react quickly to changes. It was a different change that the emerging wind turbine brought that was troubling to ELSAM’s management, namely from central to decentral. It was through this ‘noise’ that the wind turbines were a diversion away from the DEF-managements’ preferred direction towards simply exchanging large centralized oil plants, with large centralized nuclear plants. When one sees how the 1960’s energy system was defined by “many failures” that would occur at the “most unreasonable combinations” it is not surprising that the utilities had some initial concerns about *Black-out Risk* as the new technology was possibly being introduced to the system at large scale.

3.5.1 Two reports from the Fuel-coalition frame wind power as a supplement

The Fuel-coalition would frame wind power as something that could not be imagined to a large degree, as it was framed that its variability made it function as a *Fuel Supplement* and nothing more. But it was also the point of reference to an argument that too much wind power could cause electricity overrun, which would be costly in terms of lost revenue and technological costs to secure against *Black-out Risk*.

World Energy Council Committee report on Renewables 1983

The 1983 publication of "Renewable energy – Economics and opportunities" was Denmark's contribution to the 12th World Energy Conference in New Delhi and thus an important document describing Denmark's position on wind power. DEF were part of the leadership writing the report, with the purpose to give a "realistic evaluation of the economics of renewable energy sources", with a focus on "the macro-economic aspects of replacing conventional energy from fuel with renewable energy" (DNC-WEC, 1983, p. 6). This report concludes that since any conventional plant that wind turbines supplemented would "to a large extent be fully maintained for when the wind is not blowing", the price for comparison would be "very close to the share of fuel saved" (DNC-WEC, 1983, p. 7). Having framed wind power solidly as only a *Fuel Supplement*, the report went on to highlight wind power's lack of *Future Potential*, as seen below.

> "The conclusion is that most renewable types of installations from a macro-economic evaluation are not economically viable….A natural first question is whether future technical developments can change these assumptions adequately to make one or more of the renewable types of installations economically viable….Generally it can be said that even for the most promising options, it would require a doubling of energy output for a given installation. This must be considered very difficult. In example, both solar and wind power has today reached a stage of development, where you are close to the theoretically calculated yields, which reflect fundamental physical-technical limitations". (DNC-WEC, 1983, p. 61)

As can be seen from the quote above, the report did not see much potential in wind power. It even states that wind power is at the "fundamental physical-technical limitations" at a time where 0.6 MW turbines are being explored. The report does touch upon possible environmental qualities (DNC-WEC, 1983, p. 9,10) and Industrial qualities (DNC-WEC, 1983, p. 10,18,66), but dismisses these as neither sufficiently quantifiable, nor large enough to make wind power a viable energy alternative. Although the report recognized that larger turbines, such as the Tvind-turbine or the Nibe (630 KV) and Kolby (255 KV) built by the utilities, could see "considerable development in coming years" (DNC-WEC, 1983, p. 12), the overall recommendation to the UN was that “the macro-economic profitability” was so bad that “there neither should be expected nor aimed for any larger deployment” of wind installations in the coming years (DNC-WEC, 1983, p. 66). The Unique coalition’s calculations had however had a small effect, as the report did state that wind power could theoretically supply 10% of Denmark’s electricity (DNC-WEC, 1983, p. 16). A month later the DEF’s research unit, would publish a report which discussed the technical, but also very much the economic risks of installing too much wind power.

DEF Electricity Overrun report 1983

The report “Wind power in the electricity system” was concerned with the problems that wind power could cause to the power-grid, and had been ordered from the energy ministry in EnergyPlan81. In the introduction, the authors of the DEF report recognize that the Unique-coalition had written on the possible 10% wind, but noted that this 1983 report was more extensive, thus asserting their authority as a site of valuation (DEFU, 1983b, p. 6).

The report concluded that “calculations show that the value of electricity production of a wind power system” was “equivalent to the average fuel and maintenance costs of a coal-fired condensation unit” (DEFU, 1983b, p. 8). But integration of wind power would entail “certain operational problems, the solution of which will lead to expenses” (DEFU, 1983b, p. 7), the reason being that centralized steam power plants could not get full usage of their combined heat and power production (DEFU, 1983b, p. 8). This conclusion is based on the results of simulation wherein a wind power capacity of a 1000 MW would be equivalent to a 22% “electricity overrun” (DEFU, 1983b, p. 8). By those calculations, 1000 MW installed wind power would only be equivalent in effect to 175-200 MW of fuel-powered energy (DEFU, 1983b, p. 10), because 22% of the generated energy would be lost. The conclusion that it was overrun electricity and thus lost is that it did not produce according to the peak hours, but varied with the wind.

The report cautioned that further wind utilization could lead to regulation issues, which could results in large significant expenses that could reduce wind powers value, and stated that since electricity use was determined by the users, “the production units must have characteristic which enables this” (DEFU, 1983b, p. 11). Here it is assumed that measures could not be taken on demand-side response and therefore a needed characteristic is ascribed to a production unit, namely that it can turn on and off as demand requires it. This again frames wind power as something that can only be a supplement, as wind turbines cannot turn on and off as demand requires it. DEF briefly state that this system problem possibly could be mitigated by either an increased grid connection to Sweden and Norway, or by asking users to regulate their electricity use according to supply. These possibilities are however ended with a statement that both options would require extra investments, without any further calculating being done (DEFU, 1983b, p. 13). Wind Power is thus still seen as a supplement to the centralized power plants and a risk to the systems stability.

3.5.2 The mid-1980's sees wind power grow thanks to Industrial quality

In 1985, Unique-coalition economist, Frede Hvelplund, joined two Aalborg University engineers in publishing a report on jobs and exports of the wind turbines industry. This report calculated that the wind turbine industry would have exports for 1.6 bn. DKK (3.1 bn. DKK in 2015) and employ 3000 people in 1985. It would go on to state that even when state subsidies were subtracted, the wind turbine industry had generated a net state-profit of 500 mn. DKK (990 mn. DKK in 2017) (Pol, 1985a). This caused the centre-left newspaper Politiken to write the following in an august 1985 editorial.

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> "From being considered a toy for the left-wings biodynamic collectives, the wind turbine industry has become a real success. According to the report from Aalborg University Center, the turbine exports will this year amount to 1.6 bn. DKK – the equivalent of last year's exports of butter or fish. It is also interesting, that the 3000 jobs the industry has created, account for one eight of the highly praised added industry-employment". (Pol, 1985b)

The *Industrial* quality is highly salient here, as the wind turbine industry is considered a success which creates jobs in industry, something which was politically important during the unemployment crisis of the mid-1980's. This is a quality which starts to move the wind turbines away from the early 1970's categorization as being a 'left-wing toy' and not a real industry. So far wind power had not seen a large role in the first energy plans, but this would improve in the mid-1980's.

Even more progress than from the previously described energy plan from 1976 was seen in Denmark's second official energy plan, Plan81, which would include a high renewables scenario (7% Renewables in 2000) (DKGOV, 1981, p. 125). Wind power had received 70 mn. DKK since 1974, and would with a new Plan81 law "Law of State subsidies to renewable energy sources", receive another 120 mn. DKK going forward (DKGOV, 1981, pp. 17–18). Included in this was an 'establishment subsidy' which covered 30% of a builder's documented capex cost to build a new wind turbine. This subsidy would in the following eight years be adjusted down to 10% and then back up several times, until it was completely removed in 1989. It is in several historical accounts one of the key factors of the rapid growth in Danish installations throughout the 1980's (Beuse, 2000; Karnøe, 1991). The socialdemocratic government was still focused on nuclear, but although more positive towards the future of wind power ascribed the quality of *Future Potential* to wind power as they concluded that "through continued technological developments it can be expected that the renewable energy sources are made cheaper and become more efficient" (DKGOV, 1981, p. 146). As fuel prices would increase, the government saw renewables take on an increased importance. The 1981 plan also had high salience on the *Industrial* quality of energy investments in general, emphasizing that 'energy investments' gave direct employment to 35.000 in the energy sector and another 28.000 in other related sectors (DKGOV, 1981, p. 21). Herein wind power was also included, but of course between several larger energy sources. The report would go on to draw a direct link between government investments and the newly emerged energy industry as they would state "a new export industry had emerged", and its competitiveness was "tightly connected to the composition of energy investments" (DKGOV, 1981, p. 25).

It was not only the utilities which saw wind power as a supplement, which should not stand in the way of the overall goal to build nuclear energy. The first energy minister Poul Nielson (S) was initially a strong proponent of nuclear energy, but also supportive of wind power as a supplement (Beuse, 2000). This was seen in the previous analysis, wherein the 1976 Energy plan had a plan to put a nuclear plant into operation in 1985, and how the subsequent energy plan, Plan81, had to reconfigure this goal to 1993, as an investment decision had not been made since 1976 (DKGOV, 1976, 1981). In addition to this change, the 1981 energy plan included a high renewables scenario. Both Denmark's first energy minister Poul Nielson (S) and his successor Knud Enggaard (V), were supportive of nuclear energy, but had both supported wind power to some extent. Nielson had helped provide the establishment subsidies in 1981, and Enggaard had overseen compromises between DEF and the wind-turbine owners in the mid-1980's. A compromise between Fuel- and the Unique-coalition came in the form of 10 year agreement in May 1984 between the Danish Wind Turbines owners' organization and DEF. DEF was happy with the agreement as it maintained some requirements towards how far you could live from a wind turbine you had ownership in, while DWOA got some assurances that they could still sell their power to the grid at a guaranteed price. The sitting DEF CEO labelled the agreement an "electricity-historical occasion", and an organizational spokesman expressed hope that the move should end "the widespread opinion of the press and many politicians" that the utilities were against renewable energy (K. H. Nielsen, 2001, p. 275). DEF would also open up to an increased role in wind power, and would in December 1985 agree with energy-minister Enggaard to build 100 MW wind power by 1990, twice the installed capacity at the end of 1985 (DEA, 2016b, p. 25)[40]. The build-out program received EU-funding to pave the way for what was then considered large 20-25 MW wind farms. It would however not achieve this goal, as the large test-turbines which should have paved the way for the large parks, did not achieve the efficiency as the smaller ones placed around the country[41]. This law did however severely limit private citizens' and communities' ability to build more wind power than for their own consumption (Karnøe, 1991, p. 231). So Although it achieved some stability, the deal would later on be criticized from the Unique-coalition side, as it hampered the grassroots ability to build wind power, while the utilities never managed to build the 100 MW wind turbines in time (B. T. Madsen, 2000, p. 161). Despite the large documented project-losses the 1984-1985 deal caused (Karnøe, 1991, p. 231), it was however a slight first move towards wind turbines no longer being exclusively a grassroots endeavor.

But the largest step towards wind power stability of the mid-1980's, was when the party Radikale Venstre again utilized the alternative red-green majority with the left wing parties, to enact a ban against nuclear energy[42]. The Unique-coalition had ties to influential politicians in the political party Radikale Venstre, who early on were adamantly anti-nuclear. The party's effort was led first by Kristen Helveg Petersen and later by Lone Dybkjaer. Due to its position in the center of Danish politics, Radikale Venstre was during the 1980's able to function as part of a conservative-led government, while forming this red-green majority with the opposition on certain issues, one of these was the important 1985 decision to abandon nuclear power in future energy planning[43] (Beuse, 2000; DEA, 2016b, p. 24).

[40] This is the most significant mark that Venstre as a party had on the period, since Enggard's successor, Svend Erik Hovmand (V) did not enact major legislation on wind power from 1986-1988 (DEA, 2016b, p. 163).

[41] Especially the 2 MW Tjaereborg turbine is today considered an expensive and poorly designed construction. The tabloid newspaper Ekstra Bladet could under the spectacular headline of "70 Mn. DKK Wind turbine cannot rotate its blades" write about how the Tjaereborg turbine was so poorly built, that grassroots and turbine-builders suspected the utilities of consciously portraying wind power as an economically unattractive technology (EB, 1988). The utilities Nibe turbines were slightly better, but were also decommissioned earlier than originally planned. Despite the poor performance of the prototypes, the projects did serve the purpose of creating excitement and knowledge around wind power within the utilities as mentioned elsewhere in this chapter.

[42] This red-green majority had also prior to the nuclear decision forced the sitting right-wing government to take actions in the energy sector. In 1983, Socialdemokratiet and Radikale Venstre had voted with the left-wing parties to enact a phase-out of South African coal imports in a protest to the Apartheid. Venstre and De Konservative abstained from the vote (EFKM, 1984, p. 9).

[43] The vote fell in March 1985, where Radikale Venstre, Socialdemokratiet, and the left-wing parties, SF and the left-socialists, today known as Enhedslisten, won the vote 79-63. Venstre and De Konservative voted against the ban on nuclear energy Socialdemokratiet came to also be against nuclear energy. One of the pivotal moments in that process came in the mid-1980'swhen Socialdemokratiet were no longer in Government and former Prime minister, Anker Joergensen (S), was asked about nuclear energy at a Party conference. That moment is explained below by Steen Gade from the left-wing party SF.

Before going into showing the valuation frames of the two coalitions, I will sum up with a few interview quotes, to show how the two dominant qualities *Energy Independence* and *Industrial* are the once that there were shared focus on. Below is the lead engineer for DEF, giving his take on the main qualities that defined the period.

> "In 1976 it was unemployment which caused wind energy research to get funding. Then you started talking about wanting to become independent of the Arab states, the oil-nations. This was also something you wanted in 1985. Before CO2 became salient, it did not appear until in the 1990's....The whole supply security question was important". (Interview 1, Johansson, Quote 5)

As seen from the Unique-coalitions side, it was clear that it was the *Industrial* element that drove the limited engagement from the Fuel-coalitions side. The Fuel-coalition did however not see wind power as something that should have a large role in the system. This is seen in the below quote from wind power entrepreneur Birger T. Madsen.

> "Historically, the judgment must be that the utilities didn't build wind turbines without getting something in return in the form of permits to erect new coal plants and limitations on competition from private suppliers of electricity. Wind power was up until the mid-1990's considered to be something one (the utilities, ed.) wanted to promote for exports and employment, but seen as absolutely unfit and uneconomic in our electricity system". (B. T. Madsen, 2000, p. 162)

Apart from this a defining quality is the *Fuel Supplement*, as it is the metric which makes wind power's value be framed by a break-even price to fuel costs. Although this supplement grew during the 1980's, it would still only constitute just below 2% of the electricity supply in 1990 (Appendix A).

"It was a tough discussion in Socialdemokratiet. They had a large party-gathering in Silkeborg…their position was 'we are against nuclear power, if you do not handle waste properly'. There was about 1000 people in that room, and they all knew what this was about…When Anker (Joergensen, ed.) then starts to say: 'The Socialdemocrats are against nuclear,…' he was interrupted. A minute long interruption (of cheers and applauds, ed.), …it was a symbolic description of the shift within the Socialdemocrats" (Interview 5: Gade, Quote 1).

3.6. UNIQUE SUPPLEMENT: VALUATION FRAME SUMMARY

In this section, I summarize the qualities, frames and networks observed throughout the Unique Supplement period. The summary sections for each of the five periods follow the same structure to ensure consistency across the analysis. In the first sub-section, I describe the new qualities that were used to frame the value of wind power during the analyzed period. In the second sub-section, I analyze the period's dominant valuation before describing the corresponding valuation network in the third sub-section. The only exception to this structure is that the first sub-section on new qualities is only present in the first three summaries, as the last two valuation frames do not incorporate any new qualities; instead, they recombine existing qualities. The first sub-section is a bit longer in this chapter, as I present the first seven qualities that were used to frame wind power's value. Three additional qualities were added during the Climate Solution period, and the last two qualities were added during the Market Distortion period. The qualities can be categorized into three domains: technological, societal and environmental.

As explained in the theory, moments of valuation can be anything from a single meeting to an era; the emphasis is on the sites and methodologies used in valuation work. The valuation frames I have assembled represent my attempts to capture the dominant conception of the value of wind power in each of the five periods. Each valuation frame is based not a single report, but on a synthesis of several documents and statements that represent how the dominant valuation network of that period framed the value of wind power.

<u>3.6.1 The First Seven Qualities Used to Frame the Value of Wind power</u>

The first valuation struggle between Juul and DEF revealed the first three central qualities used to frame the value of wind power: *Fuel Supplement*, *industrial*, and *Energy Independence*.

Fuel Supplement (Technological)

The *Fuel Supplement* quality represents how wind power is valued by its ability to supplement an existing fossil fuel based energy source. This is seen through the metric of a break-even price, wherein wind power is considered valuable when it is cheaper to build wind power capacity than to purchase the equivalent amount of energy by importing oil, coal or gas.

Industrial (Societal)

The *Industrial* quality represents the societal value of the domestic wind turbine industry in terms of job creation, exports and tax revenues. Simply put, if Denmark bought all of its turbines from Germany and had no local production, this quality would only exist to the extent of installation jobs.

Energy Independence (Societal)

The quality of Energy Independence refers to the value of not needing to rely on fossil fuel imports from foreign countries. It is thus primarily the value of being less exposed to geopolitical tensions and the risk of major price-hikes or being completely cut off from supplies. Additionally, it covers the value of not funding potentially dangerous states by buying fuel from them.

These first three qualities remained important in the valuation struggles that followed the 1973 oil crisis.[44] Four new qualities appeared after the 1973 oil crisis: *Future Potential*, *Black-out Risk*, *Environment* and *Aesthetics*.

Future Potential (Technological)

The *Future Potential* quality represents the possibilities for development that will increase value, for instance, by lowering *Technology Cost* or improving technical performance of the turbine. This quality was mentioned briefly in the Fuel-coalition's reports on the topic of large-scale utility wind turbines, yet the 1983 World Council report reveals it only had a small positive impact on their final valuation. However, in the Unique-coalition's valuation frame, *Future Potential* had a strong positive impact, as evidenced by their use of a lower discount rate, their future expectations regarding cost reductions and capacity factors, as well as their envisioned shares of wind electricity in the Danish grid.

[44] Both the Fuel- and Unique-coalitions used the *Fuel Supplement* quality in their valuation of wind power, as evidenced by their use of break-even prices as the key metric to measure the value of wind power. It is the *Energy Independence* quality which triggers the focus on energy after the disruption of oil supplies in the 1970s. In the 1980s, the prospect of creating jobs and generating exports became especially salient, which led to a number of favorable legislative decisions in favor of wind power.

Black-out Risk (Technological)

The *Black-out Risk* quality refers to the value loss ascribed to the possibility that wind power would cause the energy system to break down temporarily or completely. It is the technical risk that wind power could not be integrated and would cause black-outs due to a lack of wind or the system's inability to handle large amounts of wind power at a given moment in time. This quality was not discussed by the Unique-coalition, but the concerns raised by the Fuel-coalition in the electricity overrun report from 1983 show that it had a negative impact. The coalition did not frame black-outs as something that would necessarily break the system, but as a risk that would need to be mitigated at high expense to the system.

Environment (Environmental)

The *Environment* quality covers the value ascribed to local benefits from using wind power as opposed to conventional sources of energy. This covers air quality as well as reduced depletion of resources, such as timber for biomass or water for coal or nuclear plants. It also relates to the avoidance of nuclear waste. Some readers may object to the notion that climate change mitigation is not included in the *Environment* quality. However, the quality related to climate change did not appear in the framing during the Unique Supplement period. In the early years of the wind turbine history, climate change was not an established fact within the scientific community, and even less so among the general public. This became more prominent with the 1987 Brundtland report (Brundtland, 1987), and the following first report from the UN's International Panel on Climate Change in the early 1990s (IPCC, 1992). Although a few actors within the Unique-coalition were aware of climate change as a phenomenon in the 1970s and 1980s[45], it was not an independent quality used in pre-1990 valuation frames.

Aesthetics (Environmental)

The *Aesthetics* quality covers perceived negative impacts on neighbors or other proximate actors when wind turbines alter the landscape. This quality is rarely calculated into a monetary value, but often is emphasized as an argument that wind turbines (especially onshore turbines) are not valuable. Therefore, although it is difficult to commensurate, it is necessary to include it as a quality in valuation frames. This quality also covers any perceived health issues from living close to

[45] One example is Niels Meyer, the president of the ATV, who wrote about it in the 1978 book, "*Oprør fra midten*" (K. H. Petersen, Meyer, & Soerensen, 1978). Therefore, in pre-1990 valuation frames climate change mitigation is considered to be included in the *Environment* quality.

wind turbines, although there to date has been found no solid proof that living in proximity to wind turbines cause illness.

These seven qualities were used to create the first framings of the societal value of wind power. In the next section, I describe how the Unique-coalition managed to replace the incumbent Fuel-Coalitions Expensive Supplement frame with their challenger frame, Unique Supplement.

3.6.2 The first shift comes with the emergence of the Unique Supplement Valuation Frame

In this first empirical chapter, I map the incumbent Fuel-Coalitions Valuation frame, Expensive Supplement, and compare it to the Unique-coalition’s frame, Unique Supplement, which became dominant during this period. Doing so reveals the first valuation struggle that ultimately resulted in the creation of the Unique Supplement Valuation frame shown in Figure 13 (GBA) on the next page. In the empirical chapters that follow, I adopt a similar analytical structure by comparing the previous period’s valuation frame against the new one.[46]

The Fuel-coalition’s incumbent valuation frame, Expensive Supplement, was dominant until the oil 1973 crisis, where after it began to destabilize due to continuous challenges from the Unique-coalition. To the Fuel-coalition, wind power was still a marginalized, low value technology that possibly could serve as *Fuel Supplement* and nothing more. Wind power was calculated as a *Fuel Supplement* that was too expensive and posed a *Black-out Risk* if deployed on a larger scale. Costs and risks outweighed the small positive impacts of the qualities related to the *Environment* and *Future Potential*. The overall valuation of wind power from the Fuel-coalition’s ranking and calculation of qualities was that wind power was not a worthwhile investment. However, the Fuel-coalition did recognize some advantages to helping the industry in order to export wind turbines and become less dependent on foreign fuels. These two qualities were what drove the Fuel- coalition’s limited commitment to wind power and facilitated some compromise with the Unique-coalition. Without these two qualities, there would have been little ground for any later compromises with the Unique-coalition.

[46] The Expensive Supplement frame is treated as historic and not mentioned after this chapter, since the Unique Supplement frame became the defining frame for the 1974-1989 period of the analysis.

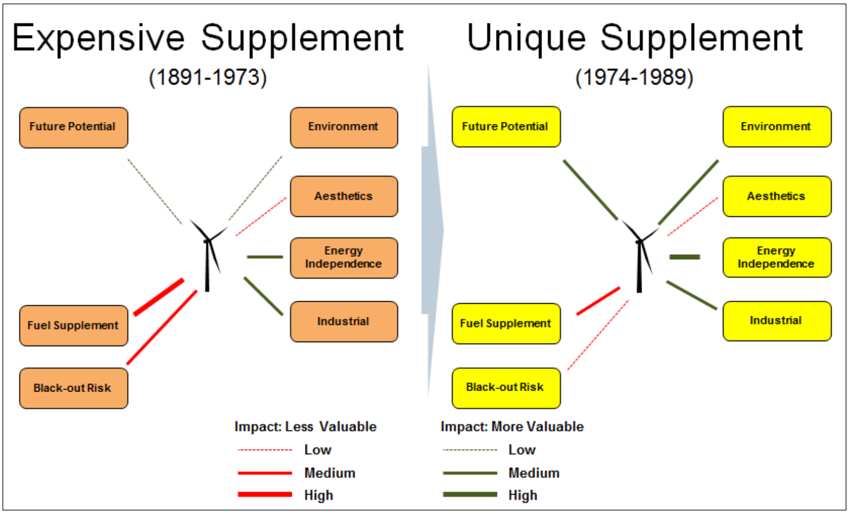

Figure 13: The historic (ES: 1891-1973) and the first modern (US: 1974-1989) Valuation Frame.

The Unique-coalition's challenger valuation frame, Unique Supplement, had some similarities to the previously dominant Expensive Supplement valuation frame. The most notable similarity was that the Unique Supplement frame still measured wind power's value as a *Fuel Supplement*, as evidenced by the metric of break-even prices relative to fuel costs for coal and gas plants. But wind power was not calculated as being much more expensive than the fossil fuel it was replacing. The Unique-coalition estimated the *Future Potential* of wind power as much higher based on high capacity factors, good wind sites and a low discount rate. The Unique-coalition also calculated much larger societal savings from being less dependent on foreign fuels. Extending the argument made by Johannes Juul, the Unique-coalition saw wind power as a highly necessary part of the energy system to guard against the shocks seen in 1973 and 1979. Additionally, they saw a higher *Industrial* value, since Denmark was building unique competences; by the early to mid-1980s, export markets began to open up. Although small concerns over *Black-out Risk* and *Aesthetics* were recognized, wind power was framed as a unique supplement that would prove valuable to Danish society in the future.

3.6.3 The Unique Supplement Valuation Networks

In this section, I map the human actor coalitions and thereafter the materiality of the valuation networks during the Unique Supplement period.

Coalitions of Human Actors

As can be seen in the analysis it is not possible to to draw up sharp lines between the various coalitions, as some actors overlapped. Examples of obvious overlaps include the renewables engineer within the DEF who also worked with the Unique-coalition, or the large internal discussions among the Socialdemokratiet during the debate leading up to the nuclear power ban in 1985. Nonetheless, the are enough reference points to draw up the rough contours of the two coalitions. Figure 14 (GBA) shows actors present at the beginning of the period (solid border) and new actors that emerged either at the start of the period or near the end (dotted border). The actors are shown on an axis, which indicates their relative dominance in setting the valuation frame and are color-coded to indicate membership in a coalition. I list the two main coalitions below the figure while gray boxes are neutral.

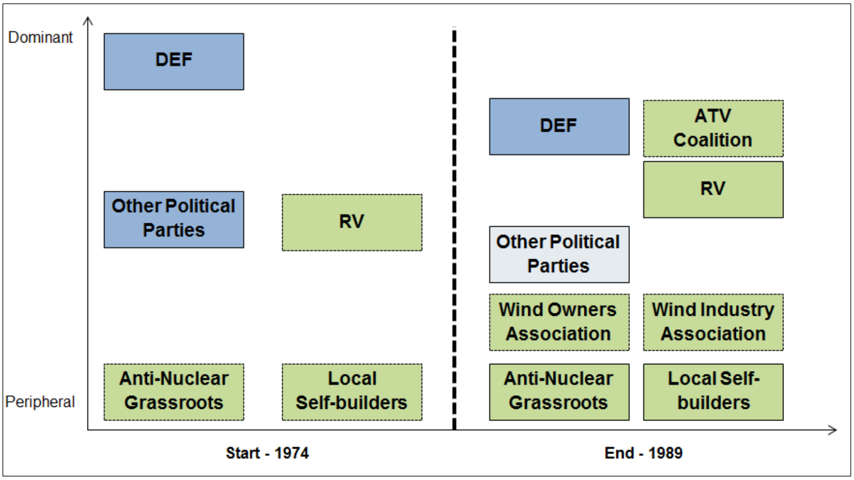

Figure 14: Key actors in US period; blue: Fuel-coalition; green: Unique-coalition.

The left side depicts the situation immediately after the first oil crisis. The Fuel-coalition was dominant in setting the valuation frame for all energy sources in Denmark, as there was broad agreement among Socialdemokratiet, Venstre and De Konservative to follow the recommendations of DEF research groups. Members of the DEF were at the center of the Fuel-coalition and considered the go-to experts in the governmental analysis of wind power during this period.[47]

In the mid- to late-1970s, the Unique-coalition formed around three actor-groups that had begun to present an alternative calculation focus. These actors were the grassroots movements opposing nuclear energy and promoting wind and solar, local turbine-builders, and Radikale Venstre, which helped coordinate grassroots conventions and drove the 1985 ban on nuclear energy. The grassroots members of the coalition were focused on large environmental challenges ahead, partly due to connections to the authors of the 1972 publication, *Limits to Growth*, and therefore saw wind power as a centerpiece of future energy supply. To a great extent, they were united in a shared search for an alternative to nuclear power, a goal which was shared with members of Radikale Venstre, who were the main political drivers behind the 1985 ban of nuclear power. They are identified by Niels Meyer as the key political drivers in this early period.

> "Already by January (1973), I had invited him (Dennis Meadows) to give a lecture at Copenhagen University. There was 500 people there to discuss....It was rather important because we got many of the younger politicians to join, Kristen Helveg Petersen, and some other older and experienced one....Lone (Dybkjaer, ed.) and several other became very occupied with it. Radikale Venstre fully supported wind power and they were luckily the decisive vote in many situations. It was important that we had them". (Interview 2: Meyer, Quote 3)

Although there were many overlaps between participants in grassroots movements and turbine-builders, they were not completely aligned. The two actors considered different qualities to be most salient, yet both participated in the valuation network that challenged the DEF's initial framing of wind power.

The right half of Figure 14 shows the positions of the actors at the end of the Unique Supplement period. The Unique-coalition had established an alternative center of calculation to the otherwise dominant Fuel-coalition. Radikale Venstre had become slightly more dominant after uniting with members of Socialdemokratiet and the left wing to form the red-green majority while being part of a Conservative-led government. This was driven by a growing industry, which apart from

[47] They either led the calculations initiated by the government, or were represented in the group, as in the 1975 ATV report. Engineers from DEF also represented the official Danish view of wind power, as was seen in the 1983 contribution to the World Energy Conference.

environmental benefits, could generate *Industrial* benefits in the form of jobs and exports. What began as loose connections between grassroots movements and turbine-builders strengthened throughout the period into an organized Wind turbine owners association (DWOA) and a small industry represented by the Wind Turbine Industry Association (DWIA). Moreover, the Unique-coalition started to carve in on the Fuel-coalitions incumbent position in the energy field, as evidenced by author cross-over in reports and the utilities' construction of test turbines. As actors within the utilities began to explore wind power opportunities, some actors within the utilities moved towards a pragmatic stance toward accepting wind power as a beneficial supplement to the energy system, but not much more than that. Influences from abroad mentioned in the analysis, such as academics affiliated with the Club of Rome in the 1970s, and actors involved in the California wind rush, had effects through actors in Denmark; therefore, they are not mapped separately in the valuation frame.

Part of the framing of wind power as a *Fuel Supplement* is not solely explained by the actor networks, but by limited available knowledge of its technological potential. Although the Unique-coalition saw much larger *Future Potential* than the Fuel-coalition, members still used the incumbent device of break-even prices, and therefore still calculated wind power as a supplement. Although the challenger coalition emphasized a wide range of potential benefits to the future expansion of wind power, they still had to play by the established rules of the game. The Fuel-coalition actually built prototype turbines in the 1980s and partially supported the development of an industry that could generate future exports. This is a classic example of an incumbent accepting a challenger, as long as it does not significantly upset current market arrangements (Fligstein, 2001). This acceptance is also evident in the next sub-section, in which I uncover the material aspects of the Unique Supplement valuation network. Once the *Industrial* benefits of U.S. exports in the mid-1980s demonstrated the potential of the wind turbine industry, installations accelerated significantly.

Materiality during the Unique Supplement period

As with most other emerging technologies, wind turbines were constructed rather quickly once knowledge networks began sharing experiences. But as can be seen in figure 15 (GBA) of key industry metrics below, the rate of domestic installations grew significantly as exports to the United States in the mid-1980s proved to politicians that the wind industry could create *Industrial* benefits for Denmark. Although several small wind turbines were built all over the country, no offshore wind capacity was built. Figure 15 (GBA) shows installed cumulative capacity throughout the period (Appendix A), as well as estimates of exports and wind industry employment (FDV, 1988; Karnøe, 1991; K. H. Nielsen, 2001, p. 337).

Although I covered events prior to 1979 in this chapter, I use this year is the starting point for the x-axis, as it is the first year for which data on employees and exports is available[48]. In addition to the domestic market, effects of the California wind rush are evident in the mid-1980s numbers for exports and employees.

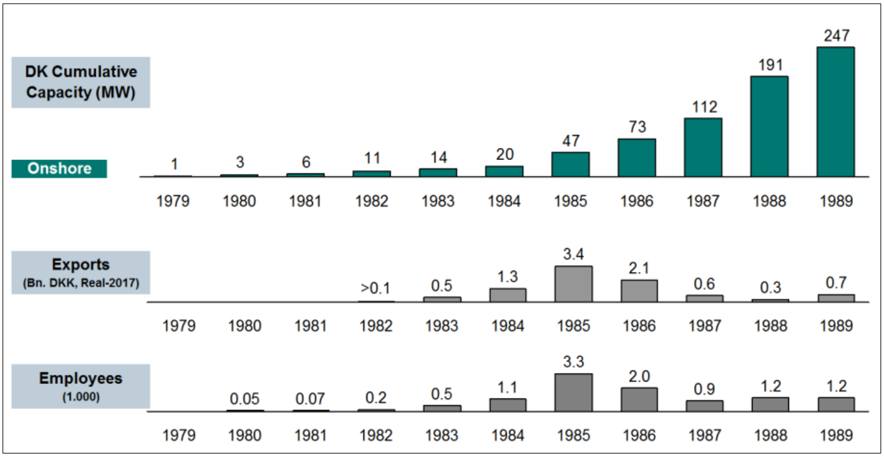

Figure 15: Capacity expansion during the Unique Supplement period.

The legislative part of the valuation network that enabled this capacity expansion consisted of a number of measures that provided incentives for wind turbine builders and new entrepreneurs. Early R&D programs created as part of the 1976 energy plan supported the network's formation, followed by the establishment subsidy, which provided financial stability for entrepreneurs attempting new designs. Quality was ensured through funding for the shared Risoe test center which certified many new small turbines. The export markets were helped through state-backed financial guarantees to ensure that small Danish companies were trusted by U.S. buyers during the California wind rush of the 1980s. The network had a small protected space wherein wind power was allowed to grow, as entrepreneurs materialized their ideas and formed new companies. Through the valuation struggles described in this chapter, entrepreneurs were able to carve out this small corner of the energy system, thereby creating the exports and jobs that turned the small wind industry investments into justifiable business policy.

[48] Numbers have been triangulated, but should be considered best estimates since slight variations exist among sources (FDV, 1988; Karnøe, 1991; K. H. Nielsen, 2001, p. 337).

There was a red-green majority in parliament, but also broad agreement over providing financial guarantees to ensure exports. Although politicians became increasingly open to wind power throughout the period, it remained primarily a small business endeavor. In terms of the energy system, the challenger energy source had to fit and conform to the terms set up by the DEF incumbents. Two important events in the mid-1980s helped establish some stability in the valuation network: the 1984 agreement with the utilities and the 1985 decision to ban nuclear power from future energy planning. The utility agreement stabilized the near-term future for wind power by guaranteeing grid access, while the ban on nuclear secured its long-term future by eliminating a competitive technological pathway.

3.6.4 Key Takeaways From the Unique Supplement Period

During the Unique Supplement period, wind power was valued by two very different valuation networks that had some agreement on the qualities to value it by, but strongly disagreed on how to prioritize and calculate them. Both networks used break-even prices to calculate the relative cost of building a wind turbine versus the cost of fuel for a power plant. The main differences between the two frames is that the Unique Supplement frame saw a much larger *Future Potential* in wind power and viewed it as the natural choice, in part due to opposition to the environmental risks of nuclear power expansion. Three critical events, the 1984 utility wind owners agreement, the 1985 100 MW capacity expansion agreement and the 1985 decision to ban nuclear energy, signal the point at which the Unique Supplement valuation frame became dominant and sufficient stability had been established to enable wind power to grow. However, it remained a challenger coalition and the valuation frame became dominant only because it was partially accepted by some of the incumbent actors.

Radikale Venstre was the most significant party for wind power during this period, as members were closely connected to the academic actors in the Unique-coalition and pushed early on for wind power to play a more central role. The other three parties were part of the fuel-coalition and initially had a pro-nuclear stance and where therefore dismissive of wind power. But Socialdemokratiet began to support the Unique-coalition through their late participation in the red-green majority, which voted to ban nuclear energy in 1985. Venstre's impact during the period amounts to Minister Enggaard's 100 MW capacity expansion agreement with the utilities, while De Konservative were absent from the wind power framing. These parties are therefore placed as neutral for the end of the period. They cannot be said to have been a part of the Unique-coalition, but they did end towards a position where they were not completely aligned with the Fuel-Coalitions most central player, DEF.

Hereafter follows the next moment of valuation.

4. NEW FRAMING OF WIND AS A NECESSARY CLIMATE SOLUTION

The previous chapter mapped how a new valuation network of wind-turbine builders, anti-nuclear activists, civil servants and pro-wind politicians collaborated to form a challenge to the conventional conception of wind power as an expensive and unreliable *Fuel Supplement*. The Unique-coalitions framing produced wind power as a supplement, which had a large *Future Potential* and as the industry grew during the 1980's, the incumbent Fuel-coalition had to give some way for a new framing of wind power. It was nonetheless still the break-even price to conventional steam power plants, which was used to compare wind power's value with other energy sources. But in the 1990's this would change, and we would also come to see a single valuation frame dominate the build-out and public discussion. This chapter takes its start with the rising international concern about climate change, as first seen in the Brundtland-report (Brundtland, 1987) and the planned formation of the UN IPCC panel.

4.1. ENERGI 2000 BRINGS CLIMATE CHANGE MITIGATION TO SALIENCE (1990)

The government of De Konservative, Venstre and Radikale Venstre, with energy minister Jens Bilgrav-Nielsen (RV) in charge of energy, presented the plan "Energi 2000" in April 1990, the first energy plan in the world with a CO2 reduction target (F. Nielsen, 2016). The report focused on reducing CO2 emissions and thus calculated build-out paths for various alternatives. Specifically, the plan had goals of a 20% drop in CO2 emissions, and a 15% drop in energy consumption by 2005. Wind power supplied around 0.7 Terawatt hours (TWh) in 1990, and the report envisioned a build-out to 3 TWh by 2000 (1.35 GW) and 8 TWh by 2030 (2.8 GW) (Beuse, 2000, pp. 98–99; DKGov, 1990, p. 54). The intent in this energy plan was derived from the very clear goal that one would have to transition away from coal to mitigate climate change. Furthermore, wind power was highlighted as valuable due to the point of reference that Denmark was "internationally leading within wind power" and a development where "more economic designs and larger turbines" had led to lower costs. The report concluded that "the price per KWh is today quickly approaching the price of the electricity produced on the Danish power plants" (DKGov, 1990, p. 54). This is an important calculative difference from the previous period. Wind power is now framed as a stand-alone energy source, which has a price per KWh of electricity it produces. This is still compared to conventional power plants, but its value is not framed as a result of how much fuel it can save.

Furthermore, the build-out goal is an independent power generation number, and not a small percentage of a total system generation. So the quality of *Technology Cost* is produced and inscribed into wind power instead of it being a *Fuel Supplement*. In addition to this the *Industrial* quality is highlighted through the mention of Denmark's international position within the wind industry. Most importantly, the new quality of *Climate Change Mitigation* (Hereafter *CC Mitigation*) is produced and takes on a central position throughout the overall purpose of the energy plan.

Bilgrav-Nielsen came from Radikale Venstre, same as Lone Dybkjaer, and aligned roughly with the Unique- coalition. They now utilized the international concern about climate change, which made the *CC Mitigation* quality very salient, as seen through the "Our Common Future" report in 1987 (Brundtland, 1987). This was the first sign that the Unique-coalition would gain a powerful ally in the government through a focus on *CC Mitigation*. The actors from the old Unique-coalition would begin to find new strong allies in government and the framing would be centered on this new quality of Climate Change Mitigation. I will therefore hereafter refer to the emerging Climate-Coalition.

Bilgrav-Nielsen believed that an ambitious energy plan would only work if pressure was held on the utilities to help integrate wind power. The two large utilities, ELSAM and ELKRAFT had not managed to build the 100 MW that was part of the agreed deal in 1985, but had as compensation committed to building two small-scale offshore wind farms, which would become Vindeby (1991) and Tunø Knob (1995) (DEA, 2016b). Bilgrav-Nielsen would with the 1990 energy plan again commit the utilities to building 100 MW onshore wind power during the subsequent five years. Energi2000 also contained a large build-out of decentral heating gas plants, and if both things were to be built, there would now be room for much other electricity generating capacity. It was for Bilgrav considered self-evident that any thought of new coal-fired power plants were considered incompatible with an energy system which should enable *CC Mitigation*. Bilgrav had therefore rejected a request from ELSAM to build a 350 MW coal-fired power plant at Skaerbaek (DEA, 2016b, p. 31). Coal was by the Climate-coalition framed to be a too pollutant energy source, and thus no new coal plant builds could qualify as valuable in a system that had a high salience on *CC Mitigation*[49]. According to Energi2000 of 1990, any new energy source's value depended on the degree to which it helped Denmark lower CO2 emissions. I will not outline the valuation frame yet, as it will emerge fully later in this period. But as mentioned I will refer to the coalition which places Climate mitigation goals at the center of energy valuations as the Climate-coalition. This coalition has many of the same actors as the Unique-coalition, but is different in that their main site of valuation would not be in academic forums and grassroots

[49] It should be noted that the energy plan was not solely built on a need for *CC Mitigation*, as one of the main drivers for the wind power build-out during the 1980's, *Industrial* benefits in jobs and export, still played a role. This quality was present in the new valuation frame, but it had taken a secondary role to the overarching dominant and necessary quality of *CC Mitigation*.

engineers, but in the calculative center of the environmental and energy-ministries. Before this coalition would solidify its dominance, a destabilization attempt would be made to it, as the abolishment of coal power went against the current build-out plans of the remaining actors of the Fuel-coalition.

4.2. DESTABILIZATION ATTEMPT BY MINISTER AND UTILITIES (1991-1992)

The balance of power between the Unique-coalition, the newly forming Climate-coalition and the Fuel-coalition valuation networks would momentarily be challenged after the election for the Danish parliament in December 1990. Following the December 1990 election, Radikale Venstre had to leave the government, which then only consisted of De Konservative and Venstre. This change where the Climate-coalition main political ally left the government showed that the previous government's favorability towards wind power had primarily been borne by Radikale Venstre. Although the previous decades' compromises had positioned wind power as a unique supplement to the energy system, it was still confined to being that, a supplement. Wind power supplied less than 2% of Danish electricity supply (Appendix A), and its future presence and potential was not guaranteed as the government offices changed. The energy ministry would be merged into the Ministry of Industry under Conservative Minister Anne Birgitte Lundholt. Lundholt had through her extensive lobbying experience for the Danish employers association and the textile and furniture industry become known as "the Iron Lady of Industry", who believed that any political attempt to force or coerce businesses to do something was bad policy (Pol, 1991b). As the area of energy policy became a subordinate element of the ministry of business, the newly forming Climate-coalition lost an important ally as Bilgrav-Nielsen left the position as minister of energy. Lundholt governed by a foremost purpose to serve the industry with the least amount of interference and her "hands-off approach" gave the Fuel-coalition Incumbents more autonomy to reassert their Valuation Frame of wind power as an Expensive Supplement, and thereby ensure the future utilization of their central power plants. On the same day the political leadership changed, the utilities announced that they would no longer comply with the 1984 agreement on wind power electricity. This specifically concerned priority acceptance of wind turbines electricity, and a subsidy payment of 35% to help wind turbines connect to the grid (Pol, 1991b). When the first utility,"Thy Hoejspaendingselskab", refused to adhere to the agreement, Lundholt refused to interfere and argued that the utility 'had good economic arguments to break the agreement' (Pol, 1991c). In what resembled a classic David vs. Goliath fight, Lundholt encouraged the Danish wind turbine owners to merely negotiate a new deal with the utilities. The coming months would see the wind turbine owners association and DEF fall further into the trenches, while Lundholt was reluctant to accommodate any proposed solution requests from political colleagues (Kaergaard, 1991). This was a destabilization attempt, as a material actor in the former ATV valuation network, namely the priority grid access and grid-connection subsidy, is disassembled by an actor, Thy Hoejspaendingsselskab, in the incumbent valuation network. The minister in charge of energy, Lundholt, decided to disregard the year-long practice in the area, and allow the Fuel-coalition to re-write the agreed upon rules. Both Radikale Venstre and Socialdemokratiet negotiated to help the wind turbine owners, but Lundholt would, in the teasing words of former Socialdemokratiet minister Poul Nielson, feel 'sad to be caught cooperating' (Pol, 1991d). The resolution of this dispute would come a year later, as Lundholt became dependent on Socialdemokratiet's votes in a political compromise over a proposed new coal plant.

4.2.1 CO2 taxes and the fight over Denmark's last coal-plant

Lundholt was determined to fight the proposed CO2 tax proposed in Energi2000 with 'tooth and claw' (Pol, 1991b), but within the parliamentary measures she had little-to-no power as minister. As the De Konservative/Venstre coalition government was a minority government, Radikale Venstre could still utilize the red-green majority with the left-wing parties to see the legislation come through[50]. They would mandate two important laws for the materiality of the continued wind power build-out. The first was Law L888 (21 December 1991) to enforce a CO2 tax of approximately 13 Euro's per ton of CO2 emitted, which was calculated into 10 Oere per KWh of electricity (L888, 1991). The second was L944 which refunded the 10 Oere/KWh to providers of renewable electricity and decentral gas power plants, and gave an additional 17 Oere/kWh to providers of renewable electricity (L944, 1991)[51]. This was how onshore wind power got the 27 Oere/kWh subsidy feed-in tariffs for the following decade. This went against Venstre and De Konservative who would rather wait for the EU to propose something. They officially opposed these laws on the ground that they would have "marginal effects" and lead to a "completely unacceptable system pervaded by bureaucracy" (BTB52, 1991). This is the material actor of the Climate Valuation Network wherein wind power is enabled through CO2 taxes on competing energy sources, and then compensation for its carbon-free electricity.

Although unsuccessful when it came to avoiding the enacted laws on CO2 taxation, Lundholt had a second fight in 1991-1992, as she was set on allowing the

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[50] This CO2 tax was voted through in parliament by the red-green majority consisting of Socialdemokratiet, The Socialistic Peoples party (SF) and Radikale Venstre and thus formed without the sitting government, (DEA, 2016b, p. 36).

[51] The 17 oere/kWh would replace Law 626 from 1983 (Beuse, 2000, p. 361), where renewable electricity providers would be compensated for the electricity tax up to a maximum of 20 oere/KWh. The electricity tax had been introduced at 2 oere/kWh in 1977 and had through several legislation been raised to a level of 33 Oere kWh in 1992 (DST, 1993, p. 172).

construction of a new coal plant (Pol, 1991b). Lundholt and the Fuel-coalition strongly disagreed with the Energi2000 wording that “build-out of new electricity capacity should preferably happen through transition of existing heat-power plants, to decentral heat-power production” (DKGov, 1990, p. 13). The Fuel-coalition’s proposal to build two new large centralized power plants was based on an assumption that the energy savings, planned in Energi 2000, would not be implemented (H. Lund, 2014, p. Ch. 8.4). But even with assumed higher energy consumption, the central power plants were almost certainly guaranteed to create a situation of oversupply. This was due to the earlier agreed build-out of small decentral district-heating plants in the Energi 2000, which was to be implemented throughout the 1990s[52]. This was where the locked-in David vs. Goliath valuation struggle over the wind turbine owners’ conditions became decisive. In March 1992, a divided Socialdemokratiet joined the government in approving the build-out of two centralized power plant, the 350 MW coal-fired “Nordjyllandsvaerket” and the 350 MW gas-fired “Skaerbaekvaerket” power plants (which the utilities had tried to get approved as a coal-plant back in 1990) (DEA, 2016b, p. 37). The coal-fired Nordjyllandsvaerket was a highly controversial decision, as it would jeopardize the environmental goals set forth in Energi2000 (H. Lund, 2014).

In return for supporting the coal-plant construction, Socialdemokratiet demanded that the utilities covered all grid connection costs for wind turbines, followed by a legislative change that would exempt both private- and utility-owned wind turbines from the CO2 tax. This part about exemption utility turbines, was an accommodation to the utilities who until now had been ordered to install wind turbines without receiving the same compensating subsidies as private owners (Hansted, 1992). The Fuel-coalition objected that the agreement was far too beneficial for the wind-turbine owners, and re-iterated their framing of wind power as a *Black-out Risk*, stating that it was “impossible” to calculate the cost of the needed grid-reinforcements to avoid *Black-out Risk* (Hansted, 1992).

4.2.2 Municipalities are allowed to block wind turbine projects

In addition to allowing the utilities to deviate from the previous agreements, Lundholt allowed the local municipalities to exercise more autonomy in denying build-out permissions and initiated an examination of any annoyances of living close to a turbine. By the end of 1992, wind power build-out was significantly behind the Energi 2000 targets, but Lundholt refused to take any political actions towards

[52] Such over-capacity in the Danish energy system would have a negative effect on the value of all energy sources, but especially fluctuating sources, since they most often produce when there is ample supply. Furthermore, the planned wind power build-out in Energi 2000 would later come to be seen as unnecessary due to the oversupply caused by the many investment decisions taken in the early 1990.

neither the municipalities nor the utilities. Instead she attempted to mobilize a majority for abandoning the wind turbine build-out goals completely and examine other renewable options (RB, 1992). During the years of 1991-1992, the wind power industry found itself increasingly framed as more subsidized than other energy sources, as seen by the below joint 1992 Op-Ed from The Danish Wind Owners Association (DWOA) and The Danish Wind Turbine Industry (DWIA):

> "In the period from 1979 to 1989, wind turbines have received an establishment subsidy equivalent to 275 mn. DKK (432 mn. DKK in R-2017), which have resulted in 410 MW installed wind power and the establishment of the world's largest wind power industry. Establishment subsidies were removed nearly three years ago. In its comparison between wind power and natural gas, the (Berlingske, ed.) article concludes that the subsidy per energy-unit is higher for wind-power….It is therefore important to also remember that the establishment costs of the natural gas grid was approximately 20 bn. DKK (32 bn. DKK in R-2017), whereof the state payed a considerable amount in to DONG (Asbjoern Bjerre & Madsen, 1992)."

As noted in the quote above, wind power was at this point in time seen as expensive to society despite several other large energy investments. Anne Birgitte Lundholt did not actively speak against wind power, but her policy actions, such as the build-out of Nordjyllandsvaerket, the removal of natural gas use restrictions (DEA, 2016b, p. 31), and the decision not to take action against the utilities and municipalities indicate that it was not a priority to enable the challenger technology to emerge. The Energi2000 plan of 1990 did however mark the early start of a shift in valuation frames for wind power, as *CC Mitigation* became a quality which was to be considered in energy planning. Lundholt delayed this starting change in framing and momentarily gave renewed power to the incumbent Fuel-coalition's historic valuation frame "Expensive Supplement".

The divide between private wind turbine owners and utilities was still present and the climate-coalition was on some issues left outside of political influence with a practical build-out stand-still, high uncertainty in the legislative frameworks. But the Fuel-coalitions stall of wind power build-out would not last as the Tamil-case would force the Conservative-Venstre Schlüter-government to resign in January 1993 (DEA, 2016b). This change saw a new set of political actors take charge of the energy policy as the Climate-coalition would move to dominance.

4.3. CLIMATE-COALITION CHANGES THE RULES OF THE GAME (1993-2001)

The following chapter uncovers how the Climate-coalition solidifies its presence and a new valuation frame emerged. I will first dedicate a brief segment to a 1-year interim period, wherein energy minister from the small party “The Christian-Democrats”, Jan Sjursen, would collaborate with socialdemocratic environmental minister Svend Auken to re-engage the municipalities in wind power build-out. Thereafter follows a more elaborate segment on Environment and Energy minister Svend Auken and how he built on Energi2000 to establish the dominant valuation frame of the 1990’s, Climate Solution. The empirical walkthrough will conclude with a number of contestations to the dominant framing. At the end of the chapter is an overall Valuation Frame summary, where the Climate Solution Valuation frame, its qualities and the network around it are analyzed.

4.3.1 Environment and Energy ministries are joined to form new powerful actor

As the Tamil-case caused Poul Schlüter’s Conservative-led Government to step down, Socialdemocrat Poul Nyrup Rasmussen became the new Prime Minister. In the following constituted government, Jann Sjursen, a 29 year-old leader of the small party “The Christian Democrats”, would serve as minister of Energy from January 1993 to September 1994. Sjursen agreed with the valuation frame set forth in the Energi2000 plan (Nørgaard, 1993a), and worked with the Socialdemocratic Minister of Environment Svend Auken, to get the municipalities to appoint sites for new onshore wind farms (Skaaning, 1993a)[53]. In one environmental journalist’s words the civil servants of the energy ministry now went from working in the ‘game of the free market forces’ to ‘green planning and active control’ (Nørgaard, 1993a).

Nyrup Rasmussen would start his second term following a successful 1994 election with a centre-left government consisting of Socialdemokratiet, Radikale Venstre and a smaller party called CentrumDemokraterne (AU, 2015)[54]. In 1992, prior to his government period, Nyrup Rasmussen had gained leadership over the party in an internal vote won over then-presiding leader Svend Auken. From 1988-1992, Auken

[53] This was something which both Lundholt and the previous environmental minister, Per Stig Moeller, had refused to do as they argued it should be left to the municipalities and not be solved centrally (Skaaning, 1992).

[54] CentrumDemokraterne were a small party who only gained 2.8% of the vote in 1994 and thus constituted 5 seats in the government. They left the government in 1996. They failed to gain seats in parliament after the 2001 election and were disbanded completely in 2008. Therefore they are not part of this chapter and the government will be referred to as the S-RV government going forward.

was vice chair of “Socialists Internationale” and represented the left-wing of Socialdemokratiet. Radikale Venstre declared they were ready to form a government with Socialdemokratiet, but only if a more center-seeking leader was elected, Nyrup became the new leader of Socialdemokratiet. But Svend Auken was at the time still a very powerful figure in Socialdemokratiet and to mend the wounds, Nyrup offered to Auken that he could have the environmental ministry, which would be expanded to include energy after the 1994 election (H. Mortensen, 2009)[55].

Auken was the initiator of most joint efforts between the environmental- and the energy ministry, and had in 1994 proposed to Nyrup that he should bring environment and energy under the same ministry (Cordsen, 1994) [56]. This was done with some very clear goals in mind, as explained below by Auken’s close political ally Steen Gade, Energy spokesman for the Socialists Peoples Party (SPP) during the 1990s.

> “The moment you became minister of something with as much money in it as oil, you became more important when you walked into the financial ministry, and could then negotiate more. It was also to be able to push the electricity sector (utilities, ed.) more” (Interview 4: Gade, quote 2).

A coalition made up of some of the Unique-coalition and new entrants started to rally around this new Climate-coalition with a goal to first and foremost increase the focus on *CC Mitigation*, but also to highlight *Industrial* benefits of wind power. The key to taking large steps in the development was to grow the bargaining power when it came to climate and environmental topics, and to get the utilities more closely involved. The Climate-coalition knew that being in the ministry which handled the income from the North Sea oil resources would give them more bargaining power when advocating for green policies.

The Climate-coalition expected that the utilities might oppose larger grid reinforcement costs, as wind turbines grew in size and increased their share of the electricity mix. This would be more challenging if the future growth consisted of many small wind turbines, than if the turbines were built in larger clusters, more typical for a utility-led build-out. Therefore it became a central goal for the Climate-

[55] The power dynamics within the Social-Democratic party are important to keep in mind throughout the chapter, as Svend Auken to a high degree shaped the green profile of the Social-Democrats in the years 1994-2001.

[56] From 1993 to 1994, Jann Sjursen of the small party “The Christian Peoples Party had responsibility for energy policy. When” the Christian Peoples Party” failed to get any seats elected by the 1994 election, Nyrup agreed with Auken to move environment and energy together in one ministry for the first time in Danish history (DEA, 2016b, p. 40,46).

coalition to get the utilities involved as a much more active actor in the wind power build-out, as explained by Steen Gade.

> “The aim was that the overall environmental concerns should direct more than the energy sector’s own interests. That was the intent. The other thing was that Svend and the rest of us were concerned with jobs. It was a little bit down-prioritized (by others, ed.) in the general public discussions” (Interview 4: Gade, quote 3).

The ministry had a high focus on the renewable build-out as a means to mitigate CO2 emissions. Although the climate agenda is often attributed to have gained traction in the mid-2000 on a global scale, it was in the 1990’s already a part of the environmental concerns for the Climate-coalition.

> “When we said ’environment’ in the 1990’s, it was also the climate. But then it happened around the 2000’s that the division really took on….That was the way it (the environmental discussion, ed.) was resurrected, through climate” (Interview 4: Gade, quote 4).

The Climate-coalition saw wind power as something that should be developed through a long-term effort, and would advocate have salience on the *Future Potential* quality of wind turbines. In a 2002 article reflecting on the 1990’s, Auken outlined his approach to deploying wind power as dependent “on both a firm policy sustained over the longer term, as well as sufficient government support to overcome the extra cost of the first installations” (Auken, 2002a, p. 1). This firm belief in the *Future Potential* of wind power and the conviction that it required government involvement is salient in the government’s 1996 energy plan, “Energi 21”. This plan set out the Climate-coalitions plans to capture the *Future Potential* and continued the Energi 2000 plan’s salience of the *CC Mitigation* quality.

4.3.2 Climate Coalition Energy-plan sets out to stabilize long-term outlook for wind power

The Climate-coalition's major energy plan of the 1990's was the 77-page document "Energi 21", published in March 1996. It maintained the goal of 20% CO2 reduction by 2005, originally set out in the 1990 Plan Energi 2000 (DKGOV, 1996, p. 3), and would increase and specify the original build-out goal of 1300 MW of wind power. This was done by outlining a goal to increase onshore wind capacity from the 600 MW installed by end 1995 to 1500 MW by 2005, a goal which would be reached in half that time less than 4 years later (Beuse, 2000, p. 104). An ambitious long-term goal was set for offshore wind power, where it was envisioned that 4000 MW of offshore wind power should be installed by 2030. This was equal to 400 times Denmark's current fleet of two demonstration projects, totaling 10 MW (Bailey, 2015, p. 12; DKGOV, 1996, p. 74). True to the Climate-coalition's goal of involving the utilities more, the plan focused on a larger future utility build-out (DKGOV, 1996, p. 40), and was accompanied by a demand to the utilities to install an additional 200 MW onshore wind capacity by 2000 (F. Petersen & Thorndal, 2014, p. 98).

CC Mitigation is a central quality in the Energy plans valuation frame

The Energi 21 plan had several segments that framed the quality of *CC Mitigation* as a key quality in the value of wind power, and the economic framework would be adapted to accommodate this need (DKGOV, 1996).

Energi 21 placed the *CC Mitigation* as the first and foremost purpose of the plan, as it uses the term of an ecological safe space to designate that energy planning had to happen within the planetary boundaries set forth by IPCC and the best available science (DKGOV, 1996, p. 18). It is also highlighted that active intervention to ensure that environmental costs are reflected in prizes is desirable (DKGOV, 1996, p. 30). It goes as far as being so necessary to a degree that the government would 'guarantee' that ongoing build-out of wind power is ensured 'economic feasibility' (DKGOV, 1996, p. 31). The plan also states that in the case of a coming liberalization of the electricity market, it had to be ensured that the instruments that enable a continued build-out of wind power were present (DKGOV, 1996, p. 38). Between the two plants, "Energi 2000" and "Energi 21", the Danish Energy Agency had calculated on mitigation costs of various ways of mitigating CO2 emission (DEA, 1993, p. 14). This was not the damage costs of CO2 emissions, but the "shadow-price" calculations of what it would costs to mitigate CO2 in various sectors and through various approaches. It was thus not a tool to figure out whether or not it was valuable to mitigate CO2 emissions, but instead which measures were best utilized to achieve the goal of mitigating CO2 emissions.

The high ambition level to mitigate CO2 emissions was justified on a moral obligation that Denmark due to its wealth and its high emission per capita level should do more than other countries (DKGOV, 1996, p. 15). Auken was during this time putting a substantial amount of work in creating the Kyoto-protocol (signed in December 1997), to commit the industrialized countries to collectively reduce their GHG emissions by 5% from 1990-levels by 2012. Herein Denmark would come to get a GHG reduction goal of 21% (Ritzau, 2001; UN, 1998). The framing in the energy plan shows that *CC Mitigation* is a quality which has such a high positive value impact that market arrangements must be changed to ensure 'economic feasibility' (DKGOV, 1996, p. 31).

In addition to the *CC Mitigation* quality, the Energi 21 plan lauded the Danish wind turbine industry as ”the largest in the world” and pledged an intention of continued support (DKGOV, 1996, p. 41). The growing numbers of exports and jobs in the sector functioned as a point of reference to the *Industrial* quality as a key piece of the plans valuation of wind power. The quality of *Energy Independence* was also mentioned, but is highlighted as something which has been almost completely solved, as the country is no longer as independent on foreign fuel imports (DKGOV, 1996, p. 14). Furthermore, it is not specifically connected to wind power in the energy plan, so it does not appear to play a role in the valuation of wind power in this specific plan.

Wind power is framed as an independent technology which the system must learn to integrate

In addition to adapting the economic conditions to achieve *CC Mitigation*, the Climate-coalition saw technical system issues to be related to the system and not wind power in particular. Energi 21 prescribed that the large electricity production facilities and transmission operators should "to a rising degree be oriented towards taking responsibility for a distributed electricity production- and consumption pattern" and thereby ensure commitment towards renewable energy (DKGOV, 1996, p. 29). The concerns that the utilities had raised about electricity overrun issues in 1983 were now dismissed in the 1996 plan.

> "On a short-term basis the electricity overrun is not estimated to pose a real problem. On a long-term basis, the electricity overrun will set higher demands for the electricity systems adaptive ability" (DKGOV, 1996, p. 35).

In the segment about electricity overrun issues, it is only once mentioned that wind power can be a contributing cause of electricity overrun issues, but wind power is nowhere categorized as the main cause of the problem. Electricity overrun is treated as a system-wide challenge, and not attributed to one specific energy source (DKGOV, 1996, pp. 34–35).

This concludes the walkthrough of the Energi 21 plan. Only a month after the plan was published, a multi-year research project to estimate the societal value of wind power would be concluded. This project was not coordinated with the energy plan, but would also frame *CC Mitigation* as a central quality.

4.3.3 AKF 1996 Report on Societal value of Wind Power

The report "The Societal value of wind power" is among the most comprehensive reports on broad societal value of wind power, and was built on numerous analyses by the Danish Energy Agency and selected Danish universities in the years 1991-1995. This was gathered and concluded upon by the public body "Amterne og Kommunernes Forskningsafdeling / The Research Unit of the regions and municipalities (AKF)", specifically by economic professor of Roskilde University Center Anders Larsen (RUC.dk, 2017), and PhD in economics of Copenhagen University, Jesper Munksgaard (J. Munksgaard, 2017). The AKF report was a compilation of several small studies, one of which was started by Lundholt in 1991, namely to study of how much lost value could be calculated on account of wind turbine visual and noise disturbances, the *Aesthetics* quality (A. Larsen & Munksgaard, 1996, p. 51)[57]. But as the AKF report work expanded to several more sub-reports, the possible visual and noise damages became a minor part of the overall conclusion. I will now briefly summarize the main findings and then go through the enacted qualities in the report[58].

AKF frames first individual Technology Cost for wind turbines

One of the most significant changes between the AKF report and the calculations analyzed in the Unique Supplement period is that this report calculates wind power costs as an independent levelised cost of energy metric. Wind power is thus

[57] The original task as it was described by Lundholt's team in 1991 is mentioned as an expectation that "wind power build-out in Denmark hardly is profitable on market terms" and that because of this expectation, the researchers should answer the main question of whether "there are broad societal conditions or considerations…which nonetheless could motivate a wind power build-out which was reasonable from a societal viewpoint" (A. Larsen & Munksgaard, 1996, p. 5).

[58] The full quotes from the report can be found in Appendix D1. They will be marked with a D1 followed by a # sign to show the number of the quote in the appendix.

calculated as an independent energy source, and not as a supplement to a conventional power plant. Specifically, the AKF authors calculated the cost for building 1000 MW of onshore wind turbines with the technology available in 1995 (Both 450 kW & 600 kW turbines), and with a future scenario where construction was set in the year 2000 (1 MW turbines). These costs were compared with two scenarios of a conventional power plant build-out of 420 MW, coal and gas respectively[59]. The authors have calculated a back-up capacity of 220 MW gas-power into their case scenario, so while wind power is framed as an independent quality, it is acknowledged that there is a costs to cover for back-up (D1, #6). The authors also mention grid reinforcement costs and the condition that a large degree of wind power lowers the price of electricity in the market, something that would later come to be known as the merit order effect (Hirth & Müller, 2016). But apart from acknowledging that any calculation of these elements would position wind power worse, they openly declare that any calculation of such elements has been disregarded (D1, #20). This means that the quality of *Fuel Supplement* is replaced with *Technology Cost* and *Back-up Capacity*. The quality *Back-up Capacity* does not mean that wind power is a *Back-up Capacity*, in this analysis refer to how wind power needs back-up[60]. It also covers possible expenses towards grid reinforcements, but does not add further costs to wind power on account of mitigating against wider risks of black-outs or other revenue losses on the system.

Technology Cost are framed through the Levelized Cost of Energy (LCOE) methodology, which had been adopted by the International Energy Agency (IEA) and the U.S. Department of Energy in the late 1980's, and by the mid-1990's had become a favored way of comparing renewable energy sources with a "standard fossil fuel-generating unit" (NREL, 1995, p. 47)[61]. AKF used this methodology to both produce a "System Cost" number, which covered production- and back-up costs, and a "Total Cost" number, a broader comparison which also counted environmental effects. The report also featured a chapter on jobs created and export potential for each scenario, but this was not incorporated into the cost-benefit figure for each energy source[62]. The averages of the key LCOE ranges have been visualized in figure 16 (GBA). This graph does not figure in the AKF-report as they

[59] The reason that 1000 MW onshore wind is compared to only 420 MW gas or coal is to account for the difference in capacity factor, namely how many hours of a full year (8760) the plant can deliver power. In example, a 420 MW coal plant delivering electricity equal to 60% of the years hours gives an output of 2208 MWh, which is comparable to 1000 MW onshore wind delivering power for 25% of the years hours equaling 2190 MWh.

[60] It is however possible that it in the near future will be that *Back-up Capacity* becomes a positive impact quality, as wind power can provide back-up to other facilities better than the usual methods used today.

[61] This was because LCOE divides the total costs of a unit with the annual energy output and thereby gives a cost per KWh metric. This is useful if the compared energy sources do not have the same capacity factor, production hours in a year, or if they have significantly different lifetimes.

[62] The employment was represented by average annual full-time jobs, and Balance of Payments benefits counted in million DKK per year in the period 1996-2015. Capacity rating was set at 20% and a discount rate of 5%.

report ranges, but the averages have been calculated and visualized here to show how AKF roughly compared the energy sources (A. Larsen & Munksgaard, 1996, p. 50). The ranges are of course important because gas had a much more wide range than coal, since it was more volatile to fuel price fluctuations. When the report refers to a "System Cost" it is the bottom two numbers reproduced in the figure below (production and System costs), while the term "Total Costs" include the environmental costs segment. All numbers in figure 16 below are sourced from page 50 in the AKF report (A. Larsen & Munksgaard, 1996, p. 50).

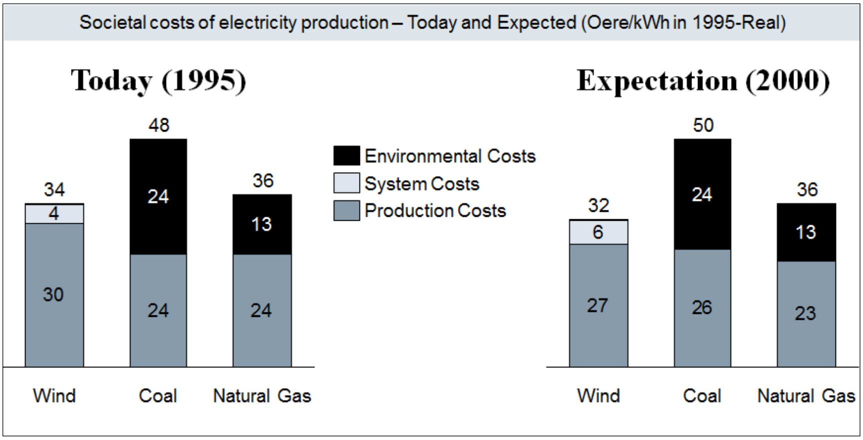

Figure 16: Depiction of the average value of the AKF's cost ranges.

As can be seen the averages of the ranges that the AKF report had reached showed wind power to be competitive with coal and gas in 1995 if environmental costs were included, and close to competitive to coal even without environmental costs in 2000. The authors thus considered future costs improvements to wind power, while any technological improvements to coal or gas power would be offset by rising fuel prices. The environmental costs were calculated as the same number for both the 1995 and 2000 number[63]. The AKF authors summarize as their main finding as being that when environmental advantages, which are mainly constituted by CO2 costs, are considered, it is "socio-economically reasonable" to build out 1000 MW of wind power in Denmark. If the environmental advantages in the form of *CC Mitigation* are not considered, wind power becomes "not quite as beneficial as the

[63] For those interested in comparing the numbers, the Expectation total cost numbers (2000) is equal to the following in 2017-Real: Wind: 48 oere/kWh, Coal: 75 oere/kWh, Gas: 54 oere/KWh. The pure production costs for the three energy sources was in 1995 equal to 45 (Wind), 35 (Coal), 35 (Gas), while it in 2000 was 40 (Wind), 38 (Coal), 34 (Gas) Oere/KWh in 2017-Real.

traditional power plants" (A. Larsen & Munksgaard, 1996, p. 7). The high impact of the CO2 emissions costs, can especially be read from the difference between 1995 total costs and system costs for coal (102% higher) and gas (54% higher). As can also be seen from the table, there are no significant added Environmental costs to wind power. This is because the comprehensive walkthrough of potential negative effect of visual and noise disturbances came to a number so low that it had "practically no influence" on the value of the wind turbines (D1, #8)[64]. When it came to employment and balance of payments, wind power had a small advantage over the other scenario. The AKF report calculated wind power build-out as producing 774 jobs per year, while a coal build-out would produce 550 jobs per year (A. Larsen & Munksgaard, 1996, p. 50). This number was however separately listed and not include in the final LCOE number. Apart from noting Denmark's unique position in the world market, the AKF authors did not highlight this as a significant difference between the scenarios. The overall takeaway from the conclusion was the total cost comparison, as seen from the first line of the author's results chapter:

> "The main result of our investigation is that the environmental advantages of wind power are so considerable, that from a broad societal valuation, it is competitive with natural gas production and more competitive than electricity produced on coal power plants" (A. Larsen & Munksgaard, 1996, p. 8).

Although the pure production and back-up costs indicated that wind power was more expensive than coal and gas, the authors decided to highlight the total societal costs as their main conclusion. The total cost number was reached through a strong focus on the quality *CC Mitigation* and to a lesser extent *Future Potential* and *Industrial*.

CC Mitigation is central to the conclusion in the AKF report, as it is the advantage of curbing CO2 emissions which makes wind power come out on top (A. Larsen & Munksgaard, 1996, p. 50). It is mentioned as the foremost reason that a wind power build-out is "socio-economically reasonable" in quote 5, and is seen in the calculated added CO2 cost ranges for coal and gas. It is thus correct when the authors state it must be "strongly underlined" that "especially the CO2 aspect" has a

[64] The quality *Aesthetics* was calculated by method of surveying neighbors to wind turbines, and concluded that the neighbors were not willing to pay very much to avoid the wind turbines and the *Aesthetics* quality was thus calculated into a diminishingly small cost of 0.04 Oere/kWh (quote 13). The *Aesthetics* effects were judged to have "practically no influence" (Quote 8), and any impact of it "diminishes in relation to the other valued effects" (Quote 13). The negative impact for the quality *Aesthetics* was here for the first time analytically calculated to have practically no impact on the overall societal value of wind power.

decisive effect on the results (D1, #11 & 18)[65]. The report reflects the new rules of the game set forth by the Climate-coalition, namely that CO2 emission reduction targets has to be fulfilled. This makes wind power a valuable energy source, as it mitigates climate change, which Denmark needs to do. This is according to the AKF authors something an obligation of which there is "necessary costs" (D1, #14), which must be incurred.

The AKF authors also brought salience to the *Future Potential* quality as they compare future build-out scenarios estimated both if construction were to start today, and if it was to start around the year 2000 (D1: #10). The authors recognize that if future constructions were to start today, wind power would be more expensive, but the authors estimate up to 25% cost reductions by the year 2000 (D1: #15 & 21). Although the industry at this time had announced that they would launch the larger 1 MW turbines, it was by any standard an ambitious goal to expect an industry to deliver a 25% cost reduction on a five year timeframe[66].

The quality *Industrial* is calculated in a separate chapter of the report and was not included in the overall valuation of wind power (D1: #4). *Industrial* benefits to wind power are considered only slightly higher than a coal or gas plant in the report, and the authors conclude that these elements are "not affected significantly" if wind power is chosen over the alternatives (D1: #7 & 16). But although the *Industrial* quality is not incorporated in the final valuation, it is still mentioned in the report (D1: #4,7,16 & 17), and the key numbers show a slightly higher estimated employment effect for wind (A. Larsen & Munksgaard, 1996, p. 50).

Reactions to AKF Report

The AKF report received some coverage in the press, wherein the debates about assumptions and effects on employment took up the headlines (Bola, 1996; Tornbjerg, 1996b; Vestergaard, 1996).

[65] The quality *Environment* is also calculated in the report in the form of reduced SO2 and NOX, but it is estimated at a very low cost effect of 1-2 oere/KWh (D1: #12). The authors mention it, but empathize that this quality has no significant effect on the final results.

[66] Simultaneously, the authors estimate that any potential future coal and gas plants would be more expensive than today, but combined with fuel-efficiency, would end at roughly the same cost (D1, #21). This assumption enforces that wind power has a quality of *Future Potential*, compared to the listed alternatives, which show no cost-improvements.

Table 2: Headline reactions to AKF report

Date	Newspaper	Headline
17.04	B.T.	Only low impact of wind
19.04	Weekendavisen	Airy policy
20.04	Politiken	New fight over wind turbine economics

Among critics of the report were on one side researchers from Aalborg University, who argued that the *Industrial* and *Environment* qualities value had been underestimated. The wind turbine industry association also criticized the reports take on the *Industrial* quality, as it had neglected to account for the large exports of Danish wind power technology, that investments in gas or coal-plants could not provide. Furthermore, the Wind turbine Industry Association (DWIA) claimed that the financial ministry's model of calculation, ADAM, was not suitable to compare a huge one-time investment in a coal-plant to the many smaller investments in wind turbines spread across a longer period of time. The Fuel-coalition's central actor DEF agreed with the AKF results on the technical and industrial parameters, but pointed to the value set on the quality *CC Mitigation*, as something that could be discussed further (Tornbjerg, 1996b).

Long-time critic of wind power Frede Vestergaard of the weekly magazine "Weekendavisen" argued that since there was no need for new capacity; wind turbine build-out should be compared with the cost of running existing fossil fuel plants and not with building new capacity. Additionally, he agreed with the Fuel-coalitions point that the central salience of the quality "*CC Mitigation*", through the high CO2 emission costs, reflected a political prioritization.

> "Because of the over-capacity, the build-out of wind turbine capacity on land should be compared to the variable costs of producing a kWh on existing coal- and gas fired plants, and not with the total costs of producing electricity on new gas- or coal-fired power plants….the relatively high value of wind power's CO2-free production is a result of the assumption that the CO2 reduction of 20 percent must be realized in Denmark. All in all, the otherwise sober calculations, which undoubtedly will be used to justify new billion-investments in wind turbines, are an expression of political prioritizations hidden in the chosen calculative assumptions". (Vestergaard, 1996)

It is interesting to note that both the DEF and Vestergaard acknowledge the *Technology Cost* quality, as Vestergaard even calls it “sober calculations”. But they disregard the high value ascribed to the “*CC Mitigation*” quality. Furthermore, Vestergaard does not think that wind power should be individually compared to gas and coal, but instead should be measured by the cost it adds when it is supplemented to the already built capacity. To understand Fredegaard’s reference to “overcapacity”, it is worth returning to the 1992 approval of the construction of Nordjyllandsvaerket and Skaerbaekvaerket, which by 1996 were under construction. As wind power build-out was also picking up along with a large build-out of decentral heat- and power-plants, Denmark was looking towards a future with excess supply of power capacity. Vestergaard uses this oversupply situation to argue that wind power should not be measured solely by its own LCOE costs, but instead measured on the notion that it is added to an energy system, which has adequate supply. It is as such a kind of new way of going back to seeing wind power as a *Fuel Supplement*. The seeds to a new framing, where the quality *Fuel Supplement* might return are being sown.

AKF Report Summary

The AKF report follows in line with the markedly different Valuation Frame that emerged with the new policy coalition in office during the mid and late 1990s. The main difference between this report and Unique Supplement period calculations is how the “*CC Mitigation*” quality of wind turbines functions as the key metric of their value, the CO2 costs. The AKF report does also not calculate wind power to a break-even price but instead as a stand-alone energy source, with attached *Back-up Capacity* costs. The *Industrial* quality is not as salient a quality, as in the ATV and DEF reports, wherein the effects of employment and export to a wind-power built-out were highlighted. Another difference, I will highlight that The AKF authors calculate wind power independently of such system costs, and do not consider these as attached to wind power as a technology.

The AKF report does however also have some similarities to the Unique-coalitions way of calculating when it comes to the quality *Future Potential*. Both reports project a *Future Potential* for cost reductions in wind power and in the case of AKF, this amounts to an assumed 25% cost reduction in five years.

The AKF report assembles a Valuation Frame where wind power is calculated as a stand-alone energy source, which was highly valuable when the full costs of CO2 emissions were considered. One of the AKF report’s authors, Peter Karnøe, would in relation to the launch explain an important distinction between the establishment subsidies of the 1970’s and 1980’s and what wind turbines received in the 1990’s. Wind power was, after the establishment subsidies were phased out, no longer primarily funded through direct subsidies, but were instead receiving a tax-refund (afgiftsrefusion in Danish) of the taxes on production of electricity. Since wind power produced pollution-free electricity, it was compensated for the electricity tax applied to power fed into the grid. In this way, the main prosthetic device that enabled wind power was a compensation of a tax and not a direct subsidy such as the establishment subsidy was (Tornbjerg, 1996a)[67]. This distinction shows that in this Climate Solution period, the market frameworks were being adapted to the type of electricity that was wanted in the grid. Whereas wind turbines before received direct subsidies in a corner in an isolated corner of the market, the new market frameworks were constructed around accommodating CO2 emission free electricity. This concludes the analysis of the AKF report, the most thorough analysis of wind power at the time, and a report which have been credited as part of foundation that formed the mid-late 1990's wind power policies (Meyer, 2000, p. 200).

4.3.4 The Fuel-coalition is split on wind power

Wind power was still rarely discussed in comparison with other alternatives, but the utilities had noticed the drop in new-build costs. Faced with the coming technological advancements and a valuation network which through CO2 taxes necessitated *CC Mitigation*, the formerly powerful Fuel-coalition would become more split on the value of wind power. There were tough requirements towards the utilities, where ELSAM and Elkraft had each built a small offshore wind demo-project as compensation for the non-completion of the original 100 MW, agreed in 1986. The new 100 MW agreed in 1990, was to be built during a high-investment period for both wind power and gas-infrastructure for heating, as explained by Bent Christensen, Project- and General Manager in Elsam Projects from 1986-2000.

> "In a parallel track, you had all of these decentral heat-power plants that were emerging everywhere. In those you had the same challenges, who would pay for grid-costs etc." (Interview 4: Christensen, quote 3)

The technological advances of wind turbines during the 1990's meant that the utilities could start counting on the output of the wind turbines and to some degree

[67] I draw inspiration of the term "prosthetic device" from valuation sociologist Trine Pallesen, who define it in her thesis on French wind power in 2013 (Pallesen, 2013, p. 179). It is understood as a device that allows the good, wind power, to survive in the market that is currently there. Prosthetic devices can thus both be isolated direct payments such as the establishment subsidy in the 1980's, but it can also be CO2 taxes, grid priority, loan guarantees etc., which change the current market framework.

the wind turbines to help balance the system, something that was impossible in the 1980s.

> "When you planned new build-out, wind power had traditionally been given a capacity factor of 0%. At some point (during the mid-1990, ed.) you raised it to 10%, and that was kind of a Eureka moment that you could now ascribe wind power a capacity factor of 10%". (Interview 4: Christensen, quote 4)

The utilities' starting acceptance of wind power was partly driven by interest and partly by necessity, as the wind power share grew and they themselves were mandated to build the 100 MW by 1994. By the mid-1990's, more than 100.000 Danish families were part of one of the 2100 wind turbine cooperatives, which had erected 86% of the installed base of wind power in Denmark (IRENA-GWEC, 2013, p. 60). So wind power build-out was apart from the few demonstration projects still mostly a local community activity. Some of the old Fuel-coalition actors saw this as some sort of distortion of the market, and argued that the local wind turbine owners were making too much money on their investments.

In 1997, DEF encouraged its members to raise fees for net-services, with resulting cases where fees would rise from 400 DKK to 9000 DKK in one year. DEF saw it as a necessary correction of an unfair distortion of the market, as explained by Flemming Bay-Jensen, head of DEF, below.

> "The wind turbines which are spinning now are little power plants. They have become an industry, and we are merely asking them to pay the same fees as everyone else….We are not out to remove the foundation for the private wind turbines, but we do believe, that there has been a distortion of the electricity market". (Fugl, 1997)

Prior to the 1990's, Wind power had not occupied a large enough role to threaten the business case of conventional power plants. But some of the utilities were beginning to fear that the rules of the game were being changed too much for their assets to survive, as stated by DEF spokesman Knud Mosekjaer hereafter.

> "Even though the Danish energy policy in many ways is a success story, it is slowly distorting the condition away from a free market. Every time a utility is forced to buy power at a guaranteed price, there is a subsidy in the agreement. It is obvious that we cannot pursue such a policy in the long run. It will end in all of the Danish environmental policies being on subsidies, and not participating in the market that is there to ensure efficiency". (Andreassen, 1998a)

To these utilities, the large wind power build-out generated a risk, that all policies are "on subsidies" and that energy sources resulting from these policies are not participating "in the market". DEF's concern corresponds to wind power losing its value to society due to the system damaging effects it can have if it is allowed to fill up too much of the energy system. It is not *Black-out Risk* that is being raised as a concern, but instead the risk of some distortion of another part of the "free market" which Mosekjaer defines as areas of the energy system where subsidies are not present. These growing seeds of contestation would be tapped into by the valuation network that would emerge in the chapter 5.

But it was not all Fuel-coalition actors who were worried about the how the technology and the energy system were developing. Wind power was reaching a scale that foreign investors might be interested in building, and a huge untapped potential in offshore wind power was starting to emerge. At a board-meeting in September 1995, the CEO of Elsam, Georg Styrbo, would acknowledge that wind power was among the best ways to reduce CO2 in Denmark, and that the utilities needed more involvement. He expressed the opinion that if the utilities did not establish the wind turbines, they would risk that private investors would beat them to it (F. Petersen & Thorndal, 2014, p. 102). So the utilities adapted to the changed rules of the game and strengthened the small renewable energy units that had been established in the organizations only a few years earlier. The urgency about the need to mitigate climate change had affected what qualities the utilities were expected to prioritize. So although the utilities only received 10 oere in subsidies per kWh, unlike the private turbine owners who received 27 oere, (O. Andersen & Groennegaard, 1998), wind power was by the late 1990's considered a better new-build option than the alternatives, as explained below by a SEAS Utility engineer.

> "It is absolutely not a loss-making business. The alternative is that we should establish power plants with air cleansing equipment, and possible other environmental effects, which you cannot put a price on". (O. Andersen & Groennegaard, 1998)

The comment from the SEAS engineer shows that costs of building wind turbines was not considered high by all the utilities, where among some were beginning to accept the Climate-coalition's central salience of the new quality *CC Mitigation*. The SEAS engineer compares the cost of wind power to the cost of delivering electricity by a power plant which must account for *Environment* through "air cleansing equipment" and other environmental effects that to the engineer are incommensurable, such as *CC Mitigation*. The question of whether or not the system could handle substantial amounts of wind power had also slowly faded away during this period, as explained by wind entrepreneur Henrik Stiesdal.

> "When we got to 2000 we were at 14%, which just happened. That thing about "what could the system take" was brought up from time to time, but anyone could see that it (the grid, ed.) could easily handle this level and that we were nowhere near any limit...From where I observed it that problem faded away". (Interview 3: Stiesdal, quote 4)

By the end of the 1990's, the risk of wind power "breaking the grid" thus appeared to have faded away as wind power took on a larger role in the energy system.

<u>4.3.5 The launch of offshore wind Power for climate change mitigation</u>

When seen across the Climate Solution period, the need to mitigate CO2 emission and the future promise of wind power stands out. This focus on the qualities *CC Mitigation* and *Future Potential* are also recurring in Aukens statements as minister. His logic appeared to be that once mitigation of CO2 emissions was considered necessary, it should be done through active investments that generated jobs and developed the technology. Auken considered wind power to be 'the most profitable' source for environmental energy production, but also a source that was 'fully competitive' and 'no more expensive' than other new generation capacity, however usually when considered a few years into the future. This is exemplified in table 3 on the following page which shows three quotes from Auken in two Op-Eds and an interview (Auken, 1997, 1998; Voigt, 1998).

Table 3: Svend Auken quotes about wind power

Year	Context	Text
1997	Op-ed Jyllandsposten	It is as if JP aims to maintain its readers in a past, where wind turbines were still at an experimental stage. That is far from the reality today, where electricity from wind turbines in good locations is competitive…. we are speaking of investments in new capacity, which seen over a span of years is no more expensive than other new generating capacity.
1998	Op-ed Politiken	Wind turbines are today the most profitable technology for environmental electricity production.
1998	Interview Berlingske	We are talking about turbines of 2 MW and above, and it is estimated that costs of electricity from wind turbines can be brought down 20% compared to today. We are thereby speaking about fully competitive prices and that is in it of itself exciting.

The central focus on *CC Mitigation* can be further confirmed from my interview with Auken's political ally, Steen Gade, who explained that "environmental concerns should steer" the energy policy to create jobs (Interview 5: Gade, quote 2). Although the wind power build-out was primarily framed as valuable due to *CC Mitigation* and *Future Potential*, the *Industrial* quality also played a role to the coalition, although it does not appear quite as salient as the *CC Mitigation* quality. In the words of CEO of Wind Manufacturer "Bonus", Palle Soerensen, he had experienced that the industry had during the 1990's experienced a change in how it was no longer fossil fuels which were in scarcity, but rather "the atmosphere, seas and rivers" (DWIA, 2006). So the climate coalition was very much gathering around the new rules of the game, namely that new energy capacity had to be able to mitigate CO2 emissions. This required that wind power took the next step and moved to large-scale offshore wind power.

Auken had in 1997 pushed hard for other countries to honor their Kyoto-agreements, and would in 1997 for the first time announce a planned large-scale build-out of offshore wind power. This plan would in February 1998 be materialized into a specific demand for the two main utility-organizations, ELSAM and ELKRAFT, to build 750 MW offshore wind power (DEA, 2016b, p. 59). This move by the Climate-coalition marked a large-scale exploration into offshore wind, which until then had only been built as demonstration projects (F. Petersen & Thorndal, 2014, pp. 97–98)[68]. Offshore wind power was important to the Auken-administration, who in an extension-report to the Energi 21 plan had calculated that it was both economically and technically realistic to have 4000 MW offshore wind in Denmark by 2030. In order to drive down costs and enable technological advances through scale, it was recommended that future offshore wind farms should be built in the range of approximately 160 MW, a huge step from the two existing 5 MW parks (DEA, 1997; F. Petersen & Thorndal, 2014, p. 98). Only one month after the report was published, Auken had contacted the two main utilities ELSAM and ELKRAFT with a notice that authorities and utilities together should prepare to build 750 MW offshore wind power through five major new wind farms (F. Petersen & Thorndal, 2014, p. 99). That same year, DEF principally decided that offshore wind could be an endeavor worth pursuing, and especially Elkraft, who had built the first park Vindeby, argued that although the first two demonstration projects had been heavily contested, they had proven how offshore wind was "cheaper to build and maintain" than previously assumed (Abild, 1997). Auken would push the offshore wind build-out plan with support from the left-wing parties, and the first two offshore wind farms, Horns Rev 1 (160 MW by Elsam in 2002) and Roedsand 1 (165 MW by Elkraft in 2003), began construction in 2000 and 2001 (Bailey, 2015, pp. 11–12). These two projects broke new ground in technological development, through what the Horns Rev 1 project manager described as 'Cowboy Engineering' (DONG, 2015)[69]. This was however done without any noticeable profits for the developers, as retroactively explained by Program Manager for Horns Rev I, Flemming Thomsen.

> "In the first projects of Horns Rev and Roedsand, we were forced to complete the projects without any profits, and our suppliers probably did not earn anything big either….It (Offshore wind, ed.) has today become a business, it was not so with the first parks, where it was an idealistic endeavor". (F. Petersen & Thorndal, 2014, pp. 117–118)

[68] The two small offshore wind farms, Vindeby and Tunoe Knob (both 5 MW), had both been delivered as compensations for other commitments, and were by 1999 still the only offshore wind-farms in the world. Vindeby was delivered by Elkraft (Eastern DK) as compensation when it was clear that the utilities could not deliver the 1985-agreed 100 MW onshore wind by 1990. This failure of delivery was however not only the fault of the utilities, as many local municipalities had also fought the erection of onshore wind farms (F. Petersen & Thorndal, 2014, p. 97). The Tunoe Knob farm was built by Elsam (Western DK), as a compensation for the 1991 deal wherein Elsam received planning permits for the Northern Jutland Coal plant build-out and the Skaerbaek Plant Gas build-out (F. Petersen & Thorndal, 2014, p. 98).Vindeby is officially recognized as the world's first offshore wind farm with its 11 turbines of 450 KV each. The world's first "offshore" turbine was a 220 KV model erected 300 meters from Nogersund, Sweden in 1990.

[69] A local development project Middelgrunden (40MW in Denmark) was built before Horns Rev 1 and Roedsand 1.

The first two offshore wind farms were not completely “non-profit” builds, as Elkraft and Elsam received subsidies from the state, and thus were not paying everything themselves. But building such large wind farms on the sea was unchartered territory and Horns Rev 1 would later run into significant retro-fit costs[70]. The opposition parties, Venstre and De Konservative, were inactive on wind power valuation, but the move to invest in large offshore wind farms was however heavily contested by especially Venstre. Below is a quote from Peter Hansen-Nord, Energy Spokesman for Venstre, on Venstre’s position regarding both offshore and onshore wind.

> “We can definitely not guarantee, that the subsidy for wind-turbines will continue at the current levels of 27 oere per produced kWh. If it is up to me and my party, offshore wind should not have subsidies at all”. (Ritzau, 1999)

Venstre’s concern that the proposed offshore wind farms were too big to subsidize was shared by wind power critic Frede Vestergaard of weekly magazine “Weekendavisen”. He highlighted that offshore wind was “noticeably more expensive” than the onshore wind costs shown in the 1996 AKF report (Vestergaard, 1996). But despite this opposition, the world’s first large-scale offshore wind farms began construction.

4.3.6 Market liberalization and the PSO-tax

In addition to the CO2 taxation, the goals set out in the Energi 21 plan stabilized wind power investments and built-out was correspondingly increasing. But the Climate-Coalition did not have complete control over the electricity market framework. Until now the electricity market had been divided into zones where the utilities had monopoly on the customers and set the prices after a “rest-in-itself” principle. This would change in the late 1990’s as the EU had initiated a procedure that mandated member states to liberalize their electricity sectors. The task to liberalize the Danish electricity sector resulted in a 1999 law package, which was among the Auken-administrations hardest tasks. Some utilities saw the liberalization

[70] In 2004, the turbine supplier Vestas, was forced to replace all of the nacelles of the park, at costs that would almost run up to the total project order they had received from Elsam. This was an experience which caused Vestas to announce a temporary withdrawal from the offshore market (F. Petersen & Thorndal, 2014, p. 114).

as a risk that the central heat-power plants would be "squeezed out" of the market either intentionally, or as a result from the build-out goals of decentral district heating and wind power (Andreassen, 1999). On the other hand, the liberalization would do away with the "rest-in-itself" principle, which could lead to utilities taking more risks in new business areas such as wind power. Auken would actively force a consolidation of the utilities with the liberalization-package, which led the utilities to look towards business opportunities in wind power[71].

Auken worried that once the market was liberalized, the value that had been built up in consumer-owned utilities would be spent on shareholder dividens, and not in investments that ensured Denmark's CO2 emission goals were met (Christoffersen, 1998)[72]. The Climate-coalition saw the Danish mitigation of CO2 emission as critically important, regardless of what other countries did. To ensure that what in Energi 21 was referred to as the 'economic feasibility' of wind power projects, the Auken-administration made sure that the broad agreement around a market liberalization in 1999 included a tax on electricity use, called the Public Service Obligation (PSO) (DEA, 2016b, p. 61). This tax was designed to avoid that electricity prices became too low to reflect externalities of fossil fuel production, so that if the price of electricity dropped by 2 DKK, the PSO would rise by 1 DKK. The revenue from the PSO-tax, would then go to paying for the subsidies to wind power and other renewables (EnerginetDK, 2016b). The Auken-administration consciously connected the funding for renewable subsidies to the price of electricity, so that the users of energy would also be the ones paying for the effort to make the future energy supply sustainable. But more importantly, it was done to ensure stability and long-term visibility around renewable energy investments, as they should not be negotiated on the annual budget every year (Klimarådet, 2016).

The various taxes that were either raised (Electricity-tax) or introduced to electricity use (CO2-tax, PSO-tax), did not please the interest organization of general production industries, Danish Industry, which by the end of the 1990's had established a separate unit to deal with energy matters. In 2000, Head of Energy in Danish Industry, Anders Stouge, would write a harsh critique of Svend Auken's

[71] While the consolidation was a benefit to the liberalization, Auken was also conscious of the risk that large utilities would dictate the energy systems development, and disregard the consumers' need, as shown in the two quotes below.
"I want to democratize the electricity sector, because if it taken over by international conglomerates like EDF, Preussen Elektra (today called E-on, Ed.) and Vattenfall, then the chance has passed." (Tornbjerg, 1998)
"We are a peaceful people. If we do not protect the consumers' interests, we risk a gigantic robbery. But as long as some of us can still shake our head, that will not happen in Denmark" (Andreassen, 1998b).
[72] Auken Quote:"There is no doubt that our CO2-quota is the most controversial. It will limit our energy exports and cost us money. But the entire Kyoto agreement would be wasted, if the individual country did not take on its responsibility" (JP, 1998).

policies. Danish Industry argued that energy intensive companies were suffering under the new tax regimes and would echo a calculation performed by DEF, which hinted that between the CO2 and the new PSO-tax, the electricity consumers would come to pay twice for the CO2 pollution of their electricity (Stouge, 2000). This calculation was based on an interpretation of how you treat the PSO-tax. If it is an obligation for developing the future energy system, it is not a double pollution tax. This was however how the industry saw it and their concern with the tax level was steadily increasing.

4.3.7 Right-wing newspapers give voice to small local opposition groups

As wind power grew in size, several national newspapers would start to criticize wind power in editorials and give media-coverage to local opposition groups. One topic of the critique was related to the subsidies, as seen in the below editorial from the Danish Tabloid newspaper B.T.

> “All Danish tax-payers actually pay large amounts in direct and indirect subsidies to renewable energy. It is a sweet deal for the Danes, who have the opportunity to erect wind turbines or get heat through solar energy. They get cheap energy, which others have paid for in large sums....We simply cannot afford to continue to enrich wind-turbine owners….The environmental area is ruled by a certain green logic, which blows away all common sense”. (Notkin, 1996)

In addition to the concern that wind turbines owners were enriching themselves on subsidies that the rest of society could “simply not afford”, the *Aesthetics* quality was also present in the contestations. These two concerns would on several occasions be combined to build the narrative that tax-payer money was wasted on building “scary ugly” turbines, as seen in the two editorials of newspapers Jyllandsposten (JP) and Berlingske below (Berlingske, 2000; JP, 1999).

Table 4: Newspaper Editorials about wind power

Year	Title	Quote
1999	JP Editorial: "Wind-Madness"	The 5200 turbines which today are ruining the landscape, only produce nine percent of our electricity….It is about time we stop the wind-turbine massacre on the Danish landscape.
2000	Berlingske Editorial: Tvang mod tvang	The problem is that wind power can still not stand on its own without public subsidies....The sum of the story is that a couple of decades attempt to replace polluting energy may have given considerable results, not least because of natural gas and cleaner cars, but it has also costs billions of kroners and lead to destruction of large areas of the open landscape with large, scary ugly wind turbines and a massive subsidy-bureaucracy.

The *Aesthetics* quality would increase in salience among various opponents to the Climate Solution Valuation frame near the end of the century, where yearly complaints about wind turbines went from 100 to 240 cases in three years (Pihl-Andersen, 2000a). A newly formed organization called "Neighbors to wind turbines" opposed local projects and took it further than *Aesthetics*, as they began to actively accuse local politicians of heralding private interests, as seen from a spokesman's statement below.

> "The big wind turbines are a goldmine, and to get a hold of one of those is better than winning the lottery. It is not about alternative energy at all, but instead about racking money for oneself and getting the big subsidies. That is why we also see examples of nepotism, where local politicians help each other get wind turbine projects approved". (Pihl-Andersen, 2000a)

What had happened was that the electricity price dropped significantly during the 1990's, and by 1998 the subsidy level was approximately double the electricity price (Groennegaard & Andersen, 1998). Since *Technology Cost* fell dramatically during the same period, the legislation was not changed fast enough to accommodate the new conditions. The Auken-administration would insert a ceiling for wind power subsidies, in order to limit any runaway profits in 1999 (DEA, 2016b, p. 54,55), but the reputation of the industry had already been hurt by a number of cases where private owners had capitalized on the combination of cutting edge new technology and not yet adjusted subsidies (Pihl-Andersen, 2000b)[73]. But although some turbine owners had benefited from this quick fall in *Technology Cost*, the estimated profits appeared to be exaggerated in the media. In May 2000, the right-wing newspaper Berlingske published an article titled “Gold for wind turbine owners”, featuring a calculation by the anti-wind organization, “The Association of power-heat users”. The calculation used Vestas’ new 660 kW wind-turbine specifications to calculate how much Danish wind turbine owners had received in subsidies. This calculation resulted in each owner allegedly having received ‘a free’ wind turbine for 4.7 mn. DKK, and additionally getting 2 mn. DKK in the bank (Andreassen, 2000). The DEF spokesman, Knud Mosekjaer used the calculation to reinforce his argument that more competition should be encouraged so that wind turbine owners instead would “fiercely compete with each other” (Andreassen, 2000). The calculation was however outdated and applied to very few owners. The subsidy-level used in the calculation had been phased out in 1999, and the Vestas 660 kW turbine had not been available to purchase until late in 1997 (Appendix A). The Wind Turbine Owners Association (DWOA) argued that although the profit margins probably should be adjusted, the total annual subsidy cost of 2 bn. DKK was not a high societal cost, compared to the amount of capacity that it enabled. This was however not enough to satisfy the critics, as the argument was not about how valuable the subsidies were for Denmark as a society, but instead related to a framed unfair gold-rush to wind turbine owners.

It is however important to note that the antipathy was not a general opinion among the population. The Danish population was in the Climate Solution period very positive towards wind power as shown by several studies. Three separate polls from 1993, 1994 and 1995 (of which two were ordered by utilities) found that respectively 77 %, 68 % and 67 % of Danes were willing to pay more to have their power come from wind power (DKvind, 2014b, pp. 1–2), and even after the increased build-out of the late 1990’s, a similar 2001 survey showed 68% of the population supported a further build-out of wind power (DKvind, 2014a, p. 7).

This chapter has now covered the major moments of valuation in the Climate Solution period. The chapter has also touched upon the contestations that laid the seeds to the valuation frame that will come to follow the Climate Solution valuation frame. But before going into this coming shift in valuation, I will hereafter map the dominant valuation frame and valuation network of the Climate Solution period.

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[73] These cases were also related to build-outs being done by groups that were not local to the area. In 2000, the state revision authority would conclude that the Danish Energy Authorities had not maintained adequate oversight over whether the people who received the subsidies lived in the municipalities where they received them. Aukens political allies in SF called the cases “damaging for wind power” and “unsatisfying”.

4.4. CLIMATE SOLUTION: VALUATION FRAME SUMMARY

During the Climate Solution period, three new qualities were enacted in the Valuation Frame and Network. First, I describe the three new qualities revealed in this chapter, before I present the new valuation frame and explain how it differs from the Unique Supplement valuation frame. Finally, I map out the valuation networks and highlight the key takeaways from the chapter.

4.4.1. Three New Qualities: A Technology to Mitigate Climate Change

Three more qualities were incorporated into the valuation frame during the Climate Solution period. Two of these qualities, *Technology Cost* and *Back-up Capacity*, replaced the *Fuel Supplement* quality, while the *Black-out Risk* quality faded away. The *CC Mitigation* quality had not been salient in previous frames or had been part of the *Environment* frame. During these first two periods of the analysis (i.e., Unique Supplement and Climate Solution), ten different qualities have now been used in the valuation of wind power.

CC Mitigation (Environmental)

Although climate change has many local effects in a closely-connected eco-system, it is beneficial to separate the *CC Mitigation* quality from the *Environment* quality due to the debate about the practicality of Denmark attempting to mitigate global climate change. There were no similar debates over whether or not it makes sense to improve air quality in Denmark. Since climate change is a global problem that unfolds over a long period of time (i.e., multiple generations), the value of mitigating it is significantly more difficult to calculate. When it is calculated, it is usually in the form of a CO2 price, which should equal the damages of emissions. But the quality also encompasses the debate over which energy source(s) wind power should replace. This is more easily traceable in the *Environment* quality, which is more locally anchored[74].

[74] As explained earlier, in pre-1990 valuation frames, climate change was encompassed by the *Environment* quality, but after 1990, it emerged as an independent quality that was included in the Climate Solution valuation frame and all subsequent frames throughout the analysis period.

Technology Cost (Technological)

The Technology Cost quality represents current costs to build wind turbines as an independent technology. These costs are calculated as LCOE, which is the cost to build and operate an energy source divided by the annual energy output element (i.e., the amount of energy a wind turbine can produce each year). Although the methods for calculating the technical costs of building a wind turbine change over time, this quality refers to how actors calculate this cost and how they frame it as signifying value compared to the available alternative technologies.

I would like to highlight an important distinction between the Technology Cost and *Fuel Supplement* qualities. When framed through the Technology Cost quality, wind power is considered a standalone energy source, whereas for the *Fuel Supplement* quality, the value of wind power is based on its ability to supplement incumbent energy sources. The *Fuel Supplement* quality thus falls somewhere between *Technology Cost* and *Back-up Capacity*, since back-up costs are considered embedded in the *Fuel Supplement* quality when used, as wind power is then considered supplemental.

Back-up Capacity (Technological)

The *Back-up Capacity* quality of wind power is an independently deducted from a total value usually derived through metrics associated with the *Technology Cost* quality. This technical quality must be listed separately, since the costs of *Back-up Capacity* are calculated differently, and in some cases are considered to be system costs that are not included in the categorization of the object being valued. In current energy systems, a minimum level of *Back-up Capacity* is still required; however, it applies to the entire grid, as it is used not only when the wind does not blow, but also when a power plant goes offline.

<u>4.4.2 The Climate Solution Valuation Frame</u>

Figure 17 (GBA) is the visualization of the dominant Climate Solution valuation frame, the name of which is derived from the key quality that had a positive impact on the valuation of wind power during this period: *CC Mitigation*.

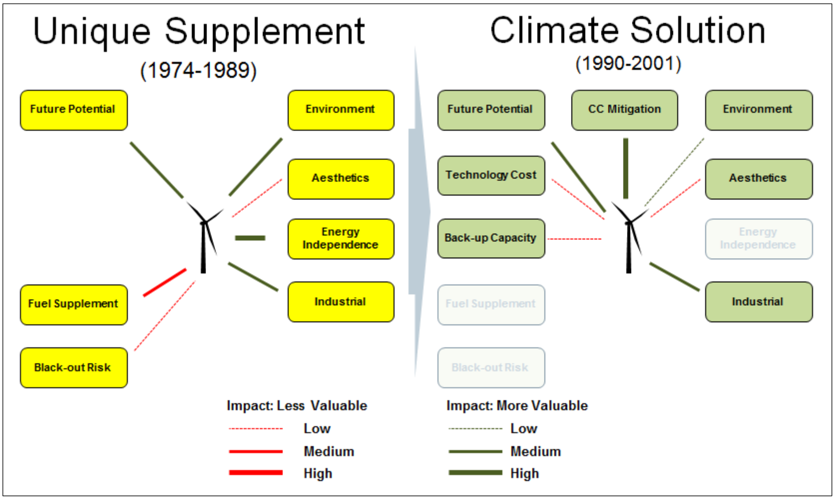

Figure 17: The first (US: 1974-1989) and second (CS: 1990-2001) Valuation Frame.

The other two qualities that had a positive impact on the value of wind power during this period were the *Future Potential* quality in terms of turbine size and cost reductions, and the *Industrial* quality, through the Climate-coalition's involvement with the utilities, and the expansion of offshore capacity to grow the scope and size of the domestic industry. In addition to the new and decisively salient *CC Mitigation* quality, the new valuation frame reflected two significant differences from the previous frame. In the Climate Solution frame, the *Technology Cost* and *Back-up Capacity* qualities of wind power are included as separate qualities which replaced the *Fuel Supplement* quality in the Unique Supplement frame. In addition, the *Black-out Risk* quality was not included in the Climate Solution frame, since both wind turbines and the grid had evolved to the point where these risks were no longer a concern. *Technology Cost* of wind power continued to be calculated as higher than conventional energy sources, but wind power was now seen as its own energy source with individual energy costs.

Moreover, the quality that was highly salient in both the Fuel- and Unique-coalitions' framings, *Energy Independence*, was surprisingly practically absent during the 1990s. Although these elements were mentioned in the energy plans, it was not part of the segments that framed the value of wind power. Lastly, it can be mentioned that the Climate Solution frame also included the first calculation of the *Aesthetics* quality, the negative impacts of which were determined to be negligible. As is evident in the visualization, the Climate Solution frame included several positive impact qualities and only a few marginal negative impact qualities. In particular, the new *CC Mitigation* quality was considered indispensably valuable as a societal investment.

4.4.3 The Climate Solution Valuation Networks

Several previous actors continued to participate in the valuation struggle during the Climate Solution period. Despite the overlap, I refer to the coalition in the 1990s as the Climate-coalition, because the Unique-Coalition actors had expanded to fully include Socialdemokratiet, the powerful calculative center of the Environment and Energy Ministry, as well as part of the utilities. In the sub-sections that follow, I map this dominant coalition and the few dispersed actors who opposed it before describing the materiality of the valuation network.

Figure 18 (GBA) shows the actors that were dominant (top of the y-axis) and more peripheral (bottom of the y-axis) at the beginning and end of the Climate Solution period. The colors reflect the actors' general valuations of wind power. Green is the climate-coalition, Blue is a dispersed group of opposing actors to this coalition. The grey actors are as usual neutral or unassignable.

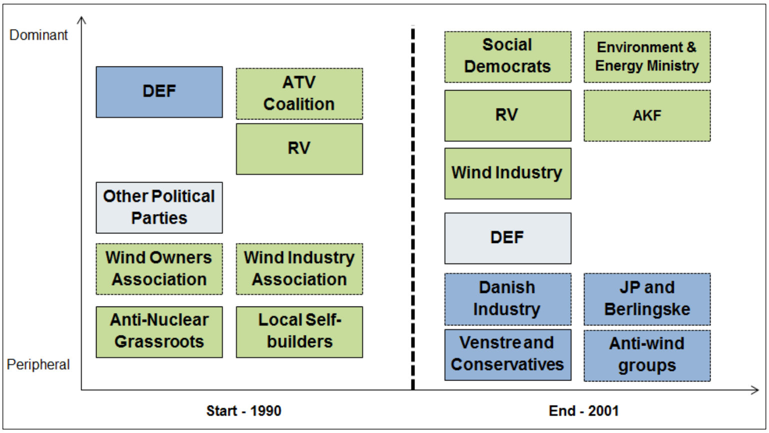

Figure 18: Key actors during the CS period; green: Climate-coalition; blue: Opposing actors.

The central position of *CC Mitigation* was made possible by the work started by members of Radikale Venstre and energy minister Bilgrav-Nielsen, who seized upon the international momentum of the 1987 Brundtland report and the 1990 formation of the IPCC, which brought attention to the issue of climate change. *CC Mitigation* became a central quality in the valuation of energy sources, and was used to justify an active energy policy (i.e., investments to improve performance and reduce costs) made salient through the *Future Potential* quality. The Auken administration continued to build on Energi 2000 and legislation to tax CO2, which had been enacted in 1992 against the former government's will. The Auken administration pushed utilities and municipalities to expand wind power capacity to realize the *Future Potential* of cheaper and more efficient turbines. The Climate-coalition's most powerful calculative center was the Environment and Energy Ministry and the many councils and boards under its governance.

To some extent, the Climate-coalition and the Unique-coalition viewed wind power similarly, in that both focused on the salience of issues related to the quality *Environment* (i.e., air quality). In another sense, the Climate-coalition was focused on large scale expansion to mitigate climate change and this expansion should happen through the utilities cooperation and a general maturing of the industry. During the 1990s, dominant actors focused on constructing an energy market that valued *CC Mitigation* highly and ensuring the economic feasibility of continued expansion of wind power capacity by establishing a stable framework.[75] This differs from the Unique Supplement period, when efforts were aimed at establishing a "protected space" within the energy market to ensure sufficient stability for small-scale entrepreneurs to construct turbines.

The actors that were not part of the Climate-coalition include the DEF, which adopted a somewhat mixed position and retained some power during the period. This is seen through the collaboration between the utilities and the Climate-coalition, especially on offshore wind power. Even less influential were dispersed actors, namely De Konservative and Venstre parties and local anti-wind opposition groups, as well as the JP and Berlingske newspapers. They were beginning to form a coalition which was not occupied with the old Fuel-coalitions priorities. This coalition had slowly been dispersed throughout the Climate Solution period as some utilities highly opposed wind power, while others were embracing it. The political parties, Venstre and De Konservative grew increasingly anonymous with the exception of the 1999 liberalization agreement. But as little those two parties had been involvement in creating the materiality of the Climate solution valuation network, the more fiercely they were preparing to disassembled the Climate Solution frame during the next period of analysis.

[75] It is worth noting that Plan 21 included a sentence that frameworks must be set up to enable the "economic feasibility" of wind power. It also could have been phrased that the current market framework had enabled the economic feasibility of centralized fossil fuel power plants, and that this had to change.

Materiality during the Climate Solution Period

The high build-out rates from the Unique Supplement period were maintained throughout the Climate Solution period, even as the installed fleet grew. A significant change in the valuation of electricity in the system enabled wind power to grow significantly, even after rapid expansion in the 1980s. Moreover, the first offshore demonstration projects became operational during this period. As shown in Figure 19 (GBA), the first 5 MW of offshore capacity was connected to the grid in 1991 at Vindeby (450 kW Bonus onshore turbines), and another 5 MW (500 kW Vestas onshore turbines) was connected in 1995 at Tunø Knob. The next major addition was in 2000, when Middelgrunden, the world's first offshore wind farm with multi-MW turbines (2 MW Bonus), was connected to the grid[76]. All of the numbers in figure 19 are listed in Appendix A.

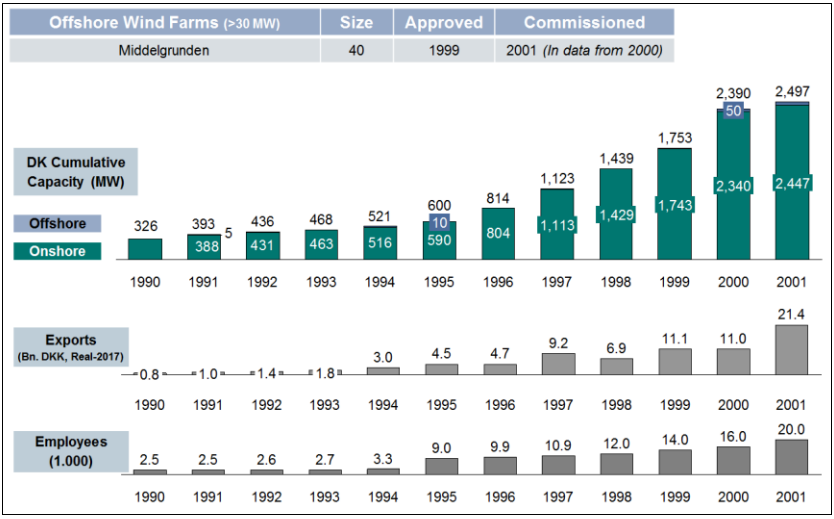

Figure 19: Capacity expansion during the Climate Solution period.

The only slow-down in this rapid expansion occurred in 1992–1993, as per the politics of drift[77] from Minister Lundholt. Yet from 1994 on, domestic capacity, exports and employment rose substantially, in what was the largest growth period in

[76] The DEA reports the 40 MW capacity for the Middelgrunden wind farm as coming online in 2000, but the formal inauguration occurred in May 2001. I decided to use the DEA's data for the graph, but listed the official inauguration year as 2001 in the table.

[77] The "politics of drift" is a term used by political scientists Jacob S. Hacker and Paul Pierson in their 2011 book "winner takes all politics" (Hacker & Pierson, 2011).Herein they refer to how politicians can let entities they do not favor disappear by ignoring emerging problems with that specific entity.

the history of the Danish wind turbine industry. Wind industry exports grew 10-fold (DWIA, 2003, p. 4), comprising 4.6% of total Danish exports (DWIA, 2010, p. 16). Danish companies entered the new millennium with a 50% global market share, led by the big three manufacturers, Vestas, Bonus (which became Siemens Wind Power in 2004) and NEG Micon (which merged with Vestas in 2004) (DEC, 2002a, p. 230; DWIA, 1999, p. 2). In the 6 years between 1995 and 2001, the compound annual growth rate (CAGR) for wind turbine installations was 25% in Denmark, while exports and sector employment doubled (DEA, 2011b, p. 4) to 20 billion DKK and more than 20,000 employees (Appendix A).

This extensive capacity expansion was enabled by a number of of laws and initiatives which fundamentally changed the rules of the game. The two 1991 laws that enacted CO2 taxation and then correspondingly compensated renewable electricity are the first material results of the Energi2000 plan. During the latter part of the period, the PSO-tax was enacted, which ensures that the device which funded the framework for wind power would not be connected to the annual budget. Furthermore, the utilities were asked to build more wind power capacity: 100 MW in 1990 and then 750 MW of offshore wind power mandated by Auken. These framework changes were combined with the visibility that comes when CO2 emission reduction and wind power capacity expansion targets are established. The establishment subsidy expired during the last period, which is very indicative of the change that occurred. Wind power was no longer a supplement on the periphery of the energy system, where it could create some exports and jobs. It was becoming a central piece of the energy system and thus began to function in a “stretch and transform” mode. CO2 taxes, along with increased electricity taxes changed the rules of the game for the other energy sources on the grid. These material changes to the framework meant that wind turbine investors had some revenue visibility and were willing to invest. Furthermore, the technology enabled larger turbines to be deployed at continually lowered costs.

4.4.4 Key Takeaways from the Climate Solution Period

The climate coalition of the 1990s was heterogeneous; several dominant actors supported the expansion of wind power. Unique-coalition actors continued to be strongly represented on the Renewable Energy Council, which was run by former ATV-head, Niels Meyer (Beuse, 2000, p. 103;105). Both the Danish Wind Turbine Industry Association and the Danish Wind Turbine Owners Association saw large growth in membership as wind turbine installations and exports grew. At the center of the Climate-Coalition was Aukens *Environment* and Energy Ministry which had momentum to create a strong link between energy and the environment, and place wind power at the center of energy policy as evidenced by a ~25% compound annual growth rate in installations, a quadrupling of turbine size, and the initial implementation of offshore wind technology. By the end of the century, the Danish wind turbine industry accounted for 60% of the world market (DEC, 2002a), and the industry grew so fast, organizations struggled to expand quickly enough to keep pace with demand.[78] Members of the wind turbine industry also saw that they could cooperate more with the large utilities. The former incumbent Fuel-coalition that had opposed the expansion wind power during most of the Unique Supplement period began to disperse during the Climate Solution period. Especially during the late 1990s, coalition members were beginning to consider wind power as a viable option. In 1995, the CEO of ELSAM acknowledged that wind power was one the best ways to reduce CO2 emissions, and therefore it could be a good idea to invest in the technology before others. This notion builds on the idea that CO2 emissions must be reduced, thus an energy source with this quality is valuable.

This growth was driven by changes to the rules of the game. Wind power delivered an indispensably valuable quality to the energy system, *CC Mitigation*. The Climate-coalition had an imperative need to mitigate CO2 emissions, and the framing appeared to be that although it was more expensive to build wind power capacity than to buy coal or gas, it was worth it to reduce CO2 emissions. The Climate-coalition also knew that the challenge of climate change would only become more salient, so expanding wind power capacity would also support an industry that would help solve this monumental challenge. The Climate-coalition knew that wind power was still technically expensive to build, but had a future vision that a strong industry would prove to be a global advantage for Denmark.

Everything appeared to be on track. But this change of the rules to make *CC Mitigation* the central focus would become a rallying point for a number of dispersed actors. Whereas the main opposition to wind power came from owners of existing electricity infrastructure, it was during the Climate Solution period, within the walls of the Danish parliament that opposition was at its highest. Members of the Venstre party, who in the 1980s had been neutral to slightly positive about the export potential of wind power, now considered the subsidies to impose a much too high burden on Danish society. Extensive wind power capacity expansion also had sparked growing opposition from anti-wind groups and the two right-wing newspapers, Berlingske and Jyllandsposten, based on the unfairness of subsidies as well as *Aesthetics* concerns. Actors in these isolated pockets laid the groundwork for a coming organized destabilization to the expansion of wind power, which was intertwined with an opposition to Svend Auken and environmental policies in general. The next period, 2002–2007, signaled a significant shift in valuation and the emergence of new centers of calculation. After the election in the fall of 2001, a new government took control of the energy policy, and by 2002, a new dominant valuation frame had begun to form.

[78] Palle Noergaard, the CEO of Bonus (Holm, 2004), described the mid- to late-1990s as a period wherein the industry grew so fast that he at times had to "press the brake and not the accelerator" (B.dk, 2003).

5. RE-FRAMING OF WIND AS A VALUE-DESTROYING MARKET DISTORTION

Immediately following the Climate-coalitions build-out of the 1990's, the valuation drama of wind power would see its most significant moment of valuation. Following the November 2001 election, the Danish parliament would be led by a new government consisting of Venstre and De Konservative with parliamentary support by right-wing party DF. This new party coalition destabilized the Climate Solution frame and would ally with newly established actors to construct a completely different framing of wind power. In a dramatic shift of devices, wind power went from being framed as an indispensably valuable solution to climate change, to being framed as a disturbing factor to a certain market conception.

5.1. PREVIOUS FRAMING IS REMOVED (2002-2005)

It would not be the old Incumbent Fuel-coalition, who would establish a different valuation network, but instead a new set of actors to the field of wind power, the Market-coalition. This new coalition moved quickly from 2002 and forward to establish the Market Distortion Valuation Network, wherein the regulatory framework for wind power was defined by great uncertainties and build-out was almost stopped completely. A natural place to start is with one of the Market-coalition's most powerful actors, the incoming Prime Minister Anders Fogh Rasmussen (AFR). AFR had prior to the 2001 election had criticized the former Climate Solution Valuation Network, and stated that the wind power subsidies equaled to how "the money was blowing out of the state coffers" (Fogh, 2008). AFR knew that he would have to change the balance of calculative power to disassemble the Climate Solution Valuation Network. This would be a central theme in his first New Year's speech as Prime Minister, only 40 days after taking office. Herein he issued a critical stance towards the role of experts and public institutions.

> "We do not need experts and judges of taste to decide on our behalf….state-authorized judges of taste, who determine what is good and right in different areas….There are tendencies towards a tyranny of experts, which risk suppressing the free popular debate….The Government will remove surplus councils and boards and institutions. It will be a very comprehensive redevelopment". (Rasmussen, 2002)

AFR-s administration was a central actor in this newly forming Market-Coalition and was quick to take action against the Climate Coalition's calculative centers. It thus terminated 17 councils and work-groups in the energy and environmental ministry and supporting public functions (Termansen, 2002). This equaled more than 400 job-cuts (Nørgaard & Tornbjerg, 2002) and what was calculated by the outside observer Center for Alternative societal analysis, as environmental cuts of more than 16 bn. DKK (21 bn. DKK in 2017 currency) over the following years budgets (CASA, 2002; Rothenborg & Andersen, 2002; Tornbjerg, 2002b)[79]. The Market-coalition viewed the many calculative centers established under the Auken-administration, as potential critics of the new directions in energy policy. The budget cuts drew stark criticism from the ministries civil servants (Reuters, 2002). In early 2003, Steen Gade the director of the Danish Environmental Agency quit his job in protest, stating that the new government was no longer 'cutting to the bone, but into the bone' (Kroeyer & Elmose, 2003). Hans Christian Schmidt (V), the new minister of Environment and long-time critic of the Auken administration's policies[80], dismissed this critique and argued that the Climate-coalition actors were still free to criticize the new valuation practices to come. Such critique would "just not get paid for" anymore (Termansen, 2002). The drastic cuts shows how crucial it was to control the positions in the legislative branch which produce calculations on legislative changes (Bruszt & Stark, 2003). The Market-coalition removed central agencies and councils, ensuring that critiques will not come from the officially recognized and established councils that emerged under the Climate Solution period. Critiques will not bear the same weight when it comes from outside, and simultaneously it will be met with counter-framings from inside the administration.

The high salience of environmental matters and climate change from the previous valuation frame would disappear in the following years led on by leading ministers in the new government. Minister of Finance, Thor Pedersen (V), would ridicule the climate change science as being "a question of faith", and "the emperor's new clothes" (Meilstrup, 2010, p. 37), while prime Minister AFR (V) compared Climate Change concerns to when people in the 1600's feared a coming ice age (Dahlager & Rothenborg, 2007, p. 126)[81]. The Minister of Economy and Business, Bendt

[79] The immediate cuts in 2002 were equal to 2 bn. (2.5bn. DKK in 2015), but when counted over the following years, the CASA consultancy group calculated that the total cuts to environmental programs were in the range 16-21 bn. DKK (21-25 bn. DKK in 2015). The newly appointed Minister of Environment Hans Christian Schmidt (V), did not agree to the NGO's way of calculating environmental cuts, as it included environmental programs in other ministries, but he never produced any counter-calculations or specified his critique (Rothenborg & Andersen, 2002).

[80] The new environmental minister, Hans Christian Schmidt, had on several occasions in the 1990's been scorned by Svend Auken in environmental debates, and was in 2002 eager to limit Aukens old ministry (Dahlager & Rothenborg, 2007, p. 80).

[81] AFR's full statement was said in response to a question about Climate Change during a town-hall like event in 2005: "In the 1600's, people believed that we were facing a new ice age. If you go around expecting a flood every day, you can expect a sad life for the next many years" (Dahlager & Rothenborg, 2007, p. 126). This was a position Anders Fogh had held since the 1990's, in example

Bendtsen (C), would also downplay the risk of climate change, as he argued that since CO2 could be used to grow tomatoes in his green-house, he did not consider it to be "pollution"[82]. It became taboo for civil servants to publish or talk of Denmark's pioneering position in wind power or the beneficial effect of environmental taxes (Meilstrup, 2010, p. 131). Inside the ministerial offices, environmental publications would be edited to downplay the dangers of climate change, and highlight areas of uncertainty (Dahlager & Rothenborg, 2007, pp. 93–94). The first annual budget would also include double-digit million funding to research alternative sun-spot theories in order to cast doubt on the existing climate change science. This very strong politization of climate change science also had the effect that some scientists at Danish universities and the Danish Meteorological Institute became cautious of speaking up in the media, in fear of being dragged into a political game (Dahlager & Rothenborg, 2007, pp. 97–98).

5.1.1 New Valuation Network quickly takes action to lighten Subsidy Burden

As shown above, the Market-coalition's first move was to turn the focus away from discussing climate change and hereafter shift the focus to a concern about the societal costs of a wind power build-out, and the following distortive effects on competitiveness (Dahlager & Rothenborg, 2007, p. 84). This would give rise to the conceptualization of the concerns that some local groups and Venstre's political party had begun to voice at the end of the 1990's. Namely that the quality *Subsidy Burden* of wind power equaled a cost to society that was simply too high for wind power build-out to continue as it did.

In January 2002, Minister of Economy and Business, Bendt Bendtsen (C), would initiate the first major legislative action that would form the new valuation network. This would come in the form of an announced cancellation of three of the five offshore wind farms, which the utilities had been mandated to build by the Auken-administration in 1998 (DEA, 2016b, p. 59). Two of the offshore wind farms, Horns Rev 1 and Roedsand 1, had already begun construction for an agreed subsidy scheme equaling 43 oere/KWh for the first 10-12 years of production, and could thus not be cancelled (P. S. Benson & Tornbjerg, 2002). The Nord-pool electricity price resided at a low level of 20 oere/KWh, so once the two parks were finished, they would receive a strike price at around double the 2002 electricity price (Tornbjerg, 2002a). Bendtsen immediately initiated the cancellation of the remaining three 150 MW offshore wind farms (proposed to be at the sites of Laesoe,

he would in a 1998 Op-Ed argue that climate change was just one among many "doomsday theories" (Meilstrup, 2010, p. 142).

[82] This is commonly known simplification-spin on a complex issue. CO2 in and off itself is not pollution, but when large amounts of CO2 are released into the atmosphere it causes warming as more heat is trapped in the atmosphere, this is why it is called the "Drivhus-effect".

Omoe, Gedser Rev), as he was "deeply worried about the societal costs and our competitiveness" if the renewables build-out was continued (J. S. Nielsen, 2002a). The high *Subsidy Burden* that would come from building the wind farms would allegedly hurt both the "industry's and the consumers' competitiveness" (Meyer, 2002)[83]. The Market-coalition thus followed in the tracks of Venstre's energy spokesman, Peter Hansen-Nord (V), who in the late 1990's had promised that offshore wind power would not receive subsidies if it was up to Venstre. Bendtsen would reiterate that the Government's position was that the wind industry should not need any more subsidies (From, 2002a)[84].

As the Market-coalition now had control over the government agencies, Bendtsen had the Danish Energy Agency perform a calculation on the low electricity price and the expected subsidy gap to the strike price. This calculation was presented by Bendtsen as proof that cancelling the remaining three OWFs would save 900 mn. DKK annually (J. S. Nielsen, 2002a). This number would on the same day be cited by the right-wing newspaper Jyllandsposten as an annual saving from cancelling the three planned OWF (Corneliussen & Rasmussen, 2002). However, the 900 mn. DKK saved came from a different calculation, which represented how much Denmark would save, if it had only had 20% renewables in it electricity mix instead of the projected 27% by 2003. The 900 mn. DKK was thus the result of a counterfactual calculation where the 'not yet built' additional seven percent renewables were cancelled, thus covering both potential future offshore and onshore wind subsidies. The three offshore wind farms that were proposed to be cancelled would actually equal 300 mn. DKK annual saving, and not before 2008 (Laursen, 2002; J. S. Nielsen, 2002a; Tornbjerg, 2002a). This large difference between the presented number and the actual calculation was later explained by a spokesperson from Bendtsen's ministry as "a misunderstanding" (Tornbjerg, 2002a). The 300 mn. DKK of savings from 2008 would later be used to frame a new quality of wind power, namely the *Subsidy Burden* from building wind power. The narrative was that the *Subsidy Burden* that followed from investing in wind power had been allowed to grow too large under the Auken-administration. The Market-coalition framed itself as the responsible coalition that reduced the negative impacts to society of the prosthetic devices enabling wind power build-out. One of these devices is the taxes on electricity, which funded the wind power build-out. In a time of historically

[83] This is not a typo but an actual statement said in a radio-interview by the minister. The author also does not know what was meant by "consumers' competitiveness".

[84] Bendt Bendtsen said that the wind turbine industry had now been given a head-start, and it should not need any more subsidies now, comparing it to the German car industry, as an example of an unsubsidized industry. The German Car industry has however been historically subsidized, such as the London Agreement on German External Debts of 1953 following WWII, which in addition to many other things, functioned as an export incentive to the car industry (Dodman, 2015). This was of course a good decision, as Germany had to be rebuilt after the WWII, but it nonetheless shows that the German car industry did not grow without government intervention. In a more recent example from 2009, which of course was not available in 2002, the German government spent €5 bn. to subsidize domestic car sales following the 2008-crisis (White, 2009).

low electricity prices, the Market-coalition made it a matter of concern to ensure that wind power build-out did not lead to rising electricity prices, as seen in the Bent Bendtsen Op-Ed below.

> "We have a responsibility to ensure that the bet on renewable energy does not lead to rising electricity prices, which will hit both consumers and businesses. In the three year old electricity reform, the Nyrup government expected that 20% of the electricity consumption would be covered by renewables by the end of 2003. Instead it looks as though the subsidy-schemes for renewable energy will bring the number up to around 27 percent. The price to electricity consumers and Danish companies is annually at 900 mn. DKK for the extra seven percent…It is unhealthy that the wind turbine build-out is artificially driven by politically decided prices, financed by the consumers. Contrary to this, competitive wind turbines, which can function without subsidies, would seriously be able to increase interest for wind turbines on the export markets". (Bendtsen, 2002)

In addition to the concern of subsidies burdening society, another quality was emerging. In the quote above, Bendtsen brings salience to a conceived risk that an "unhealthy" and "artificially driven" build-out could hurt the attractiveness of wind turbines abroad. A wind turbine build-out can according to this framing happen "artificially" in a way that is "unhealthy" for both the Danish economy and the wind turbine industry. The undergoing build-out was compared to some other notion of "competitive wind turbines". These "competitive" turbines are only defined by being "without subsidies", but it is not stated what they are competing with. It could have been the electricity price or coal plant construction prices, but this is not clear in the statement. The notion that a subsidized industry was artificial and therefore not valuable was shared by Thor Pedersen, who would compare wind power subsidies to subsidizing a banana industry in Denmark (Dahlager & Rothenborg, 2007, p. 82). In his view, the subsidies led to activity within the subsidized field, but this activity was taken from elsewhere in the economy and therefore the *Industrial* benefits of wind power was as artificial as growing bananas in Denmark. The Market-coalition brings another negative impact quality to the framing of Danish wind power that is separate from being a *Subsidy Burden*. It is also defined by the quality *Market Distortion, as* wind power investments are not valuable when subsidized, and should instead emerge in some imagined undefined "naturally occurring market". Behind this quality was the notion that electricity taxes should not fund wind turbine subsidies, and this notion brought a large private actor into the Market-coalition, namely Danish Industry. They welcomed the Fogh-government's actions, as spokesperson Anders Stouge stated that it was now okay to ask the technology to "manage on market terms, with a compensation for the CO2 reduction it provides "(L. W. Jensen, 2002).

But there was an even more important new actor who also placed this new *Market Distortion* quality centrally to the valuation frame of wind power. The Danish Economic Council was an independent and highly respected group of economists who gave advice to changing governments. They did not have energy policy or climate change as their core area but in 2002 they would produce a calculation that would define the *Market Distortion* quality in much more concrete terms than Bendtsen could. This new calculative center would deliver an important piece in the valuation frame that would come to dominate this moment of valuation as they calculated the distortive effects of wind power investments and subjected the need to mitigate Climate Change to carbon markets.

5.2. THE DANISH ECONOMIC COUNCIL QUESTION VALUE OF WIND BUILD-OUT (2002)

De Oekonomiske raad / The Danish Economic Councils (DEC), an advisory body to the sitting government, would in March 2002 publish a report which specifically focused on whether or not the Danish wind power build-out had been a valuable societal investment.

5.2.1 Actor Profile: The Danish Economic Councils

The following segment will provide a short actor profile of the DEC and go into depth on their stated motivation for writing the report, as it is important to understand what the DEC's arguments were for examining the value of Denmark's wind power investments.

The Danish Economic Councils (DEC) define themselves as an independent advisory body to the government and consists of four economists, unofficially referred to as "Wise-men" or "Sages", who have a 30-35 employee secretariat at their disposal. The DEC has existed as a sub-department of the Danish Financial Ministry since 1962, wherefrom they make recommendations to the sitting government through three annual reports. The economists who sit in the councils are picked among the most influential in the country, albeit with an overweight of connections to private enterprise (Henriksen & Stahl, 2015). They use the same economic modelling tools, such as the Annual Danish Aggregate model (ADAM), as the Financial Ministry and in this way they are regarded as authoritative on economic matters. They have however stirred controversy in the past, as they sometime go further in using the Finance ministry's modelling tools and neoclassic economic models to evaluate and advice on various societal policy-issues (Henriksen, 2013).

In 2007, the original Danish Economic Council was expanded to two councils as Institut for Miljoevurdering / the Institute of Environmental evaluation (IMV)[85], was closed down and the employees were moved to the original Danish Economic Council's secretariat, wherefrom the environmental-economic council was formed as a sub-branch. The institution is today called the economic councils in plural, although they still publish reports together (Henriksen & Stahl, 2015).

5.2.2 The DEC misrepresent OECD report to justify making wind power subsidies a matter of concern

The DEC motivated their 2002 report on a suspicion that tax-financed subsidies during the 1990's could have resulted in lowered employment, as it likely had an impact on 'private consumption opportunities' (DEC, 2002a, p. 185). The DEC listed an OECD evaluation of Danish environmental policies from 1999, as the authoritative justification that Danish environmental efforts were producing below-medium results with above-medium cost.

> "Different studies, in example OECD (1999), indicate that the effort in Denmark on the environmental area is above average, but the result is below average in international comparison. Such an assessment gives cause to discuss the following questions: How can the relationship between benefits and costs be improved?" (DEC, 2002a, p. 185)

The DEC cites OECD as an authoritative source which allegedly indicates that Denmark has achieved "below average" results for its environmental efforts. The 1999 OECD report does, however, not point to results indicating that Danish environmental efforts have resulted in below average effects. On the contrary, the OECD described Danish measures to address environmental issues as both "innovative" and "effective" (OECD, 1999, p. 19;21). The green taxes which were a central part of the Climate Solution valuation network were specifically highlighted as creating "fiscal incentives to protect the environment", which led to "important results" (OECD, 1999, p. 19;20). In addition to having tripled the share of renewable

[85] I will in this chapter return to the actor IMV, which was a calculative center established by the Market-Coalition.

energy, Denmark was applauded for having become leaders of "environmentally favorable energy technologies such as wind turbines, which are now considered as a viable alternative to coal based power plants" (OECD, 1999, pp. 23–24)[86].

So although the DEC used this report as an argument to examine the green taxes and wind power subsidies, it was actually not the environmental policies which caused Denmark to be "below average" (OECD, 1999, p. 32). The reason that the OECD labelled Denmark as "below average" was Denmark's significant growth in the 1990's, especially in the energy, agriculture and transportation sector, which had resulted in pressure on Denmark's environmental commitments (OECD, 1999, p. 21)[87]. But this is not the same as to say that the efforts that were enacted in the 1990's were "below average", or should be limited[88]. In summary, the OECD results did not indicate that environmental policies had been "below average", which is one of the DEC arguments for initiating the examination that led to the 2002 report. The OECD did however make recommendations regarding analysis showing cost-benefit relationships (OECD, 1999, p. 24,29), but did not single out wind power or conclude that Danish environmental efforts were "below average". On the contrary, the OECD explicitly highlighted the success of the Danish wind turbine industry, and did not find that environmental subsidies had limited Denmark's growth or competitiveness.

> "There is no evidence that environmental measures and expenditure in Denmark have to date adversely affected its economic growth or international competitiveness. On the contrary, environmental protection has become an important selling point for Danish industry. The Danish eco-industry has a combined annual turnover of DKr 2 billion (50 percent for export), and the Danish wind turbine industry has an annual turnover of over DKr 5.7 billion (70 percent for export)" (OECD, 1999, p. 29).

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[86] Full quote OECD, p. 23: "Over the last two decades, Denmark has almost stabilized energy use during a period of continued economic growth. It has almost tripled the contribution made by renewable energy sources to the country's energy needs, and Danish industries have become leaders in environmentally favorable energy technologies such as wind turbines, which are now considered as a viable alternative to coal based power plants."

[87] Full Quote, OECD, p. 21: "On the other hand, trends in waste generation and CO_2 emissions are not favorable. As the Danish economy continues to grow in the 1990s, environmental pressures from energy, agriculture and transport in particular are still strong."

[88] On the contrary, the OECD recommended that Denmark considered 'additional measures needed to meet CO2 reduction, particularly in the energy and transport sectors' (OECD, 1999, p. 33). The OECD additionally marked more analysis of efforts the agricultural sector as especially important in decision (OECD, 1999, p. 21,29).

The quote shows that the OECD report, which the DEC cite as reason to investigate the cost-effectiveness of environmental efforts, reached a contrary conclusion to what the DEC stated. The argument for starting the DEC 2002 investigation, that Denmark's environmental results were 'below average', must thus have come from other sources than the OECD 1999 review. The DEC is thus highly selective in the reading of the OECD report's conclusions regarding the costs of environmental measures and expenditure in Denmark. DEC as a calculative agency highlights Danish environmental policies as a matter of concern. But the OECD report which they cite as support for the need for their inquiry into Denmark's below average performance actually highlights Danish environmental policies as effective and innovative.

5.2.3 The DEC 2002 report frame wind power as a Fuel Supplement and commensurate CC Mitigation

The 2002 DEC report had the stated goal of evaluating Denmark's environmental- and energy policies of the 1990's[89], herein wind power through its subsidies and enabling taxes. This would be done through the device of a cost-benefit analysis of calculating all the direct and indirect costs, and then adding the environmental benefits calculated into a monetary value for the period of 1992-2001[90].This calculation brought them to the conclusion that the wind power build-out in Denmark during 1992-1999 resulted in a societal loss of 3 bn. DKK (DEC, 2002a, p. 210,211). The calculation would enact subsidies and taxes as the central object of the valuation for wind powers worth. It would furthermore bring salience to the new quality *Market Distortion*, which was decisive in the new dominant valuation frame for wind power as a societal investment. Hereafter follows a break-down of the major changes to the framing of wind power in the report. The device used was a cost-benefit analysis, in which every aspect of a wind power investment is calculated into monetary costs and weighed against each other. I will begin by analyzing how the DEC calculated the benefits of wind power, and thereafter dive into their estimates on costs.

[89] The DEC report placed itself in direct opposition to a previous calculation from a set of calculations the Financial Ministry under the previous government had made in 2001 (DEC, 2002a, p. 214; DKGOV, 2001).

[90] The cost-benefit calculation would not address any existing price discrepancies, such as the various carbon lock-in effects that would benefit existing generation (Unruh, 2000). The existing prices for electricity on the Danish market were thus treated as the "efficient" prices, which determine whether subsidies were valuable to Denmark or not.

DEC re-categorize wind power as a Fuel Supplement due to overcapacity

A determining assumption in the DEC report calculation is that since Denmark had enough incumbent power generation capacity over the analyzed period, the wind power build-out had resulted in a “surplus capacity” and only saved fuel costs on the power plants (DEC, 2002a, p. 210). The DEC inscribes wind power with the same quality that DEFU did during the 1970’s and 1980’s, and that ATV actually also did in their first calculations in 1975. This quality entails that the electricity produced by wind power does not on its own have any value, apart from saved fuel costs on conventional coal and gas plants. The DEC very clearly stated that wind power build out is “surplus capacity” (D2: #3) [91], and sees the “abundant electricity production capacity in Denmark” as the “first and foremost” cause of the societal loss that the wind power build-out caused (D2: #12). The DEC also argue that both satisfaction of the utilization of wind power for electricity use and the environmental benefits it has, could have been reached in a cheaper way by importing it from Norway or Sweden (D2: #8)[92].

Consequently, the only utilization value from the added electricity generation by the use of wind turbines was calculated as saved fuel costs, namely 14.3 bn. DKK. This number is not present in the report itself, but is represented in a subsequently released back-ground report called “Cost benefit Analysis, Energy Policy and Taxes on Energy and Transport” (Soebygaard, 2002, p. 15). In the 2002 DEC report, it is collated into a total cost figure which consists of the total costs of wind turbines minus fuel savings (DEC, 2002a, pp. 208–209)[93]. As was the case in earlier instance of the quality *Fuel Supplement*, the value of wind power is determined by fuel price assumptions which again are reflected in electricity price assumptions. But where the favored device during the Unique Supplement period, the break-even price calculation, showed the assumed fuel prices, fuel prices are now hidden in a background report. If one dives into the assumptions of the background report to the main DEC calculation, it becomes clear that the DEC selected a fuel price estimate instead of electricity price benchmarks used by the Danish Energy Agency at the time. This is shown in Figure 20 (GBA) below. If the produced kWh of wind power had been regarded as electricity they would have had a higher value for the final calculation, than if they are merely counted as fuel savings. Note that it is not the fuel savings vs. electricity price alone which forms the calculation of -4.7 bn. DKK.

[91] The full quotes from the report can be found in Appendix D2, The quotes are listed as D2, followed by a # sign and the numbered quote.

[92] The DEC authors did go on to calculate a value for the quality of *CC Mitigation*, so this point is included to highlight that in the framing of the DEC, the cost of building the wind turbines could have been avoided, thereby empathizing the quality of wind power as a *Fuel Supplement* to the energy system.

[93] As the DEC assumes that the only value of the electricity generated by wind turbines is the saved fuel on conventional power plants, and benefits related to *CC Mitigation* and *Environment* from displacing that fuel (discussed later), they have subtracted an estimate of the saved fuel costs from the total cost number presented in the report.

It is a sensitivity analysis, which shows what the final result would instead have been, if an electricity price of either 23 Oere/KWh or 32 Oere/KWh had been chosen instead. This is also noted specifically in the background report, as it is stated that the final report would have shown a "societal plus" for wind turbines if the high electricity price estimate had been chosen (Soebygaard, 2002, p. 28). If they had chosen the low estimate for electricity prices, it would still have resulted in the surplus of wind power being halved. So this choice of regarding the wind turbine electricity as an entity which was not sold as electricity but merely saved fuel is decisive for the final outcome of the DEC report. Figure 20 (GBA) is the authors attempt to visualize the above-described sensitivity of the fuel and electricity price assumptions.

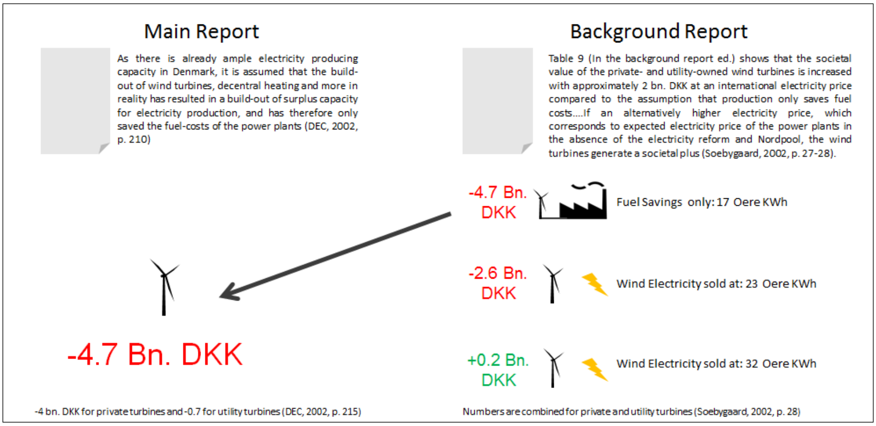

Figure 20: Visualization of the DEC fuel and electricity assumptions.

To summarize, the background report has a spans of high and low electricity price estimates as well as a fuel saving estimate. Furthermore, it is mentioned that a higher estimated fuel price would result in a higher value of wind power (Soebygaard, 2002, p. 28). But the high sensitivity of these assumptions is not elaborated in the main report, and the alternative values at higher or lower prices are not presented.

When the Auken-administration had been cooperating with the financial ministry in the 1990's, it had been calculated that the produced wind turbine electricity was sold, so equivalent to the alternatives mentioned in the background report. In the 2002 DEC report, they only counted saved fuel and thus reached a lower value for wind power. This change in assumption has a decisive impact as the societal loss of wind turbines increases with 80% (from 2.6 bn. to 4.7 Bn.) between the lowest electricity price alternative and the fuel savings benchmark. This sensitivity is briefly explained in the background-report (Soebygaard, 2002, p. 14), but not mentioned in the main report. The value of wind power in the main DEC report was however also impacted by calculations on the value of mitigating CO2, which will be analyzed next.

CC Mitigation Quality is commensurated

As shown above, the DEC only counted fuel savings on central plants, as the value of the electricity output of wind turbines. They would however also set out to assign a value to the broader environmental benefits of wind power[94]. To account for the *CC Mitigation* value, they needed to calculate a benefit for every ton of CO2 that would be displaced by the previous decades' wind power investments. They used this estimate to figure out whether or not the monetary representation of fewer CO2 emissions exceeded the societal costs of wind power. Before diving into the calculation, it is worth mentioning that the DEC authors hypothesized that *CC Mitigation* could be achieved more cheaply through flexible mechanism options mentioned in the Kyoto-protocol. This would be achieved through a theoretical quota market (DEC, 2002a, p. 217). However, as the EU Emission Trading System would not come into force until 2005, so at the time of writing the trading of emission quotas within the EU was still a theoretical option. The EU-quota market would in later reports become the cornerstone of the DEC's reason to ascribe a low value to the quality of *CC Mitigation* for wind power.
To estimate the benefit of CO2 emissions avoided, the DEC calculated a monetary estimate of the damage done by emitting one ton of CO2. The DEC presented an upper bound of 270 DKK/ton and a lower bound number 47 DKK/ton[95] for calculating the damage effect of emitting CO2 (DEC, 2002a, p. 205). By not presenting a middle bound figure, the DEC leaves it to the readers' interpretation to determine what he considers to be closest to the right price for emitting CO2. In their calculation, the DEC uses the upper bound number in their case example for the value of wind power. However, the sources that they used to find this number did not consider it to be their highest estimate, as will be explained hereafter.
The upper bound CO2 cost estimate of 270 DKK originated from the Danish adaption of an extensive EU project called ExternE. In the ExternE project, which was one of the highest credited calculations of CO2 damage estimates at the time, two ranges of monetary CO2 estimates were presented (DKGOV, 2001; Schleisner

[94] The DEC changed also changed how much air quality would be improved by wind power, as they updated the assumptions on how much pollution was assumed to come from Danish power plants. The DEC calculated that due to smoke-cleaning and other initiatives, the displaced power centralized power plants did not emit as much CO2 as in the 1980's (DEC, 2002a, pp. 216, 266; Soebygaard, 2002, pp. 7–8). This lowered the amount of displaced CO2, but it also had a minimal impact on the environmental quality, which relates to air quality.
[95] The upper bound is equal to 36 EUR/tonne in Real-2002, equivalent to 343 DKK / 46 EUR in Real-2017. The lower bound number equals 6 EUR/tonne in Real-2002, equivalent to 60 DKK / 8 EUR in Real-2017.

& Sieverts Nielsen, 1997). The CO2 damage estimate ranges in the ExternE project were closely related to the used discount rate[96]. The ExternE authors did not recommend one specific discount rate, but carefully explained their considerations of the difficulty in setting it[97]. Due to the difficulty in setting one final discount rate, the ExternE authors recommended two ranges for estimating climate change costs. The first was a called a “conservative” outer range, as the authors considered even this broad range to likely “underestimate the true uncertainty” (Schleisner & Sieverts Nielsen, 1997, p. 90). The ExternE authors also presented an inner range called the “Illustrative Restrictive Range”, which did not stretch as far in both directions. This meant that the inner range had a slightly higher low-bound, but also a significantly lower high bound. This ranges high estimate covered an estimate with a discount rate ranging between 1% with a (388 DKK/tCO2) and 3% (152 DKK/tCO2) (Schleisner & Sieverts Nielsen, 1997, pp. 88–90). A lot of calculations went into the ExternE ranges in terms of both discount rates and confidence intervals, but what is key to notice is illustrated in figure 21 (GBA). Namely that the mid-point in the ExternE’s “Illustrative range” would come to make the upper bound estimate of CO2 damage costs in the DEC report (DEC, 2002a, p. 205).

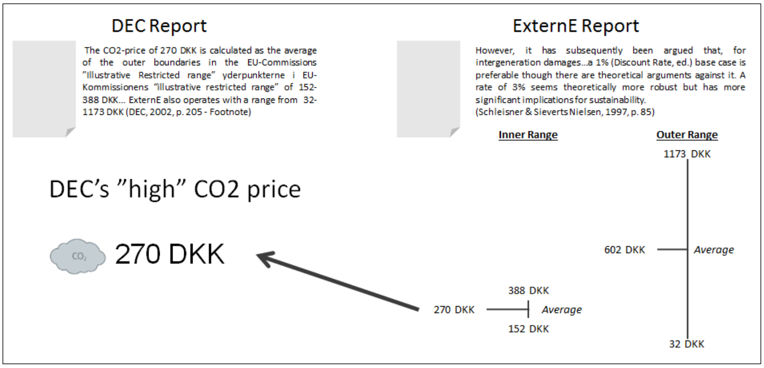

Figure 21: Visualization of how the DEC selected their high CO2 price.

[96] A discount rate relates to how one values something now as opposed to having it in the future, as quoted by the US EPA: “The value of $1 billion in 100 years is $85 million, $52 million, and $8 million, for discount rates of 2.5 percent, 3 percent, and 5 percent, respectively” (EPA, 2013) .

[97] To exemplify how the discount rate relates to climate change mitigation, the ExternE authors explained that a 3% discount rate was equal to judging the damages caused by emitting CO2 today, to fall to “negligible levels” (Defined as costs of less than 10% of original damages) after 77 years. A discount rate of 1% would in comparison mean the CO2 emission damages would not become negligible until 230 years later (Schleisner & Sieverts Nielsen, 1997, p. 85).

The DEC high CO2 price is thus the middle estimate of the narrow middle-range in the ExternE project. As can be seen from figure 21, it had been a higher number had the DEC taken the middle estimate of ExternE's broader range (602 DKK/tonne), or even if they had taken the high estimate for the narrow range (388 DKK/tonne). As the *CC Mitigation* value of wind power increases in correlation to how high the damage estimate cost of emitting carbon is, the choice of what the DEC considers a high CO2 cost estimate is important to the value of wind power. While the ExternE authors recognize the political nature of the discount rate and its "significant implications for sustainability" (Schleisner & Sieverts Nielsen, 1997, p. 85), the DEC authors do not appear explicate these considerations when they sourced the number from the ExternE material.

The DEC's choice would however create a discrepancy between the costs of wind power build-out, which was estimated with a 6% discount rate, and the environmental benefits calculated at roughly a 2% discount rate (Soebygaard, 2002, p. 5). To account for this discrepancy, the DEC included a lower-bound damage estimate, which would be quoted from a 1994 paper by professor Samuel Fankhauser (1994) to achieve an estimate of 47 DKK/tCO2 (2002 currency). But Fankhauser had only reached the 47 DKK number by setting his model to discount the future as heavily as possible. At a discount rate of 3 %, Fankhauser reached 47 DKK, but this would mean valuing the benefit of being able to emit CO2 today as significantly higher than the cost of those emissions damaging impacts in the future (Fankhauser, 1994, p. 179). The number of 47 DKK was the converted and adjusted for inflation 5.5 $/tCO2, which was cited from the high-discounting end of Fankhauser's range of estimates. Fankhausers range had 20.3 $/tCO2 as the mean of the range and recommended estimate. I have visualized this choice by the DEC in Figure 22 (GBA) on the next page.

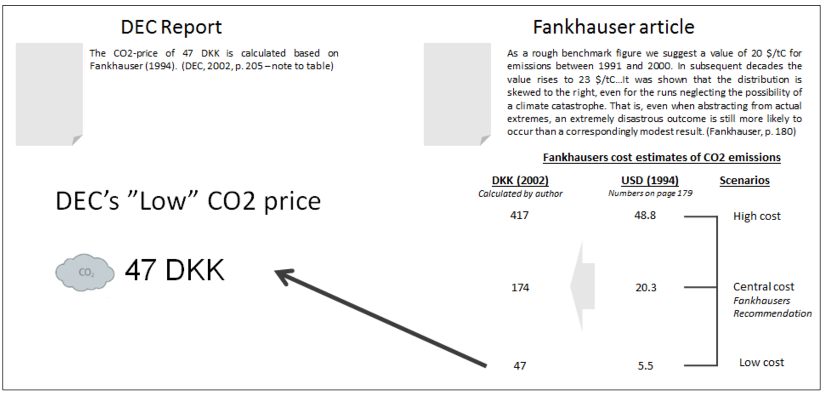

Figure 22: Visualization of how the DEC chose the low CO2 price.

The DEC label the 47 DKK as a low estimate choosing the equivalent low estimate from Fankhausers range[98]. It is however worth a deep-dive to examine what Fankhauser stated about his own initial low estimate. In his 1994 article, Fankhauser emphasizes the need to consider the ethical implications of the level of the chosen discount rate (Fankhauser, 1994, p. 178)[99]. Fankhauser especially pointed out that his results indicated that 'the probability of an extremely disastrous outcome is higher than that of an extremely modest result' (Fankhauser, 1994, p. 174) . In the conclusion of his paper, Fankhauser therefore recommended a significantly higher cost of CO2, than the one used by DEC, as seen in the quote below.

> "Although the parameter values underlying the above results broadly reflect the current understanding of global warming, there is still an element of subjectivity inherent in them. In particular, by assuming a triangular distribution for random parameters they neglect the possibility of a climate catastrophe….As a rough benchmark figure we suggest a value of 20 $/tC for emissions between 1991 and 2000. In subsequent decades the value rises to 23 $/tC". (Fankhauser, 1994, pp. 179–180)

Fankhauser was concerned that even his mean number of 20$/tC, neglected the risk of a climate catastrophe, and would follow up his initial paper two years later. In his follow-up paper, Fankhauser and co-author Richard Tol explained that as the increased scientific understanding of future climate change impacts, such as rapidly increased health risk in the form of the spread of disease, had strengthened Fankhauser in his original suspicion that the benchmark estimate of 20 $/tCO2 was set too low (Fankhauser & Tol, 1996, pp. 668, 669). The DEC does however not mention Fankhauser's initial concerns, nor his later 1996 paper, wherein he deemed his original estimates too low to account for climate catastrophes.

Based on the two above-mentioned sources, combined with minor positive impacts for air quality, the DEC calculated the benefits of wind power to be 7.9 bn. DKK for the low CO2 cost estimate (47 DKK/tCO2) and 20.8 bn. for the high cost

[98] The DEC do not specify from where in Fankhausers 26-page article they have drawn the numbers from, or how they converted to Danish currency and accounted for inflation from 1994 to 2002. The author has therefore located Fankhausers mean numbers for his three scenarios, high discounting, central and low discounting. At a conversion rate from USD to DKK of 8.2 in 2002 and when corrected for inflation, Fankhausers high discount mean number of 5.5 USD matches roughly with 47 DKK (USFOREX, 2016). The same conversion has then been applied to Fankhausers central estimate (called Random), and the low discount case. This is done to make the numbers comparable in DKK.

[99] Full quote: "The high sensitivity of the results with respect to discounting should come as no surprise….The results clearly underline the importance of the discounting question and the crucial role ethical issues ought to play in the future debate on global warming". (Fankhauser, 1994, p. 178)

estimate (270 DKK/tCO2) (DEC, 2002a, p. 209). The 20.8 bn. in environmental benefits gets offset by societal cost of 25.5 Bn. DKK to reach a surplus of 4.7 bn. DKK. Oddly enough this cost had already had the fuel savings benefit of 14.4 Bn. DKK taken out of it. The specific number of fuel savings (14.4 bn. DKK) could thus only be found in the background-report. Likewise the specific number of what the benefit of having the same amount of electricity sold, as by the alternative kWh prices shown in figure 20 could not be found even in the background report (Soebygaard, 2002, p. 15)[100]. I will hereafter open the black-box of the 25.5 bn. that make up the cost-side of the cost-benefit calculation.

5.2.4 The DEC 2002 report commensurate the market distorting Costs of Wind Power

It is on the cost-side of the cost-benefit analysis that we can see how the DEC's use of the *Market Distortion* quality makes the DEC 2002 report such a significant break from prior methods of calculations. The DEC took the direct subsidies paid out to wind turbines in the analyzed period and combined it with a number of indirect cost to signify costs of the new *Market Distortion* quality.

The DEC 2002 calculation of the registered subsidies and research grant awarded to wind power from 1976-1999 is an uncontroversial *Subsidy Burden* quality calculation, which came to a total of 5.3 bn. DKK (DEC, 2002a, p. 194). This figure is however not the decisive one, as the DEC used a total cost figure which drew heavily on the *Market Distortion* quality in their framing. After revealing the table which counted all direct subsidies registered, the DEC authors presented a different table wherein their own estimated total cost of wind turbines was calculated to be 25.5 bn. DKK[101]. The 25.5 Bn. DKK cost figure consisted of an "Investment, Operation and Maintenance" cost of 37.9 Bn. DKK to which direct and indirect distortive tax effects (0.7 bn. DKK), and distortive consumption effects (1.2 bn. DKK) were added while the fuel savings of 14.4 bn. DKK were subtracted.

The "Investment, Operation and Maintenance" cost of 37.9 bn. consists of both the direct subsidies paid by the government, as well as the construction costs incurred by wind turbine owners. The DEC explain this cross-calculation of public sector

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[100] This is also why I have not been able to show a specific "electricity price sold value" in Figure 20, as the background report I analyzed only showed a sensitivity analysis of how the parameters of fuel savings vs. low or high electricity price would have impacted the final results of the cost-benefit analysis.

[101] It is important to note that like all of the tables in the DEC report, the table III.8 splits the wind power costs between private wind turbines and utility turbines. In all of my calculations I have combined the two numbers to simplify these already complex calculations. Table III.8 shows total costs for privately owned turbines to be 18.8 bn. DKK and for utility owned turbines to be 6.7 bn. DKK, so 25.5 bn. DKK combined (DEC, 2002a, p. 209).

costs with private sector costs by stating that it is “reasoned that investment costs are paid by electricity consumers” (Soebygaard, 2002, p. 14). So society’s cost in this calculation is not only the direct subsidies, but also the private funds spent by an individual who builds the turbine.

The indirect tax and consumption distortion costs are not explained in detail, although it is noted that they are derived from distortive effects of the taxes used to fund the subsidies, and that it is calculated through the Financial Ministry’s model called “Danish Rational Economic Agents Model” (DREAM). This model calculates the indirect costs, namely distortion effects of having to tax in order to subsidize, and derived effects of having higher electricity prices compared to energy produced on central power plants (DEC, 2002a, p. 209) . Taxes and subsidies are treated as distorting because according to the DREAM model, they caused a lower supply of jobs, than in a supposed efficient market with lower taxes and no subsidies (DEC, 2002a, p. 206)[102]. The calculation of these indirect costs is argued on the grounds that “taxes are distorting” as they “reduce labor supply” leading to a loss in welfare (D2, #2).

The Market Distortion quality negates the Industrial benefits and Future Potentials

The DEC framing of wind power as defined by the quality *Market Distortion* also has the impact that the value of the wind turbine industry and the *Future Potential* of wind power as a technology to a large extent is disregarded. The DEC did not count any value from the jobs in the wind industry sector, as it was “assumed that the growth of wind industry employment, does not affect the overall employment level” (DEC, 2002a, pp. 224, 233) [103]. Thus, according to the DEC’s calculations, the people employed in the wind turbine industry would have been employed elsewhere, if the Danish wind turbine industry had not existed (DEC, 2002a, p. 236)[104]. Wind turbine exports were not counted, as similar exports could have been achieved through any alternatively created goods (DEC, 2002a, pp. 224, 236). According to the DEC, these jobs would have appeared in other industries had there not been taxes to collect revenue for wind power subsidies (D2: #7). The DEC concluded that although the Danish wind turbine industry has done “especially well”, it could just

[102] The DEC do not provide further details on how the indirect costs come to be calculated as 21.2 bn. DKK, and they are not represented separately in the report. Instead the DEC writes in a footnote that the numbers are based on own calculations, and cite the published background report by economist from the DEC secretariat Jacob Krog Soebygaard (Soebygaard, 2002).

[103] Full quote: It is assumed that the growth in the wind turbines industry employment does not affect the total employment level...The potentially positive employment effects must also be held against the costs of supporting the industry, there among distortions by collecting a tax revenue. (D2: #7)

[104] The DEC authors note to this point that any minor effects would have to be held against the distortive impacts of the taxes required to deliver the subsidies (DEC, 2002a, p. 233).

as well have been caused by “luck” (D2: #16). This is a significant change away from both the Unique Supplement and the Climate Solution Valuation Frame, which had both included some positive impact from the *Industrial* quality to wind power.

The assumption that energy taxes distort markets is based on the assumption that electricity would be priced efficiently in a market without subsidies to wind power. There is thus an absence of fossil fuel externalities and no consideration of the historic subsidies that are sunk into the energy system in the DEC framing. But although the current prices cannot be considered “efficient” in signaling value of energy investments, the DEC use them to claim that wind power subsidies and the taxes enabling them are distorting the market.

In addition to the *Industrial* quality, the DEC also discounted the future in a way that would disfavor wind power investments. With regards to the discount rate, the DEC decided to follow the current discount rate for societal projects used in the financial ministry at the time, namely 6%[105](Soebygaard, 2002, p. 5). The DEC would then conduct a sensitivity analysis with a 3% discount rate and a 270 DKK/tCO2 price (DEC, 2002a, p. 208), which the DEC at one point in the report acknowledge would have cause the wind power investments to be societally profitable (DEC, 2002a, p. 213).

The DEC also discusses whether or not the investments in wind power could have caused more exports through faster learning curves. They concluded that there is “nothing which indicates that domestic market sales should have contributed with substantial experience gains” (DEC, 2002a, p. 252). Specifically DEC calculated that production subsidies given from 1992-1999 only caused a 1.8% decrease in wind turbine production costs, compared to a counterfactual “no subsidy” scenario (DEC, 2002a, p. 259). But despite this dismissal of wind power investments, the DEC include an learning curve benefit of 2 bn. DKK due to domestic sales causing an increase in learning effects (DEC, 2002a, p. 266). This number does not appear in the table of the background report and appears to have been added to the main report without an explanation of the motivation behind[106]. The number is however so low that the total cost-benefit analysis of wind power still comes to a surplus. The DEC authors recognize that future turbines may be “expected to become more profitable” due to technological developments (D2: #15). But nonetheless the many black-boxed calculations frame wind power as a value-destroying investment for Denmark and not something that has been worthwhile. I have attempted to gather the many assumptions of the calculation in figure 23 (GBA) below. Note that the

[105] The lower the discount rate is, the more profitable long term projects such as wind farm would become. In 2009, the Financial Ministry would lower its discount rate to 5% and again in 2013 it would be lowered to 4% (DKGOV, 2016).

[106] The authors do however state that there is a potential that Danish wind power companies might have a position to create export benefits through their market position in the future (DEC, 2002a, p. 245), which could be in relation to this benefit.

surplus of 4.7 Bn. DKK showed in the sensitivity analysis in figure 20, was the final number for the calculation before the black-boxed number of 2 bn. DKK for learning curve benefits to the industry (bottom-left corner of the below graph) was added. As one can see the surplus of 2.6 bn. is the 4.7 bn. after the learning curve benefits have been added. The difference of 0.1 is due to rounding of between the many calculations.

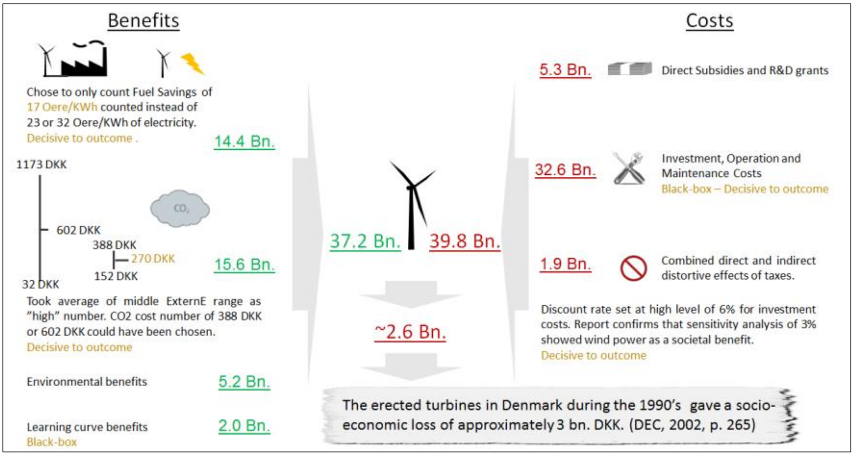

Figure 23: Overview of the DEC cost-benefit analysis assumptions.

The DEC's value framing concluded that the wind power build-out during the 1990's has only given surplus capacity, had not created any jobs, but have had a minor effect on increasing domestic sales which enabled marginally faster learning curves. This resulted in a welfare loss of roughly 3 bn. DKK to the Danish society due to the wind power build-out (DEC, 2002a, pp. 210, 265). The wind power investments were categorized as "social-economically unprofitable" and something which "should not have been enacted" had the politicians of the 1990's known better (DEC, 2002a, p. 263,264)[107]. Ultimately, the DEC framing is based on several black-boxed assumptions, which under a minor adjustment would have caused a significantly different outcome.

[107] Full quote in English: "The wind power build-out in the 1990's is an example of a policy that has been social-economically unprofitable, even when the business-economic advantages of the wind turbines industry is accounted for…. These policies should not have been enacted with the knowledge which exists today. "

5.2.5 Reflections on the DEC 2002 framing of wind power

The first assumption which is decisive for the socio-economic loss, comes from the “surplus” argument, that there was enough generating capacity in Denmark (DEC, 2002a, p. 265). This raises the issue of why wind powered electricity is the ‘surplus capacity’ and not the already built coal power capacity. This reintroduction of the *Fuel Supplement* quality is decisive to the outcome as is openly shown in the alternative calculations of the background report. This calculations show that if wind power electricity had been assumed sold at a price of 32 Oere/kWh and not only counted by a 17 oere/kWh fuel saving, the calculation would have showed a societal plus.

The second assumption is that once it is accepted that the prosthetic devices of wind power are distortive, there is no value calculated to the industry. There is then again at the end produced a black-boxed low number of 2 mn. DKK, which is largely offset by the 1.9 bn. DKK of distortive effects of the taxes that enable the wind turbine subsidies. But the logic here goes well along with the framing that the political actors of the Market-coalition used.

The third assumption to have a decisive impact is the calculation of cost of CO2 emissions. In the DEC’s main report, the benefits of mitigating CO2 Emissions are calculated in two rows , where the highest number (270 DKK) is the middle of the ExternE’s most narrow of two CO2 ranges. But the high number that the DEC lists is in reality the middle-range number of the most restrictive of the ranges in the ExternE project. If the DEC had selected either the highest number of the cautious range (388 DKK) or the middle of the broad range (602 DKK), there would have been a significantly higher benefit to displacing CO2, and had thereby a higher value of *CC Mitigation* value of wind turbines. Furthermore, the DEC does not adjust their discount rate to reflect the 2% which would match the number for the high CO2 price (270 DKK). Instead, they include a lower price on CO2 (47 DKK) and hold on to a discount rate of 6% to evaluate the cost of building wind turbines. The estimate of 47 DKK was so low that even the source author, Samuel Fankhauser, warned against using it for calculations both in the 1994 and again in 1996.

The cumulative effects of the DEC’s calculative assumptions are important because it is the fact that the DEC present 270 DKK as their highest price of CO2, which makes their argument of wind power being expensive so potent in the media. It thus reinforces the period’s beginning narrative that wind power is too expensive, although it may have some *CC Mitigation* effects. When the same report discusses the benefits of purchasing CO2 quotas on a market, it is framed that the *CC Mitigation* quality of wind power can be gained elsewhere cheaper and therefore this is not a justification for valuing wind power positively. The wind power investments can in the DEC framing be seen as an inefficient and therefore a not advisable way to mitigate climate change. This is one of the elements where the *CC Mitigation*s high positive impact quality of wind power is questioned, which is seen in other areas of the Market-coalitions framing.

The DEC categorizes wind power through the reintroduction of the *Fuel Supplement* quality, so that the value of the produced electricity only is counted through saved fuel and environmental benefits. Additionally, the DEC brings forward the notion that wind power distorts the energy market and proximate markets through the taxes that enable it. Both of these notions build on a categorization that wind power is a disturbance to an established energy system and a coherent market. But unlike the Fuel-coalition that saw wind power as both a technical grid-disturbance and a business-model disturbance, the DEC see wind power as a disturbance to growth and competition in Denmark as a whole. A very powerful narrative is created which goes something like “If wind power is not a societally economically attractive, even at the highest listed CO2 price, when will it ever be”. It plays into a long established public understanding that “wind is expensive”. The “Climate Solution” Valuation Network was highly based on the decisive positive impact of *CC Mitigation*, to justify that although *Technology Cost* might be high right now, the *CC Mitigation* benefits made investment in wind power valuable. The DEC’s valuation disassembles the positive impact of this quality, as it (on the surface) frames *CC Mitigation* as something that can be bought on a carbon market cheaper than the cost of building wind power. The DEC finishes their report with the following recommendation.

> “There should however not be kept a narrow focus on developing environmental- and energy policies, which have economic advantages, as one can overlook alternatives, which have economic costs, but nonetheless give a higher net value of society due to environmental advantages”. (DEC, 2002a, p. 268)

The segment separates itself in that it generally recommends away from the DEC’s own economic calculations and overall conclusion that they were socially-economically unprofitable and should not have been built with the knowledge society has today (DEC, 2002a, p. 263). This is an interesting way of portraying the DEC results as being purely about getting the numbers on the table and absent of political priorities. The underlying logic appears to be that a politician could want to invest in wind power from a politically motivation, while the DEC valuation is the neutral economic portrayal of the world. But the many choices of assumption of the DEC; pricing CO2 emission, disregarding all wind power jobs and exports, discounting the future at 6%, and categorizing wind power as a *Fuel Supplement*, makes their numbers political. These numbers would be discussed vividly in the following months, as will be covered next.

5.2.6 Reactions to the DEC 2002 report

The major newspapers all focused on the key point that wind power and the policies that had enabled it has been "expensive for society" and was being criticized by the government body (Pe. S. Benson & Josevski, 2002; JP, 2002a; Olsen & Hansen, 2002; Soenderriis, 2002).

Table 5: Newspaper headlines to DEC report

Date	Newssource	Headline
25.05.2002	Information	Wise men: Wind turbines have been expensive
25.05.2002	Politiken	Wise men: Wind turbines are expensive for society
25.05.2002	Jyllands-Posten	Wind power: Wise men criticize the energy policy
28.05.2002	Berlingske	Wise men: Expensive and bad environmental policy

Apart from the initial coverage, the major newspaper editorial pages were also discussing the report, and here the division of opinion was clear. The left-wing newspaper "Information" stated that the analysis may be correct, but questioned how the costs of wind power compare up to other large infrastructure investments (Saietz, 2002). Jyllands-Posten, a right-wing newspaper, was on the other hand glad to be confirmed in what they had always known to be true, namely that the wind power build-out was exclusively driven by 'faith, lies and distortions' (JP, 2002b)[108].

In the framing contest that followed, the DEC would exchange written arguments with several critics, who did not agree with their assumptions and results. The critics counted Svend Auken (Auken, 2002b), Asbjoern Bjerre, director of the wind turbine owners association (Asbjørn Bjerre, 2002), Soeren Krohn, director of the DWIA (Krohn, 2002), Christian Ege, director of the NGO, The Ecological Council, and a combined letter from Niels Meyer, now retired professor of DTU, Henrik Lund and

[108] Full quote from JP OpEd: Rotating Madness: "The landscape-polluting wind turbines that were set up during the 90's have combined resulted in a loss in the billions…Denmark's energy- and environmental policy (has) exclusively been driven by faith, lies and distortions."

Frede Hvelplund, both professors at Aalborg University (Hvelplund, Lund, & Meyer, 2003). The discussions concerned several assumptions, but what drew the most critique was the assumption that wind power was only excess energy. In this regard Asbjoern Bjerre brought up older examples of public spending, which had not been mentioned in the DEC report.

> "The economists have taken the clear political choice of considering wind power in the period of the later 1990's to be excess capacity. They themselves write that it was decisive for their results....As one will remember, the necessity of building the Northern Jutland plant and other coal-powered blocs was heavily debated (in 1992, ed.). With market-terms and privatization in sight, one (the Government and the social-democrats in 1992, ed.) chose to build excess power plant capacity to a sum of 10 bn. DKK…..The wise men could just as well have written, that the field did not pay off until the corn had been harvested". (Asbjørn Bjerre, 2002)

Asbjoern Bjerre refers to the 1992 decision to build the Nordjyllandsvaerket, the last built 410 MW coal plant in Denmark. As described earlier, there had been heavy debate about whether or not Denmark should have built the coal plant, as it would jeopardize the environmental goals set forth in Energi2000 (H. Lund, 2014). Asbjoern Bjerre argued that since none of the existing infrastructure, which DEC consider the 'non-excess' supply of power, appeared on free market terms, then it could just as easily be the coal plant, Nordjyllandsvaerket, which was a bad societal-economic decision (Asbjørn Bjerre, 2002).

To this argument, the DEC would reply that they were not trying to justify the decision to build the Nordjyllandsvaerk, but were focusing on the cost of wind power (DEC, 2002b). Since the coal plant was there first, it is not the DEC's task to calculate whether this was a good investment decision or not. Niels Meyer and the two Aalborg University academics, Frede Hvelplund and Henrik Lund, picked up on this notion and responded with a calculative comparison, explained in the following quote[109].

[109] Note that in Hvelplund, Meyer and Lunds quote, they cite a societal loss of 10 bn. DKK This is because the DEC had also calculated their way to show that the decentral heating investments were a loss-making endeavor. The reply of the academics was thus related to the full calculation and not only the part about wind power.

> “Capacity costs (of the existing coal and gas fleet, ed.) are not included, and the wisemen apparently overlook operation and maintenance costs. Hereby, the wisemen change the calculative assumptions compared to the Danish energy agency or the financial ministry, without any form of analysis as justification for this change. This way of calculating is completely essential to the wisemen’s arrival at the societal-economic loss of approximately 10 bn. DKK for wind power and decentral heating....practically all new facilities would come badly out of such a calculation…with the same assumptions the two central power plants (Nordjyllandsvaerket and Skaerbaekvaerket, ed.) would show a combined loss of roughly 13 bn. DKK”. (Hvelplund et al., 2003)

> “It can be hard to understand how the Wisemen have been able to make such fundamental mistakes, but maybe it is caused by the recent years development, where the Wisemen-institution have moved into new areas, which are far away from the expertise the institution possess…It is also a large problem, that the Wisemen-institutions prestige is so large, and press coverage of their conclusions is so comprehensive, that it is practically impossible for the Wisemen to admit to fundamental mistakes”. (Hvelplund et al., 2003)

By opening the black box of the calculations for the existing energy infrastructure, which the DEC authors had left closed throughout their calculations, Meyer, Hvelplund and Lund further warned of the implications of DEC moving into the field of energy planning and calculations. As Meyer, Hvelplund and Lund argued, the DEC 2002 report represented a fundamental break as economists from the field of public Finance, now moved into energy system calculations. These discussions went on for several months until January 2003, where the DEC authors concluded the discussion and maintained their conclusions.

> “Electricity production from wind turbines is unpredictable and varies considerably across the year. Out of concern to supply security, the system-responsible companies can therefore not account any effect-value of significance to wind turbines…It therefore seems reasonable to assume, that wind power only saves fuel costs on the central power plants. (DEC, 2003, p. 4)

> …We maintain the report’s recommendations and conclusions. We hereby consider the debate as ended as far as we are concerned, and leave it to others to take it further”(DEC, 2003, p. 7).

With this article, the half year of discussions back and forth between DEC and their critics would end. The 2002 report represents the introduction of cost-benefit analysis as a device for valuation of societal cost of wind power. The DEC's conclusions made it into the IEA's first country review report for Denmark in 2006. The DEC 2002 calculation was in connection with this highlighted as part of the proof that support policies came with 'additional costs' in the form of "interference with the competitive dynamics of the electricity market", and decreased 'market efficiency' (IEA, 2006, p. 10)[110].

The 2002 DEC report has also in recent years been cited by right-wing newspapers such as Berlingske (P. Andersen, 2012) and politicians. One recent example of the latter is head of Liberal Alliance, Anders Samuelsen, who in 2013 quoted the DEC 2002 paper as proof that the wind power investments of the 1990's were "a colossal societal waste of resources" (Samuelsen, 2013). In addition to the 2002 report, the DEC would in the years from 2008-2016, especially reiterate the part of their framing revolved around the EU ETS carbon quota Market. This became one of the most resilient arguments against wind power. I go into a further analysis of the DEC's framings of wind power in the reports from 2008-2016 in Appendix C.

5.3. NEW CALCULATIVE CENTERS ARE ESTABLISHED (2002-2004)

In addition to the Danish Economic Council (DEC) entering the scene of energy as a calculative centre, completely new calculative centers also emerged in the first few years of the Market Distortion period. The first one, "Institut for Miljøvurdering / Institute for Environmental Assessment (IMV)", would create reports specifically related to wind power shortly after its conception, whereas the second, Center for Politiske Studier / Center for Political Studies (CEPOS), took on a broader ideological scope and would not produce its first report on wind power until 2009. The conception of both centers will hereafter be covered in this chapter, while the 2009 CEPOS report will be covered in chapter 6.

5.3.1 New center established as platform for climate mitigation delay

The IMV center originates from the Fogh-government manifesto, which included an intention to establish a center to ensure environmental goals were 'reached in the most economically effective way' and that pollution was mitigated where you 'get

[110] . In this report, the IEA's own analysis concluded that Danish industry and the country as a whole benefitted from a large share of renewables which was 'a direct result of policy action'(IEA, 2006, p. 119).

most for the effort' (STM.dk, 2001). In line with the Market-coalition's stance against a "tyranny of experts' (Rasmussen, 2002), the new IMV was not required to have a professor or similar academic expert as its director (FT, 2001) . Rumours emerged that the controversial choice of Bjoern Lomborg as director for the IMV was decided early on, and the left-wing opposition parties would strongly oppose the process around this choice. This is seen in the opposition's comments to why they opposed the law which set up funding for the institute.

> "These parties (S, R, SF, ed.) share the view of the collected evidence answers, that the institute (IMV, ed.) should apply a broader approach to the field than solely an economic view… This act has been handled in a deeply unsatisfying and deeply biased manner, but this is due to a fully conscious choice from the government's side". (FT, 2001)[111]

Anders Fogh Rasmussen (AFR) had met personally with Lomborg shortly after having won the election (Dahlager & Rothenborg, 2007), and Ole P. Kristensen, Lomborg' s former political science professor, was appointed as head of the governing board responsible for choosing the director (Kjoelby, 2003; J. S. Nielsen, 2002b; Ritzau, 2003)[112]. Lomborg had in 1999 drawn significant attention for four opinion pieces in the centre-left newspaper Politiken, in which he argued that climate change problems were highly exaggerated, and that money was being wasted on mitigating it (Hoyer, 2015). The majority of Lomborg's IMV team primarily consisted of political scientists and economists, as Lomborg emphasized that the nature of the employees' professional background was not as important as their ability to argue for a given viewpoint (From, 2002b). The Market-coalition had thus by the spring of 2002 established a new calculative center, which would help establish the new framing of wind power as value-destroying. In the words of energy and climate journalist at Politiken, Jesper Tornbjerg, the new government had wanted a significant shift in how the quality of *CC Mitigation* was framed or left out completely.

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[111] The opposition parties had on their own arranged hearings with the ecological Council, DTU, Aalborg University and other climate-coalition actors, wherefrom the evidence they mention stems from. The opposition's objection had no effect on the act, which was not subject to a public hearing.

[112] Ole P. Kristensen would go on to join the board of CEPOS, a rightwing think tank, and become an editorial writer at Boersen, an influential rightwing newspaper. The only member of parliament who was part of the initial board was Anders Samuelsen (R), who 7 years later would go on to form the right-wing party Liberal Alliance.

> "From 2001 and some years onwards, the (Venstre-Conservative, ed.) government seriously questioned the issue of climate change. There were some sceptical researchers that were a lot more active. There was the whole controversy around Lomborg and Svensmark. There was a different psychological climate in Denmark". (Interview 6: Tornbjerg, Quote 1)

The IMV would over its five year lifetime publish several reports with the purpose of creating debate and shaping public understanding in comparing climate change mitigation costs to other global development issues. This work helped shape the Market Distortion Valuation Frame, as explained by environmental spokesman for Venstre, Eyvind Vesselbo.

> "The purpose of the institute (IMV, ed.) was that it should spur debate and create reports, which we could design politics from,….you should be able to demand that an institute which was created to place the topic of "most environment for the money" at center, also deliver some material, as they used to be good at". (R. B. Petersen, 2005)

The IMV was from the start designed to create devices of assembly for the new framing of environmental policies and herein wind power. The specific logic was that the environment should be protected for the minimum possible cost and only to the extent that a limited pot of money would allow. This is evident in the IMV's fifth report "Denmark's costs of reducing CO2" which calculated different approaches to meeting Denmark's 2012 commitments under the Kyoto protocol (IMV, 2002). In this report, the IMV compared an initiative of closing Denmark's electricity exports while enacting a domestic CO2 price with an alternative of constructing 5.3 GW of offshore wind power. The IMV reached the conclusion that Denmark could fulfill its Kyoto protocol ambitions by the above-described exports maneuver between 2005-2012 at a price of 1.6 bn. DKK (2002 Currency). The authors did however foresee complications with neighboring countries, so they argued that Denmark's CO2 emission reductions could also be reached by utilizing flexible CO2 quota trading (IMV, 2002, p. 49). The cost of 1.6 bn. DKK was then compared to what it would cost to solve the Kyoto commitment only by building offshore wind farms. For numbers on this, the IMV used the DEA's estimates on the five proposed offshore wind farms of the 1998 SR agreement (IMV, 2002, p. 25). In that calculation, the DEA estimated that the 750 MW offshore wind power could displace 2.1 mio. t/CO2 per year. The IMV then took this number and scaled up the investment by a factor of six to get enough offshore wind farms to displace 15 mn.

t/CO2 annually. This corresponds to a build-out of 5.3 GW of offshore wind farms at a scaled-up cost of 33 bn. DKK between 2005-2030[113]. The 8 year maneuver of closing Denmark's borders for electricity export from 2005-2012, combined with a domestic CO2 price from 2008-2012, is then compared to the total direct societal cost of having 5.3 GW of offshore wind built in 3 years (2003-2005) and operate for 25 years (IMV, 2002, p. 25; 49). The IMV admitted that the wind turbines would generate CO2 reductions far beyond the timeframe of Denmark's Kyoto commitments, but argued that it still was "fair" to disregard the later CO2 reductions and compare the two substantially different timeframes. The basis for this conclusion was that "only the total investment of 33 bn. DKK, would entail reductions in a size equivalent to the totaled shortfall' (IMV, 2002, p. 26). The IMV authors thus concluded that "it is approximately 20 times more expensive to build wind turbines than it is to stop electricity exports" (IMV, 2002, p. 25). This report would immediately go into the news cycle, as the IMV wrote a large OpEd in Jyllandsposten about the framed high subsidy cost of offshore wind turbines.

> "IMV's calculations show that if wind turbines for example should save Denmark for the same amount of CO2, that a stop to exports would do, the price would be 33 bn. DKK. Even though the wind turbines would produce power and reduce CO2 emissions over the next decades, it would nonetheless still be very expensive to construct them to live up to Kyoto in the period 2008-2012". (Lomborg & Kristoffersen, 2002)

The calculation that is explained above is an example of how the *Market Distortion* quality can impact the *CC Mitigation* quality of wind power. This is manifested through how the materiality of the power derived from the wind rotating the blades, is compared to a commodity that could be bought cheaper through emission trading certificates.

The IMV would under Lomborg's management continue to write reports like the one examined above, mainly based on external sources and focused on isolating elements of environmental policy to highlight the costs. In 2003, a group of six Scandinavian professors within economics and environmental studies assessed the IMV's first eight reports on a set of parameters, among them scientific quality. On the examined report "Denmark's cost of reducing CO2", the group of professors

[113] If this sounds unrealistic to the reader, she is correct. As the IMV's analyzed period is 2005-2012, and the 2,1 mn. ton/CO2 is when all parks are up and running at full capacity, this would require Denmark to build the parks in 2.5 years, equivalent to more than 2 GW of build-out per year. At the end of 2002, Denmarks total wind power capacity was at 2.9 GW, hereof 0.2 GW offshore wind (EnerginetDK, 2016a).

concluded that the comparison was "misleading" and presented a "very un-nuanced perspective", as the conclusions were built on the "completely unrealistic assumption" that CO2 emissions would seize to be a problem after 2012 (Hjorth-Andersen, 2003, p. 9).

Following the stark critique, Lomborg resigned as director of the IMV, but continued to be connected as a consultant. The IMV would over five years receive a total funding of more than 88 mn. DKK (93 mn. DKK in 2017-real), until a prolonged period of critique and errors (Tang & Aagaard, 2006) led to its closure (Ritzau, 2011). The 2007 financial budget split the planned IMV funding between Lomborg's newly established Copenhagen Consensus Center and the Danish economic Council, which established an "environmental economic council" branch to host the former IMV employees (Ritzau, 2006). This Copenhagen Consensus Center carried on Lomborg work and received a total funding of 49.5 mn. DKK (52 mn. DKK in 2017-Real) up to 2012 (Ritzau, 2011)[114].

The IMV reports were not used directly in any legislation, but nevertheless Lomborg used the IMV as a platform get exposure as a global speaker (Jerking, 2008)[115]. His exposure peaked in 2004, when he was listed among the world's 100 most influential people by Time Magazine (TIME, 2004), and he had continued to stay engaged as a global opinion-maker, frequently advocating against the build-out of wind power (Oreskes & Conway, 2010). This message has made him a favored voice in debates on public energy-policy for some right-wing politicians in Denmark, which will also be mentioned in Chapter 7: Subsidy Burden (2015-2017).

5.3.2 CEPOS is formed to uphold Market Distortion quality over the long-term

In addition to creating the IMV-centre, AFR would in a October 2003 parliament speech encourage private companies to fund a think-tank, which could promote liberal ideas and make it easier for him to pass liberal policies (O. B. Olesen, 2003). The two liberal newspapers, Jyllandsposten and Berlingske, would shortly thereafter reiterate AFR's encouragement in their editorial pages. Jyllandsposten called for a think-tank modelled after American examples and sponsored by organizations like Danish Industry and the Danish Employers Association. This think-tank should not engage in academic research but instead deliver 'a product, which is immediately

[114] Once a new centre-left government took office it cancelled all funding for the centre. Lomborg moved his Copenhagen Consensus Centre out of Denmark and thereafter used private donations for funding. There is little transparency over the donors, but it is known that roughly one third of the centers total reported donations in 2013 (621.057 USD) was a 200.000 USD donation from the billionaire hedge-fund manager Paul Singer's Foundation (Readfern, 2015).

[115] Steen Gade, Energy spokesman for SF: "Lomborg had significant political importance. But professionally it (the IMV's work) was a fluke". Eyvind Vesselbo, environmental spokesman Venstre: "The specific reports were never used for anything." (Jerking, 2008).

useable for politicians", and help Fogh Rasmussen fight against the "Social-democratic worldview, which lays as a heavy blanket over the public debate" (JP, 2004a). Berlingske called for an end to "a leftist orientation", which had become so "taken for granted" that it had "dulled everyone's political orientation" and led to an "amputated dialog" in society (Berlingske, 2004). In March 2004, the new think-tank CEPOS would be formed in an effort initially led by PhD-fellow in medieval political history David Gress, who a few months earlier had returned from the conservative and privately-funded American Hoover institution (O. B. Olesen, 2003). Among other notable founders were Christopher Arzrouni, former strategic advisor to AFR, and Peter Kurrild-Klitgaard, economist and Mont Pelerin Society member (Kronsted, 2004b). CEPOS would list conservative American think-tanks such as American Enterprise Institute, Heritage Foundation and the Cato Institute as an inspiration for "Important laboratories for developing new ideas", and would initiate a fund-raising campaign (Elbjørn, 2004). They were very quickly denied by Danish Industry and the Danish Employers Association, who supported the idea, but would not sponsor it (Kronsted, 2004a). But seven months would pass and when CEPOS called for their first annual gathering in October 2004, they had suddenly raised 15 mn. DKK (18 mn. DKK in Real-2017). CEPOS would not disclose their donors, but highlighted that it was primarily from privately owned "beneficiary foundations" (Busch, 2004), which according to CEPOS ensured that they would not be "in anyone's pocket" (Rose, 2004). A new calculative center was born and in the next period, we will see how CEPOS specifically targeted wind power in a 2009 report on the *Market Distortion* effect of wind's prosthetic devices.

5.4. THE INDUSTRY CONSOLIDATES DURING POLITICAL STANDSTILL (2004-2006)

Once the Climate Solution valuation network had been destabilized and the domestic market had come to a stand-still, the wind turbine industry turned its focus abroad. There was however a short re-opening of wind power build-out plans in 2004, as the utilities pushed the government to negotiate a broad agreement on the electricity market. This would see a revival to some of the formerly cancelled offshore wind power farms.

5.4.1 The political compromise of 2004

The first years of the Market Distortion period was a time where new calculative centers were established and little new legislation was made. But in 2004, DEF and ELSAM had begun to put pressure on the Fogh-government to solve two specific issues that followed after the 1999 liberalization of the electricity market. The first issue was a request for full access to a part of the companies' equity, which since the 1999 liberalization was not accessible. In the 1999 liberalization agreement, certain parts of the utilities equity was designated as "bound", and should be used to lower electricity taxes for consumers (Tingkær, 2012). The municipalities and shareholders of the various utilities wanted access to the equity, which by 2004 amounted to a total of 20 bn. DKK (Tornbjerg, 2004).

The second issue revolved specifically around ELSAM, the largest utility-coalition in Denmark, owner of 36% of Danish electricity production and 49% of district heating (DR, 2004). Elsam was planning to buy a majority share in the large electricity seller NESA for 10.5 bn. DKK, an illegal move since 1999 as a utility provider was not allowed to own a seller (I. H. Andersen, 2004; Bjerge & Kaufholz, 2004)[116].

The left-wing opposition, led by Socialdemokratiet and Radikale Venstre, knew that the government had to include them in an agreement as they were part of the original broad political agreement in 1999. These remaining Climate-coalition actors demanded that some of the cancelled offshore wind capacity was restored in the form of three new offshore wind farms, as well as a kick-start to the onshore wind build-out (Pihl-Andersen, 2004)[117]. The Market-Coalition did somewhat recognize that the wind turbine technology had evolved (Ritzau, 2004), but worried that new offshore wind farms would be too heavily subsidized, and would prefer to wait until offshore wind could be built on market terms (Pihl-Andersen, 2004). In March 2004, the negotiations were close to a complete breakdown and Venstre's energy spokesman, Kim Andersen threatened that if no deal was reached, then "energy would no longer be a theme in this election cycle" (Tornbjerg, 2004). A compromise was reached on the 29th of March 2004. The Market-coalition secured the necessary votes to solve the two above-mentioned issues, and the Climate-coalition got plans for two 200 MW offshore wind farms, assigned to the sites Horns Rev 2 and Omoe, and a repowering subsidy scheme aimed for a net increase of 175 MW onshore wind (Bjerge & Kaufholz, 2004)[118].

The agreement is likely among the most difficult to land in the history of Danish energy policy, and consisted of three separate agreements. Svend Auken led the negotiations for Socialdemokratiet, and noted that although the VK-government had

[116] The deal would also give ELSAM a 36% share in E2 Energi, a large utility in Eastern Denmark, thereby creating a monopoly-like position in the Danish electricity market.

[117] SocialDemokratiet and Radikale Venstre were not happy about releasing the equity in the utilities, as they feared it would be used for areas outside of energy. Additionally, they feared the monopoly-position that ELSAM could gain from buying NESA.

[118] Notable other mentions of the agreement is a decision to liberalise the decentral heat-power plants, so that they would only receive a fixed subsidy (grundbeloebet) and therefrom would operate on the NordPool market when it came to electricity (Sandoe, 2004b). The agreement also saw common ground on the creation of a state grid operator, EnerginetDK, which would own the transmissionlines, to ensure they never came off Danish hands(I. H. Andersen, 2004).

not mentioned "environment" once in the final 12-page energy agreement, the opposition had managed to secure some wind build-out (I. H. Andersen, 2004)[119]. CEO of Elsam, Peter Hoestgaard Jensen, was pleased with the liberalization part of the agreement, but criticized the decision to build more wind power stating that "this is not the way to get more environment for the money" (I. H. Andersen, 2004). Economics and Business minister, Bendt Bendtsen ensured his critics that the money spent on wind power, would be saved on the liberalization, and that he had no further plans "to make more deals, which costs the consumers money" (Sandoe, 2004a). The Fogh-government also had to make a separate agreement exclusively between themselves and the Danish People's party, giving the right-wing supporting party veto-right to block any further increases in PSO-costs during the next 10 years (Sandoe, 2004d). This veto right did however only apply to the sitting VK government and was nullified with the 2012 energy agreement.

5.4.2 Market-coalition try to maintain unity as material build-out goes into complete standstill

The 2004 agreement was clearly a difficult political compromise on both sides of the isle, and did not significantly change the Market-coalitions dominant framing of wind power. The planned onshore build-out stayed flat in the coming years, as only 4 out of 16 regions designated suitable build-out areas within the deadline. In November 2004, half a year after the regions should have designated areas, the newly appointed Conservative minister of Environment, Connie Hedegaard, was tasked with the uphill battle of getting the regions to comply. Although she would call the regions in for a "friendly conversation" on the importance of building wind power, she could not guarantee that the areas would be designated. Hedegaard was, unlike her predecessor Lundholt, motivated towards solving the stalled local build-out (H. Munksgaard, 2004), but she was unable to coerce the regions to comply. Combined with the still very uncertain framework conditions, the onshore wind power build-out remained at a stand-still for years to come.

The year 2005 would see the first small signs that not all actors in the Market-coalition still agreed on the framings of wind power. Venstre's environmental spokesman, Eyvind Vesselbo, would in May 2005 attempt to justify the government's dramatic 2002 cuts as a necessary move away from a "far too religious" environmental policy. Vesselbo reminded the journalist that Venstre had

[119] Although it may appear as a victory for the Climate-Coalition actors that they got two offshore wind farms negotiated into the deal, the final agreement this was a small part of the total agreement. The far-left party Enhedslisten decided to abstain from the move to liberalize the energy sector further, and was therefore left outside of the whole agreement. On the other far side of the political spectrum, the Danish Peoples Party was so adamantly against the build-out of wind power that they only voted for the liberalization sub-part of the agreement (Sandoe, 2004c).

roots as a farmer's party, and that the environment had not historically been a core value of theirs. But he now believed to have experienced a "more and more open attitude to wind-turbines" in the population and even in Venstre' s political base (Rehling, 2005). But despite Vesselbo's experiences, the government did not change policy. In July 2005, a government energy strategy for 2025 was published which only contained the already agreed build-out from 2004, combined with an ambition to phase out renewable subsidies (DKGOV, 2005)[120]. Flemming Hansen, Conservative Minister of Transportation and Energy, defended the plan by arguing that "we are not running a planned economy, we let the market decide"[121] (J. S. Nielsen, 2006a). The right-wing newspaper Berlingske would continue to cite the DEC 2002 report as documentation that wind power caused societal losses due to the *Market Distortion* quality (B, 2005). Minister of taxation, Kristian Jensen (V), would also echo the DEC's praise of quota markets (K. Jensen, 2005). In a 2005 Op-ed, he would voice his suspicion towards the "planners and bureaucrats" who tried to "save the world" with wind power investments, as seen below.

> "In a planned economy, reality must submit to the plan…Those who can get their hands on the states' revenue thinks this is good policy. There is thus many who have an interest in a (energy, ed.) plan....Planners and bureaucrats in the state and in the semi-public "rest-in-themselves" companies are ensured occupation and career. The fact that many stand to gain something on a plan, is not necessarily an endorsement. On the contrary, it is ordinary citizens and companies that lose much more than the proponents of the plan gain….The government is with the new strategy and tax-stop particularly active in the fight for the ordinary citizens and companies' interests. That is achieved by saying no to those, who temptingly state that they can save the world through a 'targeted', 'ambitious', 'progressive' public plan-regulation". (K. Jensen, 2005)

The description of "planners and bureaucrats" draws parallels to AFR's 2002 speech about "taste-judges" and implies the notion that if these people were not arguing

[120] The 2005 Energy plan also came with a task to re-evaluate the possible offshore sites that were identified in the 1997 survey of the seabed to identify where the two agreed 200 MW offshore wind farms should be. Horns Rev 2 was ok, but local inhabitants had voiced concerns that the Omoe location might endanger wildlife or buried cultural sites. The survey would end up delaying the construction of both offshore wind farms and one of the farms, Roedsand 2, would not have its tender decided until 2007 (Ritzau, 2007c). Apart from the two wind farms agreed in 2004, the 2005 Energy Plan stated that any future offshore wind power should only be built at the pace of the energy-system.

[121] In the same interview, Flemming Hansen ridiculed a recently published energy plan from Radikale Venstre, which looked towards 2050, stating that it was "embarrassing", that Radikale Venstre thought they could predict what the future energy system would look like.

about externalities and market failures, there would be a ‘natural’ result produced by the energy market. Kristian Jensen also frames some citizens as the “ordinary citizens and companies”, who would suffer from the value-destroying investments in market-distorting subsidies. He thus implicitly argues that he would prefer to have no plan, instead of risking that “reality must submit to the plan”.

It was the highly salient *Market Distortion* quality which held together the dominant frame of this period. The *Aesthetics* quality was also present but mainly confined to the editorial pages of newspapers Berlingske and JP. They would describe how wind turbines cause “aesthetic” and “physical” pollution through their size, and through claims of low-frequent noise and flashing sunlight annoyances (B, 2005; JP, 2004b). Together with these two newspapers, the political actors of the Market-coalition were, apart from outliers like Eyvind Vesselbo and Connie Hedegaard, still strongly assembled around the framing of wind power as a value-destroying distortion of markets. But the actors who had been at the boundary of the Market-coalition were Danish Energy (Formerly DEF) and their utility members. They were undergoing a larger consolidation in these years and would begin to break away from the Market-coalition’s framing of wind power.

5.4.3 Industry consolidation creates Danish offshore wind power-house

While politicians and media railed against wind power’s distortive effects at the home market, the wind power industry had focused on developing export markets, and was towards 2005-2006 growing its exports considerably. The manufacturers were consolidating, as suppliers NEG MICON and Vestas merged (Godske, 2004) merged in 2004 while the third large manufacturer, Bonus Energy, was bought by German industrial giant Siemens AG shortly thereafter (Holm, 2004).

In addition to growing a consolidated and stronger *Industrial* footprint the turbine manufacturers would also gain an important ally. In March 2006, the EU commission approved the merger of DONG, Elsam, E2, NESA, Københavns Energi and Frederiksberg Forsyning to form the utility giant of DONG Energy (DR, 2006). This would give the industry a strong voice led by Anders Eldrup, long-time head of department at the influential Ministry of Finance that Svend Auken had collaborated with during the Nyrup-administration in the 1990’s. But although Eldup had worked with Svend Auken in the 1990’s, he was not only focused on *CC Mitigation*, as he considered *Energy Independence* to be as salient a quality. This is seen in the following 2006 statement from Eldrup.

> "We are facing two considerable problems – a climate problem, which is larger than in any other European country and an energy supply security problem in connection with the transition from being an energy exporter to becoming an energy importer…If we can utilize the strong competences we have in the area of energy, we have the opportunity to solve the challenges of the Danish energy supply and contribute to solving the climate problems simultaneously. It requires large resources for research and transition. It requires cooperation between energy companies, knowledge institutions and the public sector." (Eldrup, 2006)

The new DONG Energy was a company, which had a unique knowledge-base on offshore wind power compared to its global competitors. There were opportunities going forward, but the new large industrial actor did not share the assuredness that there was no room for coal, which had defined the Climate-coalition. To Anders Eldrup, there was still some way to go in terms of *Technology Cost* and integration, as seen in the below two quotes from January 2007.

> "We need to do a lot more about renewable Energy, but it cannot cover our needs in the foreseeable future and therefore needs 'a partner': coal…the perfect partnership, as I see it". (Ritzau, 2007a)
>
> "Wind power cannot solve the energy problem in the foreseeable future because wind power is too unstable and perhaps too expensive". (Stenvei, 2007)

Although Dong Energy was a global powerhouse within offshore wind power competences, it owned major coal assets in Denmark. So there was a new coalition forming which included a larger group of actors, wherein some of them still operated coal. However, the *Industrial* potential of offshore wind power was growing and this was also leading to a change in valuation devices. The first sign of this change was a small calculation that Danish Energy ordered from the consultancy EA Energy-Analysis in 2006. The task was to make an LCOE comparison of build-out options for Denmark. Danish Energy wanted to highlight what costs would look like for 10 different energy sources Denmark could build in 2015. The newsletter, in which Danish Energy published the results, would refer to wind power as a generic source, but the costs that had been calculated were on new offshore wind farms, with the word "offshore" only occurring in the graph that compared the sources (Energi-Agenda, 2006). In the background report that EA Energy Analysis delivered to Dansk Energi, the consultants explained that offshore wind had been chosen, as it “was expected to have the greatest build-out potential in Denmark (EA, 2006, p. 48)”[122]. Onshore wind was at this point in time considered such an unlikely build-out option, that it was absent in a comparative calculation on the various energy sources.

The Climate-coalition’s device of LCOE was returning, but it appeared that the new framing would be slightly different than in the 1990’s. The utilities were starting to actively frame wind power as valuable, although they left out onshore wind. But although these new actors did not see a future without fossil fuels as clearly as the Climate-coalition had done, there was an international momentum gathering around the urgency of solving the climate crisis. These many new developments would usher in the Global Advantage frame that would slowly come to form from 2007 and onwards. But before we move on to this period, I will summarize the Market Distortion valuation frame and the valuation network that upheld it for the five years from 2002-2006.

5.5. MARKET DISTORTION: VALUATION FRAME SUMMARY

In this section, I summarize the third period of the analysis, Market Distortion. I describe two new qualities that influenced the framing of wind power during the period before providing an overview of the new dominant valuation frame. I conclude this section by mapping changes in the valuation networks and discussing key takeaways regarding this period.

5.5.1 Two New Qualities: Subsidy Burden and Market Distortion

Two connected, yet distinct societal qualities emerged during the Market Distortion period. Whereas the *Subsidy Burden* quality reflects general concerns about subsidy costs and their impacts on society, the *Market Distortion* quality embeds wind power valuation in a complex calculation of lost value due to certain beliefs about how markets work. This is one of the more peculiar qualities as it interferes with the value ascribed to other qualities (e.g., *CC Mitigation, Industrial*).

[122] The EA Energy-analysis report found that offshore wind had costs in the range of 40 Oere/kWh and that if onshore wind had been calculated it would probably be around 35 Oere/kWh (EA, 2006, p. 48). They calculated a 200 MW wind farm in 2015 to see *Technology Cost* reduction of 10 oere/kWh by 2015, and a system integration cost of 7-8 Oere kWh. In comparison, a 1000 MW nuclear was estimated as having 3 oere/KWh system integration costs and Gas and coal were estimated as having no integration costs (EA, 2006, p. 46) .

Subsidy Burden (Societal)

The *Subsidy Burden* quality refers to the costs incurred by companies and citizens who pay the taxes that fund wind power subsidies. These investments to support wind power are collected through taxes such as the CO2 tax, Electricity tax and the PSO-tax. This quality refers to the investments paid out through subsidies or grid connections costs covered by the state. This does not include alleged indirect distortion costs of prosthetic devices, which are covered by the *Market Distortion* quality. A further calculation of direct subsidy costs and societal investments in wind power can be found in Appendix A4.

Market Distortion (Societal)

The *Market Distortion* quality is the negative value of the prosthetic devices that enable wind power. The calculation is based on a perceived equilibrium state in which all necessary technologies would emerge from the "free market" if government did not intervene. As such, all interventions (i.e., both taxes and subsidies) can be argued to distort the market. This causes a socio-economic loss relative to "what could have been" if those prosthetic devices had not existed.

5.5.2 The Market Distortion Valuation Frame

The valuation frame that emerged in 2002 reflected a perspective that was almost the complete opposite of the perspective reflected in the Climate Solution valuation frame. The shift shown in figure 24 (GBA), marks the most abrupt moment of valuation of the analysis.

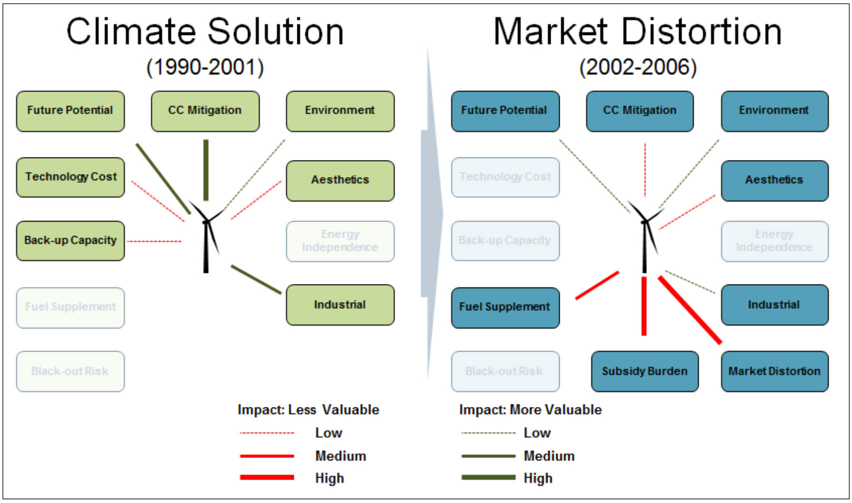

Figure 24: The second (CS: 1990-2001) and third (MD: 2002-2006) Valuation Frame.

The year 2002 marked a distinctive shift in the dominant valuation frame for wind power. The Climate Solution Valuation Frame saw wind power as indispensably valuable based the high positive impacts of the *CC Mitigation* and to a lesser degree *Future Potential* and *Industrial* qualities.

Wind Power is not framed as valuable based on a high impact from the CC Mitigation quality

The most dramatic change was the decrease in the value of the *CC Mitigation* quality from a high positive impact to a low positive and even slightly negative impact. First, the focus on climate change and the link between energy and environmental matters was disassembled. Mentions of climate change were consciously eliminated from government documents and communications, while councils and advisory bodies related to climate change and the environment were downsized as much as possible. The environmental ministry became part of the ministry dealing with food and agriculture, while the transportation ministry assumed responsibility for matters involving energy. Both the DEC and the newly established IMV argued that more *CC Mitigation* could be achieved by trading carbon offsets on the market than by expanding wind power capacity. This framing was made possible by a very selective set of calculations to commensurate the damage costs of CO2 emissions. Once this framing was applied, expanding wind power capacity appeared less cost-effective, and the strong positive impact of *CC*

Mitigation on value weakened significantly, even to a slightly negative impact at times. It was still recognized that wind turbines could mitigate climate change, but since building them was more expensive than carbon quota trading, capacity expansion was framed as an expensive an inefficient way to mitigate climate change. Wind power was therefore no longer framed as valuable through its ability to mitigate climate change through emission-free electricity. The *Market Distortion* quality thus changes the *CC Mitigation* quality, as it becomes implied that the market could deliver better mitigation solutions. Wind power build-out can in this framing carry a risk as exemplified by Minister for Taxation, Kristian Jensen's statement that too many subsidies carried the risk that "planners and bureaucrats" pushed for market-distorting solutions to climate change.

Wind Power Once Again Measured as a Supplement

The DEC and IMV calculations also heralded a new era in which assessments of the value of wind power related not to *Technology Cost*, but to subsidy costs. The DEC report revived the old notion that the electricity from wind power has no effective value; due to overcapacity in the 1990s, the DEC only counted the value of saved fuel. Although wind power penetration grew significantly during this period, the *Fuel Supplement* quality was reintroduced into the valuation frame. The DEC's responses to critiques reveal how they viewed existing coal plants (even the recently built Nordjyllandsvaerket) to be part of the black-boxed infrastructure. The DEC did not consider the plant to be a supplementary energy source, and thus did not apply the same metrics it used for wind power to assess its construction costs and value. The individual *Technology Cost* or *Back-up Capacity* cost for wind power was not calculated in this framing, as it had been in the 1990s, since the entire wind power fleet was considered supplementary. For the entire 5-year period it was neither the *CC Mitigation* quality or the individual *Technology Cost* of wind turbines determined their societal value.

Wind Power Framed as a Burden to Society and a Distortion of Free Markets

Instead, wind power was judged by the impacts of the subsidy and tax devices that enabled its existence in the energy system. These impacts were directly calculated through the *Subsidy Burden* quality. Direct and indirect subsidies were calculated and evaluated in both the DEC and IMV reports, and Economics and Business Minister Bendtsen expressed that he was "deeply worried" about subsidy costs hurting Danish competitiveness. Likewise, in the early 2000s, Prime Minister Fogh Rasmussen alluded to wind power subsidies with expressions such as "the money is blowing out of the state coffers." The industrial association Danish Industry welcomed subsidy cuts, as the benefits of lower tax payments outweighed the benefits of the capacity expansion and research activities the taxes were funding.

More complicated than rising subsidies enabled by industry-burdening taxes was the other new quality, *Market Distortion*. According to the DEC's calculation, prosthetic devices, such as the PSO tax and the CO2 tax, were not only burdensome, but actually distorted general growth more than other taxes. Additionally, the jobs that were created in the wind industry sector were framed as jobs that would have been created in other sectors if wind power infrastructure had not been built. This notion that the wind industry is an unnatural and thereby distortive creation was echoed by leading politicians during the period. Examples of this include Minister of Economics and Business, Bendt Bendtsen, who in 2002 labeled the expansion of wind power capacity "unhealthy" and "artificially driven." Likewise, in 2005, Minister for Taxation, Kristian Jensen, compared Danish wind power expansion plans to a "planned economy, (where) reality submits to the plan" which causes "ordinary citizens and companies" to "lose much more" than "planners and bureaucrats" stand to gain. Inherent in the *Market Distortion* quality is the expressed notion that someone in society gains by placing a large distortive burden on the majority of citizens and companies.

The Market Distortion valuation frame was built around the highly negative impact of these two qualities, thereby construing the goals of the wind turbine industry and societal interests to be contradictory. In addition to changing the value of *CC Mitigation* by injecting the notion that CO2 emissions should more effectively be traded in a carbon markets, the *Market Distortion* quality diminished the value of the industry quality, and thus the *Future Potential* quality.

Industrial Benefits and Future Potential fade to the background

According to the DEC, the potential small industrial benefit of wind power in the form of exports was outweighed by the negative distortive impact of the devices enabling wind power, thereby creating a context in which the industry was artificially created. Impacts for the *Industrial* and *Future Potential* qualities were valued in a context wherein the objects embodying them (i.e., wind turbines) cause societal losses. *Industrial* benefits and increased potential were recognized, but simultaneously calculated to have emerged at the expense of growth that would have "naturally" occurred in other industries.

Aesthetics still present but with limited impact

The impact of the *Aesthetics* quality is continually bolstered by the editorial pages of the Jyllandsposten and Berlingske newspapers. Nevertheless, the stagnation in build-out is not so much due to the regions not appointing possible sites, as it is to the uncertainty surrounding the future framework conditions. *Aesthetics* thus had a small negative impact on the overall valuation of wind power but was not decisive or highly impactful to the developments.

5.5.3 The Market Distortion Valuation Network

In this section, I map the new dominant market coalition and analyze their impact on the materiality of the valuation network.

Market-coalition Injects Politics of Drift

The market-coalition was comprised of members of the two governing parties, Venstre and De Konservative, and new calculative centers that either created or entered the field of wind power valuation, the DEC and the IMV. They framed wind power through the *Subsidy Burden* and *Market Distortion* qualities to spark debate over whether or not Denmark could afford to build wind power capacity in light of other non-energy budget priorities. From a climate change mitigation perspective, wind power was judged as equivalent to buying CO2 offsets on a market. Actual CO2 emission reductions were expected to occur somehow, regardless of whether wind turbines were built in Denmark. Although wind turbines reduce CO2 emissions, the coalition anticipated that similar CO2 reductions could be bought less expensively on the market in the form of carbon offsets. The focus of attention was whether Denmark was paying too high a price by allowing value-destroying wind power subsidies and taxes to distort its growth potential. Once this notion was established, a large number of non-energy related investments became comparable to wind power, and the Technology Cost quality disappeared from the framing. The actors that formed the Market-coalition in opposition to wind power were a group of economists and politicians, as energy policy discussions extended to a forum of non-energy experts.

The market-coalition focused on subsidy costs to both state and private stakeholders. The strong negative impacts of the *Subsidy Burden* and *Market Distortion* qualities outweighed the small positive impacts of the *Industrial* quality. This coalition thus diverged from the view that a strong domestic wind industry has a fairly high positive impact, which up until that point had been an assembling device for the

Fuel-, Unique- and Climate-coalitions. The wind turbine industry and the utilities involved with wind power, however, remained active on export markets and continued to grow during this period. Green is the dispersed Climate-coalition, while the Blue is the new dominant Market-coalition.

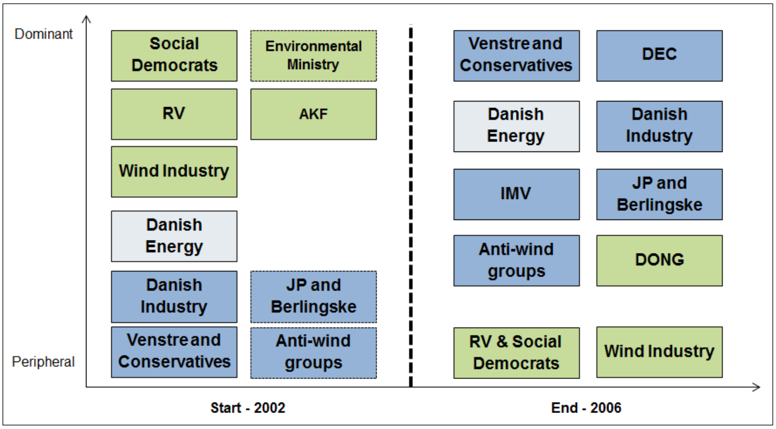

Figure 25: Key actors during the MD period; green: Climate-coalition; blue: Market-coalition.

There were two notable shifts among key actors during the period: De Konservative began to soften its stance towards wind power as Connie Hedegaard took over the Ministry of Environment in 2004, and secondly the formation of DONG energy creatds a new strong actor.

Materiality during the Market Distortion Period

Having grown nearly tenfold during the previous decade, onshore wind power build-out came to a near-complete halt between 2002 and 2006, and only two of the original five offshore wind farms approved in 1998 were built. It is also worth noting that exports and employees increased significantly from 2005 to 2006, as foreign markets began to invest heavily in wind power. This is one of the early developments that laid the foundation for change in the next period. All numbers in figure 26 (GBA) are available in Appendix A.

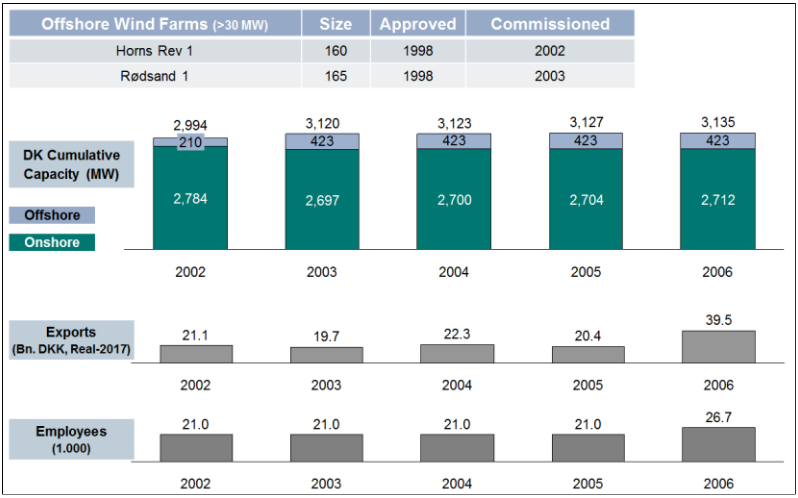

Figure 26: Capacity expansion during the Market Distortion period.

There was not much legislation during this period. As the 1999 liberalization act had been forced to include a failing green certificate scheme for wind power subsidies onshore wind had stalled and the Market-coalition decided not to act. It was not until the government needed a larger scope transformation of the electricity market in 2004 that the opposition managed to negotiate some changes into the onshore subsidies. This was not sufficient to kick-start the market, but two of the canceled offshore wind farm projects were reinstated. This process was severely delayed, and the offshore wind farms were not built until the next period.

5.5.4 Key Takeaways from the Market Distortion Period

Between 2002 and 2006, a new coalition enacted a highly critical framing of wind power by focusing on the costs of the subsidies and taxes that supported capacity expansion. The specific *Technology Cost* of wind turbines faded from the public debate and the framing of wind power's value focused on the societal costs of subsidies and taxes. Once again, wind power was framed as a supplemental energy source within a functioning system of coal and gas plants, reflecting the perspective animated in the Fuel-coalition's reports published between the 1960s and the 1980s. In their 2002 report which documented a loss from building wind turbines, the DEC framed the value of wind-power electricity to only equal the cost of fuel for existing conventional power plants. The DEC thus re-embraced the original logic of the

Fuel-coalitions first report in 1962, when the value of electricity generated by wind turbines was evaluated relative to fuel costs for the original steam power plants.

The Market Distortion valuation frame stood in stark contrast to the previous Climate Solution frame, and in the mid-2000s. As much as the Climate Solution valuation network dominated during the mid- to late-1990s, the Market Distortion valuation network and its corresponding calculative centers dominated the five years between 2002 and 2006. But as shown at the end of this chapter, growth and consolidation were underway in the wind industry by the end of this period. The Market Distortion valuation frame began to destabilize after 2006 and a new broad coalition would form its own new valuation network. In the next chapter, I explain how these new actors formed a near-consensus agreement about a new valuation frame that was built on the future envisioned in the 1990s.

6. WIND AS A GLOBAL ADVANTAGE ON CLIMATE, INDEPENDENCE AND JOBS

A strong consolidated wind power industry and a growing world market were starting to show at the end of the Market Distortion period. This development would become central to the Danish valuation struggle of wind power as international climate negotiations and growing export markets became harder and harder to ignore. This would bring salience to the *Industrial* quality as Denmark was a central player in what was projected to become a large market for wind power.

6.1. OFFSHORE WIND IS MADE VALUABLE AGAIN (2007-2011)

The period starts with the emergence of new actor Connie Hedegaard and her increased mandate, which came from a changed perception of wind power within an already powerful actor in the Market-coalition, the Danish Prime Minister Anders Fogh Rasmussen. These two actors are central in some of the changes that lead to a new valuation of wind power.

6.1.1 Hedegaard re-ignites climate change mitigation salience

Connie Hedegaard was one of the major transformative forces in De Konservative and is a central actor in the shift to a new valuation frame. Fogh Rasmussen appointed her to Minister of Environment in 2004 to strengthen the governments green profile after some tough years. Hedegaard had previously been a member of parliament for De Konservative from 1984 to 1990[123], and had between 1990 and 2004 been writing for newspaper Berlingske, the Danish Public Broadcast station DR1, and centre-left newspaper Politiken. Hedegaard was well-versed within climate change matters, through her journalistic work (Dahlager & Rothenborg, 2007, p. 106;110), and had developed a personal friendship with Thomas Becker, a former energy advisor to Svend Auken (Meilstrup, 2010, p. 123). Becker was, similar to Svend Auken, a strong advocate for wind power[124], and followed

[123] She left in protest over the De Konservative's line in the Tamil-case (FT.dk, 2010; Meilstrup, 2010, p. 33).
[124] Becker would later go on to become the head of the European Wind Energy Association (EWEA) from 2012-2015 (DWIA, 2015a).

Hedegaard into the Ministry of *Environment* and later into the Ministry of Climate and Energy (Dahlager & Rothenborg, 2007, p. 106),.

As minister of the Environment, Connie Hedegaard was highly involved in the fight against climate change, although the energy department was initially still a sub-department under the Ministry of Transportation, limiting her influence. One area where Hedegaard had an impact was in attending the COP-meetings for Denmark, and in arranging a 2005 pre-COP12 trip for 25 Environmental Ministers to the arctic (Rothenborg, 2005). Hedegaard and Becker turned their focus on growing Denmark's influence in international climate negotiations while advocating for Denmark to host a major climate summit. In March 2006, Fogh gave Hedegaard approval to pursue the ambitious plan at an informal Government workshop talk (Meilstrup, 2010, pp. 32–33), and one year later, she and Fogh could jointly announced that the 15th UN Conference of Parties Summit (COP15) would come to Copenhagen in 2009 (Keiding, 2007)[125]. As was seen during the Market Distortion period, Hedegaard faced some difficulties in exercising her mandate in Denmark[126]. She knew this and would attempt to leverage the international attention in domestic issues. A few days after the COP15 announcement, Hedegaard met with five mayors to ensure that locations were found for new wind turbine test sites. After the meeting Hedegaard emphasized that the whole world was coming to Denmark for the COP15, and that "Denmark is completely in the lead on wind power, and we need to stay there" (P. Andersen, 2007a).

The positive results would pay off and following the 2007 re-election of the Fogh-government, Connie Hedegaard was appointed as minister of climate and energy, but was to the disappointment to her and the opposition not allowed to have transportation or environment under her ministry. Observers at the time argued that this was because both a large segment of Venstre's parliamentary group, as well as supporting party DF, saw Hedegaard almost as a clone of Svend Auken, and worried that she would become too powerful (Meilstrup, 2010, p. 34,37; Rothenborg &

[125] The announcement immediately revealed tensions inside the government, as reports emerged, that the Financial Ministry, headed by Lars Loekke Rasmussen, pushed for the 200-300 mn. estimated costs of COP15 to be taken from the environmental ministry's budget (Keiding, 2007). The whole COP15 project ended up costing 1 bn. DKK (Meilstrup, 2010, p. 19). Hedegaard's achievement had caused great admiration among the opposition lead by Svend Auken and Martin Lidegaard, wherein the former declared their willingness to help Hedegaard find the funding for the COP19 meeting separately (Keiding, 2007). Although the funds were not taken from the environmental budget the Financial ministry would however end up deciding that part of funds for the meeting would be taken from the foreign aid budget (Information, 2008).

[126] As will be seen, Hedegaard achieved impressive results on the stage of the international climate negotiations, but the many members in Venstre and DF, who disagreed with her would make it hard to create large national results (P. Andersen, 2007d). During the time Hedegaard was minister (2004-2010), Denmark's coal-use and CO_2 emissions increased, while the growth in share of renewables mainly came from increased biomass-burning (Vogt-Nielsen, 2010).

Mygind, 2007)[127]. These actors still held on to the Market Distortion valuation frame of wind power and their concerns about Hedegaard's potential influence were well-founded. She would play an important role in destabilizing the Market Distortion valuation network, as she moved her party out of the Market-coalition, and brought international attention on climate change to Denmark's door-step. Her success on the international stage had not gone unnoticed and another important actor would also change his position in these years. Anders Fogh Rasmussen, who had been central in establishing the Market Distortion Valuation frame, would also come to reject it and support something new.

6.1.2 Anders Fogh Rasmussen's sudden green transition

There have been many speculations as to the factors that caused Prime Minister Anders Fogh Rasmussen (AFR) to have a sudden turnaround on green energy. The most commonly described is the large pressure for action, rising from an increased salience of the *CC Mitigation* quality. The VK-government faced increasing criticism for its cuts to energy research from leading businesses in Denmark, and the opposition parties tried to expose AFR's inactions, by presenting their fully developed proposals for energy plans at the start of this period (J. S. Nielsen, 2006d)[128]. There was indeed a large international momentum around *CC Mitigation*, as exemplified through such publications as the Stern Report (2006), the IPCC's fourth Report (2007), Al Gore's documentary "An Inconvenient Truth" (2006), and other governments' actions, such as Sweden's declaration to be oil-free (Dahlager & Rothenborg, 2007, p. 114; J. S. Nielsen, 2006b).

One of the less covered factors in AFR's transition was a renewed focus on *Energy Independence*. AFR would shortly after the Danish Cartoon Crisis state he found it "quite nice that we were not dependent on oil from the middle-east" (Dahlager & Rothenborg, 2007, p. 128). In a 2018 retrospective interview on his whole transformation, AFR again named this crisis as "decisive" for his green awakening. Hedegaard did play a central role in this process, but she also argued to AFR that an international Climate Summit was just the type of international event of high prestige, that could make the world forget the 2005-2006 Danish Cartoon crisis, which at the time still hurt Danish exports (Dahlager & Rothenborg, 2007, p.

[127] The feud over Climate Change mitigation efforts had grown between the administrations of the financial ministry and the environmental ministry, since Thor Pedersen had significantly downsized the environmental ministry in the 2002-2003 years. In one seasoned observers view, the remaining environmental civil servants saw the financial ministry as cynical, while the financial ministry servants considered their environmental colleagues to be "idealistic, soft and removed from reality" (Meilstrup, 2010, p. 64).

[128] Socialdemokratiet had proposed to reduce energy consumption by 28% towards 2025. Of the remaining energy demand 50% should be covered by renewable energy. This should be achieved by a build-out of 3 GW offshore wind and 1 GW onshore wind towards 2025 (J. S. Nielsen, 2006e).

119,127; Meilstrup, 2010, p. 19). The *Energy Independence* quality was in AFR's judgment something that made it easier for other Venstre party members to accept his political turn (Oeyen, 2018).

The third contributing factor was the immense business opportunity that was emerging in the global wind power market. While wind power build-out had been at a standstill during Fogh Rasmussen's first five years in office (Appendix A), global wind capacity had tripled from 24 to 74 GW (GWEC, 2018). Wind power was thus expanding together with growing global energy consumption. During a visit to the U.S. in June 2006, AFR was proud to tell President Bush about Denmark's previous achievements in the energy sector, as the U.S. president was worried about the U.S.'s increasing dependence on foreign fuels (Dahlager & Rothenborg, 2007, p. 123). Three days after the meeting with Bush, AFR visited Stanford University and a student asked AFR how Denmark had achieved a high BNP-growth while holding energy consumption flat. After a short pause, the prime minister answered that it had come through "a mix of government-investments and taxes, I'm sorry to say", recognizing that Denmark's unique energy system, and position of low dependence on foreign fossil fuels had not emerged from market forces alone (Dahlager & Rothenborg, 2007, p. 129). Denmark was in a good position to capitalize on this growing demand for wind power solutions, as the newly merged DONG Energy represented the largest portfolio of offshore wind power experience in the world (F. Petersen & Thorndal, 2014, p. 119).

The first time AFR would mention his newly found green ambitions in a major speech was at a September 2006 meeting for Venstre. Without mentioning specifics, AFR stated that being "independent of fossil fuels" was a long-term goal, and stated that Denmark had a good position to build out renewable energy (J. S. Nielsen, 2006c). AFR would however make sure to outline that his "type of environmentalism" was much more focused on keeping costs down and therefore different from the opposition.

> "The most ambitious goal is that we shall be completely independent of fossil fuels….But it is important that we do it in a way which is also economically profitable. We must be sure that investments happen where we get the most environment and energy for the money. The goal for the modern environmental-liberalism is better environment and renewable energy. We say no to environmental-socialism, which strangles initiative and entrepreneurship". (J. S. Nielsen, 2006d)

AFR had to fight hard internally with his own party as well as the supporting party DF. As can be seen from the above quote, he was not specific in the first mentions of this new direction and kept a strong focus on independence of fossil fuels. Additionally, he made sure to highlight an, unspecified, ideological difference between his approach and Svend Auken's approach. AFR was faced with questions about the sharp contrast between what he said today, and the actions of the last 5 years. This was understandable, as it was less than two years earlier that AFR jokingly had compared modern scientific concerns about climate change to concerns about a coming ice age in the 1600's (Dahlager & Rothenborg, 2007, p. 126)[129]. At the 2008 Venstre national meeting, he would address this discrepancy in what would become known as AFR's "green" speech.

> "I have for a long time belonged to those who were in doubt about climate change….and that was maybe wrong. Because if I am completely honest, there are probably many of us, which have been a bit cautious, if not too say been dragging our feet,…We have not been the energy-political avant-garde". (Fogh, 2008)

There is a clear and self-acknowledged turn here from AFR and his political party. Along with this newfound acknowledgement of the need to mitigate Climate Change, a change in AFR's framing of wind power would follow. But AFR knew that *CC Mitigation* was still a contested quality within his own party Venstre, and went on to emphasize the quality of *Energy Independence* as a strong motivation for building renewable energy.

> "But we have to acknowledge, that it may be that in 20 years' time, we are no longer self-sufficient and thereby no longer free and independent, as we are today. It is therefore today that we should take the first steps to secure, that we within that period have built alternative energy sources, so that we are still free and independent when 20 years have passed….The choice must never be between oil and freedom of speech. We must strengthen the free world by weakening the dependence on oil and gas. We must increase our security by lowering the transfer to those that threaten our freedom…. I can tell you that exactly in that period during the beginning of 2006, I was deeply, deeply thankful that we in Denmark had lead an energy policy, which meant that we did not have to buy oil in the Middle-east at that time. That is what this is about". (Fogh, 2008)

[129] Fogh Rasmussen's comment was at a voters meeting up to the 2005 election at Holstebro Commercial College on the 28th of January: "In the 1600's people thought that we were facing a new ice age. If you spend every day believing that a flood will happen, you can look forward to a sad existence for many years to come" (Dahlager & Rothenborg, 2007, p. 126).

AFR dedicated significant time to the geopolitical aspects of energy and coupled wind power to freedom of speech, through its ability to lower oil and gas imports and thereby achieve energy security. He particularly emphasized the 2006 Danish Cartoon Crisis, and how seeing "Danish embassies on fire, burning of the Danish flag" as well as target shooting after picture of him, had made a "large impression" and considerably contributed to his new attention to *Energy Independence* (Fogh, 2008). This speech confirms the reports that the Danish Cartoon crisis played a role in bringing salience to the quality of *Energy Independence*, and creating the moment where AFR started seeing the future as green (Lehmann, 2008). While the quality of *Energy Independence* clearly occupied his agenda, it has been harder to discern how much the quality of *CC Mitigation* was salient to him. In later reports from the state ministry's civil servants, speechwriters noted that the grandiosity of the COP15 summit excited AFR, but that the civil servants "painted Anders Fogh Rasmussen green" by writing a speech which he would then passionately deliver (Meilstrup, 2010, p. 133). AFR has not occupied himself with *CC Mitigation* matters since his time as Prime Minister, but has since been involved in geopolitics related to *Energy Independence*, most recently in opposing the proposed Russian-German gas pipeline Nord-Stream 2 (Just & Tang, 2017).

As Connie Hedegaard gained control of both the domain of environment and energy from 2007, while having secured the COP15 for Copenhagen, there was a renewed view of wind power emerging. AFR was aware of the emerging focus on the world stage and the advantage of the growing wind industry which created exports and jobs. But his renewed green focus was also born out of a salient *Energy Independence* quality, as he had seen the middle-eastern oil states burning Danish flags during the Danish Cartoon crisis. Following this momentum, Connie Hedegaard was given the mandate to negotiate a new energy agreement, which will be covered next.

6.1.3 Contested 2007 Energy Plan leads to 2008 Agreement (2007-2008)

The change of valuation would lead to the first signs of action in 2007, as Horns Rev 2, one of the two parks in the 2004 agreement that had been delayed (DKGOV, 2007), was approved for construction. This year would also see the government launch a proposed energy plan in the form of a 7 page note. The energy plan had a goal of minimum 30% energy from renewable sources in 2025, and 100% at an unspecified point in the future (Dahlager & Rothenborg, 2007, p. 134). There were few specifics in the plan but energy-research was to be doubled over three years to reach 1 bn. DKK in 2010, with a focus on wind power, low-energy buildings and alternative fuels in transportation (Boddum, 2007). The Governments energy plan was immediately challenged by the EU commission, who labelled it "insufficient", as the plan lacked transparency about how Denmark would meet their CO2 reduction commitments (Ritzau, 2007b)[130]. Meanwhile at home, the opposition called the Government's plan unambitious in comparison to their 2006 plans, one being the Socialdemokratiet plan of 50% renewable energy in 2025 (J. S. Nielsen, 2006e). Socialdemokratiet had its assumptions calculated and validated by the Danish Engineering Association (IDA) and energy experts at Aalborg University (P. Andersen, 2007c). These research communities, who had several ties to the old Climate-coalition, were reluctant to calling the VK governments seven-page note "a plan", but instead awaited more details (J. S. Nielsen, 2007). The plan was slightly better received among Danish Industry who welcomed that energy research was back on the agenda, but who also highlighted that the goal of 30 % energy from renewables would need further investments (Pol, 2007). Connie Hedegaard would spend the remainder of the year struggling with reluctant Venstre-politicians and the supporting party DF. She pushed for a greener direction, while forced to defend an energy plan that was less specific than she would have wanted. An example of this was seen in a 2007 election debate, wherein Hedegaard stated that she wanted Denmark to be free of oil, coal and gas in 2075. Although the opposition argued that this was way too far in the future compared to what was needed, it was a goal which was not mentioned in the Government's official published energy-plan (P. Andersen, 2007c). But her struggles in the Ministry of Environment would end after the 2007 election, as she secured higher negotiating power in the Ministry of Climate and Energy. She would utilize this power to complete a 2008 energy-agreement only three months into her new position (J. S. Nielsen, 2008a).

The 2008 energy agreement included a re-tendering of the delayed 200 MW Roedsand 2 offshore wind farm, which was agreed in 2004 and originated as one of the original five from 1998 (DKGOV, 2008b, p. 10). The subsidy level agreed in 2004 had not been able to attract investors, so the wind farm was now to be built under new conditions by 2011 at the latest (Ritzau, 2007c). But although Hedegaard and her own party De Konservative aimed for a high build-out of wind power, the Market-coalition was still strongly represented in the larger government party, Venstre[131]. So when the VK government announced its first proposal for a new

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[130] One of the fights was over a request from the Danish government, for a compensation of 25 mn. tons worth of CO2 quotas in the period of 2008-2012. This request was due to the fact that Denmark's base-year, 1990, was a very rainy year, and had meant that Denmark had imported large degrees of hydro-generated electricity from Norway and Sweden. Since hydro-energy is generated in the dams and mountain reservoirs it is carbon-free and as such the government argued that compensation was warranted, since as Denmark had unusually low CO2 emissions in its base-year. After months of negotiation, the Danish Government had to settle for a compensation of 5 mn. tons of CO2 quotas, a fifth of its initial demand (Ritzau, 2007b).

[131] The VK-Government would also control very carefully how much momentum was building for wind power. In 2006, the VK government ordered a report about future energy system build-out options by EA Energy Analysis and researchers at the Risoe test-center. The report lay ready in the spring of 2007 with the conclusion that a favorable scenario was to expand wind power to supply 70% of Denmark's energy use in 2050, and that the transportation sector should be electrified early on to accommodate this expansion (Djursing, 2008). This report was hidden from public view for

energy agreement, it contained no plans for further wind power build-out, but instead new subsidies for biomass and biogas (P. Andersen, 2007b). Only after the opposition parties and various energy academics pushed back on the lack of ambition, a revised energy proposal was released 20 days later. The proposal now included a proposal for new offshore wind capacity and Conservative energy spokesman, Per Ørum Jørgensen, stated that the government with the revised proposal had "stretched to meet the demands of the opposition to a very high degree" (P. F. Larsen, 2007).

The revised proposal would be negotiated into the 2008 agreement which included a tender for another two 200 MW offshore wind farms, which would later become the 400 MW Anholt offshore wind farm. The deal also included a re-introduction of 25 oere/kWh subsidy for onshore wind turbines, and a scrap-and-reuse scheme to facilitate replacement of aging turbines (DKGOV, 2008b, p. 2,3)[132]. The 2008 agreement also delivered an increase in onshore wind subsidies to kick-start the stalled onshore build-out, while the 600 MW offshore wind power pipeline, of which 207 MW were already underway from the previous 2004 agreement, created some future visibility for the offshore wind industry. These 207 MW was the Roedsand 2 offshore wind farm, which probably has one of the longest journeys from conception to completion in Denmark. It had been agreed in 2004, as the compensation for the cuts to the original 1998 build-out plan of five parks. But after several more delays, the farm was commissioned by 2010. Figure 27 shows the installation of one of the 90 SWT-2.3 MW turbines at the offshore wind farm (Source: SGRE).

more than a year, and did not surface until the 2008 energy agreement was in its final stage of negotiations.

[132] In addition to the wind power measures, the agreement also included a 50% increase in biomass subsidy-levels for decentral power plants, new subsidies for biogas use and an aim to double annual energy research funding to 1 bn. DKK by 2010 . The VK Government and its right-wing supporting parties would also agree on a side-agreement which allowed two centralized power plants to increase their coal use (DKGOV, 2008a).

Figure 27: Installation of Roedsand 2 offshore wind farm (2010).

As can be seen the necessary supply chain to install and erect these power plants at sea was going through a necessary expansion, and with two offshore wind farms in planning following the 2008 agreement (Roedsand 2 and Anholt) and the Horns Rev 2 ready for inauguration, Denmark was prepared to welcome the many delegations for COP15. In September 2009, two months before COP15, new Danish Prime Minister Lars Loekke Rasmussen[133], would cut the ribbon on the Horns Rev 2 wind farm, signaling Denmark's dedication to wind power. Despite the change of leadership in Venstre, the public displays of the newly found faith of wind power persisted.

[133] AFR had in April 2009 left the leadership to then-Vice Prime Minister Lars Loekke Rasmussen, to become General Secretary of Nato. Lars Loekke Rasmussen had until 2009 not publicly mentioned climate change by a word in any Op-Ed pieces, interviews or the two biographies about him (Meilstrup, 2010, p. 21).

6.1.4 COP15 brings salience to CC Mitigation

Several factors contributed to the renewed investments in offshore wind, but the COP15 is likely to have had some impact to bring attention to what Denmark as a host-country was doing for the climate. The exposure related to the COP15 was not only beneficial for the wind turbine industry, but also several of Denmark's other large companies such as Novo Nordisk, Danfoss, Grundfos and Novozymes, who were working on enhancing sustainability in their business models (Meilstrup, 2010, p. 103). The tourism sector also gained from the exposure, as it made close to 400 mn. DKK in this record-high exposure event for Copenhagen. This served to bring salience to the *Industrial* quality of wind power investments, as fields outside the energy sector now also benefited from Denmark's pioneering position on wind power. The tourism organization Wonderful Copenhagen called for even more conferences on ecology and wind power, while a Danish Industry spokesman proclaimed a "very positive effect" for companies who dealt with lowering CO2 (Hussain, 2009).

The heavy industrial conglomerates would also be represented by such actors as Peter Löescher, the CEO of Siemens AG, parent company of Siemens Wind Power, who underlined that "climate policy is economic policy" (B. H. Sørensen, 2009). So although the COP15 in many ways was regarded as a failure with regards to the watered down climate commitments (Meilstrup, 2010, p. 248), it did create a *CC Mitigation* salience and a pressure for action from the private sector in Denmark (M. Lund, 2009). The foreign actors, the UN International Panel on Climate Change (IPCC) and the UN Conference of Parties (COP) organization, had by publishing the large IPCC AR report in 2007, and holding the COP15 convention in Copenhagen two years after, enacted a strong salience on *CC Mitigation*. However, the emerging Valuation framing was not as primarily driven by an aim to achieve *CC Mitigation* as the 1990's Climate Solution valuation frame was, but also by a high positive impact on the quality *Industrial*. This was due to the high global salience of the *CC Mitigation* quality, which also saw the coalition forming around a new framing to include more actors, some of them brought in by a global export potential. The Climate-Coalition actors were still pushing hard for the *CC Mitigation* salience, but they now had industrial actors joining them as well as the political party De Konservative. This new broad coalition will due to its focus be named the Global-coalition.

6.1.5 Market-coalition actors fight to resist destabilization

Although the contours of a new valuation frame were starting to show, there were still Market-coalition actors who fought to maintain the existing Market Distortion framing of wind power. Below are two examples of such reports, one from the right-wing think-tank CEPOS and the other from the main agricultural lobby-organization

Landbrug og Fødevarer / The Danish Agriculture & Food Council (L&F). Together with the L&F report is also a short coverage of the internal struggles in the government majority party Venstre.

American fossil fuel interests fund CEPOS report critical of wind power (2009)

The new-found salience around the *CC Mitigation* and *Industrial* qualities of wind power would not only come from international venues, it would also draw critique from foreign actors. One of these actors would work through the right-wing think tank CEPOS, who in 2009 would publish their first calculation on wind power. In the days up to the Horns Rev 2 inauguration, CEPOS would present a calculation indicating that each family sent the equivalent of 2400 DKK out of Denmark in subsidized exported wind powered electricity ever year. CEPOS claimed that Denmark exported more than 50% of the wind power it generated (CEPOS, 2009, p. 2), and concluded from that calculation that it was a “senseless act to continue a violently expensive build-out of wind power in Denmark” (Ritzau, 2009). The CEPOS director would in another interview state that the Danish energy system required “completely stable electricity production because of our electric appliances”, and therefore argued that Denmark’s investments in wind power build-out was comparable to “driving at 180 km an hour over a bridge that is not built to the other end yet” (Børsen, 2009), and would spark TV-headlines such as “Wind-turbines waste money” (Ritzau, 2009).

Shortly after gaining media coverage, the report came under heavy critique among others from Energinet, the public Transmission Systems Operator (K. B. Andersen, 2010a). But the largest critique would come from a report, which was accompanied by a larger energy-plan, which will be covered in chapter 6.1.6. The CEPOS report would be discredited completely in 2010, as it was discovered that it had been ordered and payed for by the fossil fuel-sponsored U.S. think tank “Institute for Energy Research” (K. B. Andersen, 2010a).

Agricultural lobby argues that wind turbines are too subsidized

Another actor which until then had been confined to a proximate field to the energy discussion was the main agricultural lobby-organization in Denmark, Landbrug og Fødevarer / The Danish Agriculture and Food Council (L&F). The group represents Danish farmers as well as the meat and dairy industry, and would in September 2010 publish a report titled “Energy with Growth” (EL, 2010). The report used the newly announced strike-price subsidy of 105 oere/kWh for the planned Anholt offshore wind farm as a point of reference to draw focus to the *Subsidy Burden* quality of wind power. The report concluded that agricultural producers would pay an additional 837 mn. DKK in energy taxes from 2013-2020 (Dyrskjøt, 2010), and claimed that a subsidy investment in biomass and biogas would create 8500 permanent jobs, while offshore wind farms only created “temporary jobs” and variable electricity output at a very high cost (EL, 2010). The report recommended that politicians stopped all plans for offshore wind farms until 2025 and instead invested heavily in biomass and biogas, (Borsen, 2010), which L&F labelled “the most important piece of the renewable energy supply” (EL, 2010).

The proposed ramp-up of biomass for energy production was criticized by one of the academic actors from the old Climate-coalition, Klaus Illum. He argued that there was not enough land to both produce massive amounts of agriculture and biomass for energy production (Soerensen, 2010). Another researcher, who would co-author the upcoming from the CEESA (Coherent Energy and Environmental System Analysis) group report, Professor Henrik Wenzel, expanded this critique to a global scale, stating that there was “far from enough biomass in the future” to bet on it to solely decarbonize the energy sector (K. B. Andersen, 2010b). As such the lines were being drawn. On one side were the remaining Market-coalition actors, who framed biomass and biogas as the future renewable energy sources. On the other side was the newly forming Global-coalition which encompassed both Climate-coalition actors and some defectors from the Market-coalition such as De Konservative and Danish Industry.

The ongoing disassembling of the Market-coalition was most apparent in the governing party Venstre during 2008-2010. While the leadership of the VK-government was cutting ribbons to Horns Rev 2, and rushing to get the plans for the prestige project Anholt ready (Østergaard, 2010), other actors were downplaying wind power on the internal lines. As previously described, the 400 MW Anholt offshore wind farm had not been proposed by Venstre, but was negotiated in by the opposition, while Horns Rev 2 and Roedsand 2 were given as compensation to the opposition in 2004. Energy spokesman for Venstre at the time, Lars Christian Lilleholt, was among the key actors who disagreed with the new direction (Loevkvist, 2016). In the same week Prime minister Lars Loekke Rasmussen opened Horns Rev 2, Lilleholt clarified that it was still Venstre’s policy to phase out wind power subsidies as soon as the 2008 agreement expired in 2011 (Stenvei, 2009a, 2009b). Onshore wind build-out was still impeded by local opposition, and Lilleholt had actively blocked planned wind-turbines in his home-municipality (C. L. Madsen, 2009).

The 2010 L&F report had responded particularly well with Lilleholt’s ambitions, as he had argued strongly for biomass and biogas to be a mandated new focus for energy build-out (P. Andersen, 2008). Lilleholt would in 2009 play a leading role in developing a strategy for the Venstre parliamentary group, which called for a tripling of biogas-plants (Tang, 2009)[134]. There were other opponents to the direction set in motion by Connie Hedegaard and Anders Fogh, but Lilleholt is worth highlighting as he exemplifies the dilemma in Venstre. The Market-Coalition wing of Venstre saw biomass and biogas as the future for renewables and fought against the focus on wind power. But the market-coalition would face further destabilization in the coming years, as the Global-coalition formed new and powerful calculative centers.

6.1.6 Global-coalition contest the framings of the Market-Coalition actors

Two new large calculative centers would emerge within the Global-coalition, in the same period as the market-coalition argued against wind power's value as a societal investment.

CEESA research group and IDA Energy Plan shows wind power can be backbone of energy system (2010)

A cross-university research group called "Coherent Energy and Environmental System Analysis (CEESA)" would only five months after the previously mentioned CEPOS publication launch a comprehensive reply. The CEESA group consisted of a broad collection of academics and analysts with varying ties to the climate-coalition such as Henrik Lund (AAU), Poul Erik Morthorst (DTU), Frede Hvelplund (AAU), Jesper Munksgaard (Pöyry), Peter Karnøe (CBS), Hans Henrik Lindboe (EA), Brian Vad Mathiesen (AAU), Henrik Wenzel (SDU) and several others. The credibility of the 35 page report was strengthened by the CEESA groups close collaboration with the Danish Engineering Society (IDA) (CEESA, 2010b)[135]. The report argued that only a small degree of Danish wind power electricity was exported during the year

[134] Lilleholt also referred to RV's communicated goals of 50% CO2 reductions by 2020 for "stupid and irresponsible" and concurred with the DEC 2002 report point that there would be no point in Denmark doing more for *CC Mitigation* than other EU countries, due to the CO2 quota market (Lilleholt, 2007).

[135] Several members of the CEESA group collaborated with the Danish Society of Engineers (IDA), to perform the calculations for a comprehensive energy plan, a document called "the IDA Climate Plan 2050" (IDA, 2009). The plan was aimed at pursuing four goals towards 2050; reduce Denmark's CO2 emissions 90% from 1990-levels by 2050, maintain Denmark's energy self-sufficiency, develop Denmark's commercial position within climate and energy-related business sectors, and finally to develop the Danish economy and affluence in general (IDA, 2009, p. 7). The IDA plan saw wind power as the backbone of the energy system, with an envisioned 2050 capacity of 9.1 GW, split evenly between onshore and offshore (IDA, 2009, p. 32), but as the four goals showed the wind turbines were not chosen only because of their *CC Mitigation* effects. Expectations for a more than 250% increase of wind turbines exports by 2030 were set out in the report, as two of the four goals were related to Denmark's commercial position in energy, and its general economy and affluence respectively (IDA, 2009, p. 16).

at a loss during the year, and that the technological circumstances to integrate a 50% share of wind power was already in place in 2010 (CEESA, 2010a, p. 6). This dispute between CEPOS and CEESA opened the discussion about how much wind power could be integrated in the future grid (Wittrup, 2010b).

The discussion would see the Danish TSO Energinet take a more active role in developing future scenarios and communicate about possible technical pathways. Energinet released a statement comparing the two reports wherein it concluded that the CEESA report was built on a "well-founded understanding of the Danish energy system", while the CEPOS report's assumptions and results were found to be "not serious" (Wittrup, 2010a). The CEESA group would go on to publish its larger main report in November 2011 (CEESA, 2011), which would serve as sparring material for international researchers such as Stanford scholar Marc Jacobson's Solutions project. At home it would go on to serve as inspiration for a later 2014 report on energy costs from the Danish Energy Agency. The Global-coalition drew strongly from the same notion of the Climate Solution Valuation Frame. A combination of technology cost comparisons and future pathways for build-out. This would also be the key theme in another large report from that period, the 2010 Climate Commission publication.

Climate Commission frames wind power as key to fossil fuel independence (2010)

Connie Hedegaard had in March 2008 established "The Danish Commission on Climate Change" known as The Climate Commission, to explore how Denmark could become independent of fossil fuels (Keiding, 2008)[136]. The Climate Commission would work closely with Danish Energy Agency and the consultancy EA Energy-analysis (EA, 2010), to complete their report "Green Energy – the road towards a Danish energy system without fossil fuels" in September 2010.

The project was headed by Katherine Richardson, Professor in Biological Oceanography at Copenhagen University and included Poul Erik Morthorst (Professor at DTU, who also worked on the AKF and CEESA reports) in addition to eight other researchers, international commissioners and energy professionals (Klimakommissionen, 2010, p. 17). One central task that the climate commission took on itself was to actually define what "fossil independent" should mean. Anders Fogh had mentioned it in his speeches, but he had never put a deadline on the goal

[136] The Climate Commission was first mentioned in the VK 2007 Government Manifesto, wherein it was written that a commission should be set down to explore how Denmark could become independent of fossil fuels in the future (Klimakommissionen, 2010, p. 18).

or defined at what point a country was "independent" of fossil fuels[137]. The Commission therefore took it upon itself to define fossil independent as follows:

> "No fossil energy is used in Denmark and domestic production of electricity based on renewable energy must on annual average basis correspond to the Danish consumption". (Klimakommissionen, 2010, p. 18)

The Commission underlined that their plan would correspond to bringing Denmark's fossil fuel share of 80% in 2008 down to 0% by 2050 (Klimakommissionen, 2010, p. 18). The climate commission concluded that it was realistic to reach fossil independence by 2050 with the technologies available today and technically possible to make the energy and heating sector fossil independent already by 2030 (Klimakommissionen, 2010, p. 20)[138]. The commission said that it may be a cost which seems "surprisingly low" to the reader, but explained that because energy imports would disappear if the plan was followed, the total budget costs for the energy system would be lower than today (Klimakommissionen, 2010, p. 8). The proposed strategy consisted of a strong focus on energy efficiency and on sourcing energy from renewables, where offshore wind was singled out as the future backbone of the energy system.

> "The energy system should in a large scale transition base itself on electricity, which primarily should come from offshore wind turbines. Further energy should come from biomass...and other forms of renewable energy such as geothermal and solar heating". (Klimakommissionen, 2010, p. 28)

[137] Until then it had been referred to by Anders Fogh Rasmussen in his speeches, and in Venstre published Energy plan from 2007. It was also mentioned in the Government manifesto from November 2007. However it was never specified what it would mean that Denmark should be "Independent of Fossil Fuels". Even two years after the initial mention, Anders Fogh Rasmussen had still not put forward a deadline or any milestones to get there (Mahfelt, 2008).

[138] The Commission even went as far as saying that Denmark "in principle " could transition away from fossil fuels "already tomorrow", if enough fierce restrictions on fossil fuels were enacted. This would however stop society, so a gradual transition was judged to be preferable. Although that theoretical proposition was not feasible, it underlined the Commissions point that the speed of the transition was determined by political will and not be technical limitations (Klimakommissionen, 2010, p. 21).

Wind power was now again framed as the primary future energy source, at a time where other options such as geothermal and solar were still considered to be further down the road options[139]. The Commission set a range of installed wind power to be between 10 to 18.5 GW by 2050, depending on how the energy system would develop (Klimakommissionen, 2010, p. 32). *Energy Independence* understood as long-term energy supply security is a central focus of the report and is frequently discussed throughout the entire document (Klimakommissionen, 2010, p. 3,4,8,13,14,18,20,38). In addition, the authors of the report would highlight the *Industrial* benefits of pursuing a fossil-independent society, or as one of the authors phrased it in an interview, "lots of gold on the street, just waiting to be picked up" (Mahfelt, 2010).

The report was positively received as a bipartisan plan that was thoroughly researched (Stenvei, 2010c). The head of the green think-tank Concito, Martin Lidegaard, especially emphasized that the commission have had five economists and the report was not just written by "environmental hippies". He called the commission's report "a convincing plan for a fossil-free society", which should appeal to both sides of the political spectrum (From, 2010). Lidegaard also supported the commission's focus on offshore wind power and stated that it was "completely unrealistic" to make Denmark fossil independent without wind power, which he considered the low-carbon energy source closest to commercialization (K. B. Andersen, 2010c). Danish Energy, also lauded the report as a sign of "a historic unity" in Danish energy policy (Springborg, 2010) and agreed with both the proposed investments in offshore wind and biomass (TWC, 2010). Danish Industry was positive towards the proposals but cautioned that too high energy taxes could move jobs overseas (Stenvei, 2010a). The agricultural organization L&F stayed quiet about the offshore wind element, and instead applauded the investment recommendation for biomass and biogas (Stenvei, 2010c), which was still a contested topic. The only openly critical actor was the VK-governments supporting party, Dansk Folkeparti / The Danish People's Party (DF), who said that the energy taxes which enabled wind power would ultimately "kill" Danish businesses (Stenvei, 2010a). DF compared the newly announced Anholt offshore wind farm's subsidy level of 105 oere/kWh with the current electricity spot price of 36 oere/KWh to argue that offshore wind investments were an "economic slap in the face". DF claimed the commission was a group of biased "so-called experts", whose proposal for more offshore wind could only be supported if the majority of the onshore wind was removed, so that it no longer "bothered" the Danish citizens (S. Petersen, 2010).

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[139] An interesting point for the historians is that the report mentions solar heating, and does not consider solar PV as a viable large-scale option. This goes to show how fast the cost reductions on this solar PV happened as it went from being a non-option to one of the most promising renewable energy sources for the future. At the time the 2010 report was written there was less than 10 MW solar PV installed in Denmark. This figure had grown to 850 MW by 2017 (Lillevang, 2017).

6.1.7 Flawed auction design causes high price of Anholt Wind farm

In the previous sub-chapter, the Anholt wind farm has come up a few times. This is because the strike price agreed in 2010 would become a highly critical point of reference for several old Market-coalition actors. It is therefore worth to relay the process around how this strike price level came to be set. In April 2010, it became clear that the auction for the 400 MW Anholt offshore wind farm had only seen one bidder, Dong Energy. Other potential bidders such as Swedish utility Vattenfall had stated that the bidding conditions were not good enough, due to a very tight project-schedule with heavy fines in the event of delays (Holm & Wittrup, 2010a). Without competition, Dong Energy thus won the project at the high strike price of 105 oere/KWh, and committed to deliver first power by the end of 2012. Socialdemokratiet, Radikale Venstre and the Socialistisk Folkeparti / Socialistic Peoples Party (SF) were critical about the VK government's auction-design, and the resulting high price. They feared that the high price could give the perception that offshore wind power was significantly more expensive than it would have been if project timelines and related fines had not been so strict. But Minister of Climate and Energy Lykke Friis (V) insisted that this was the price, and that focus should be on the fact that "the project could be realized" (Holm & Wittrup, 2010b). After an examination from the Danish Energy Agency and a validation report from external consultants Ernst and Young, it was concluded that the price was not unusually high when the strict conditions were taken into consideration. They furthermore noted that developers at that time could alternatively spend their efforts on bidding for projects with feed-in tariffs in the UK (Wittrup, 2010d).

Among Anholt's most unlikely defenders was energy spokesman for Venstre Lars Christian Lilleholt, who pointed to the Ernst and Young validation as proof that "it has been estimated that the price is reasonable for the project" (Wittrup, 2010c). When faced with critique over the decision, Lilleholt responded that "it does not come for free" to become "free of fossil fuels, reduce CO2 and make us independent of energy supplies from politically unstable areas" (Stenvei, 2010b). Lilleholt would emphasize the *Subsidy Burden* that Venstre took on itself and stated that "it costs a lot of money to secure the energy supply and improve the climate, but Venstre is willing to pay that price" (Skouboe, 2010). But although the focus was on seeing the project through, Lykke Friis would a year later recognize that the short deadlines and the high fines in the auction design, had indeed caused the Anholt offshore wind farm to be more expensive than needed (T. Jensen, 2011).

6.1.8 Political Parties disagree on definitions (2011)

In 2010-2011 the government was preparing for a new energy agreement, wherein *Energy Independence* would be a key element. But the government had the Danish Energy Agency perform an individual assessment of Danish supply security, wherein they would cite the DEA work to put their main focus on "supply security" defined as "having energy-services available at competitive prices" (DEA, 2010, p. 2; DKGOV, 2011a, p. 13). This differed from the Climate Commission's definition of *Energy Independence* which was "having access to the energy sources, which are necessary to fulfill the needs of society" (Klimakommissionen, 2010, p. 14). Now the VK government did not speak of *Energy Independence* as Anders Fogh Rasmussen had in 2008, but instead spoke of a supply security goal with an element of "competitive prices" in it. This term also included more options to what an energy system independent of fossil fuels could entail, as seen in the VK government 2011 vision report "Energy strategy 2050".

> "The government's goal can be summarized as a Green-House-Gas (GHG) neutral energy sector, which uses 100 % renewable energy or a combination of renewable energy and coal/biomass with CCS (Carbon Capture and storage)...With regards to the transportation-sector, the goal is also a renewable energy based transportation sector, but here we are dependent on the international technology-development, and are therefore forced to adjust our level of ambition to the future technical and economic realities". (DKGOV, 2011a, p. 9)

Independence from fossil fuels was thus defined as something that could possibly be an energy mix with coal plants included. This illustrates further that although there was a high salience of the quality of *Energy Independence*, the VK government defined an energy independent society as still including coal-plants and something which should feature "competitive prices", without defining what such prices are benchmarked against.

This was a way to get negotiations on the way for the broad energy agreement that should set the framework for energy policy between 2012 and 2020. The VK government recognized wind power as the renewable energy source with "the largest physical potential", which "in principle could cover Denmark's electricity use multiple times over". However, due to land-restriction concerns, the VK government foresaw that offshore wind would "probably" come to have a central role in the future energy system (DKGOV, 2011a, p. 18).

The energy-plan also included concrete goals to build the 600 MW Kriegers Flak offshore wind farm as a joint project with Germany and Sweden, 400 MW of near-shore turbines, and a number of test-site improvements (DKGOV, 2011a, p. 32). These planned build-outs would bring the share of electricity from wind power in 2020 up to 40% (DKGOV, 2011a, p. 47). The VK government's 2011 energy strategy was thus historically ambitious for a right-wing government, but it still had a high focus on the quality *Subsidy Burden*.

> "There is no point in pursuing energy and climate policy at the expense of businesses and Danish jobs….With the governments' strategy, a balance is created between the concern for competitiveness and the need for a fair distribution of the burdens of the transition". (DKGOV, 2011a, p. 57)

The above quote illustrates how energy and climate policy is subordinated to competitiveness concerns for some groups of Danish businesses. The *Subsidy Burden* quality is also salient as the green transition is framed as a counterweight that must be balanced against "concerns for competitiveness", and a "burden" that must be distributed. It was especially the long-term goals which separated the framings of the VK-government's energy plan and the one proposed by the opposition. There was a general agreement of which direction was to be taken, but the opposition's energy plan had less of a focus on the *Subsidy Burden* quality and focused on the long-term goal of being free of fossil fuels. This framing is seen in the left-wing opposition's shared energy plan, "KlimaDanmark 2050", which had been published in May 2010.

> "Our goal is to make Denmark's energy supply completely free of fossil fuels before 2050. The electricity and heating sector is made independent of coal, oil and gas already by 2035, while we expect that it will take up to 15 additional years for the transportation sector" (SDP, 2010, p. 3)

The opposition cited the IPPC, the 2006 Stern report, and the Danish Engineering union (IDA)'s "Energiplan 2050", which was heavily influenced by the CEESA work, as sources for the feasibility of their ambitious goals. Those goals included a requirement for all new energy investments to be sustainable, a goal to get 50% of Danish electricity from wind power by 2020, and a phase-out of coal power by 2030 (SDP, 2010, p. 5). On the long-term, the opposition sought to change the flexibility of the electricity system so that "wind can become the largest source of energy - also for transportation" (SDP, 2010, p. 3). The reasoning for the ambitious plans was laid out as three main points. The first reason was global responsibility to mitigate climate change, the second was the aim to decrease fossil fuel imports and third, becoming a global pioneer in wind power (SDP, 2010, p. 4).

Nonetheless, these years were defined by a consensus forming about the direction of the Danish energy system, and the central role for wind power. This historically broad consensus came after a general push from various actors in the energy industry. The powerful utility actor, Danish Energy pointed to the many energy-plans as proof that there was unity for action, but that ‘now we would like to see action’. This call would be echoed by the spokesman for the association of decentral heat-plants (mainly gas-powered), Dansk Fjernvarme, who would express frustration over the fact that there was ‘fairly large agreement in the energy sector on where Denmark should go, but the politicians make no long-term decisions’ (J. S. Nielsen, 2010). Despite the call for action from many private Global-coalition actors, it was not possible for Hedegaard’s successor, Lykke Friis (V), to gather the political parties around an agreement in 2011. In September, a new left-wing coalition government of Socialdemokratiet, Radikale Venstre and the supporting party Socialistisk Folkeparti / Socialistic Peoples Party (SF) formed a new government. Martin Lidegaard, Member of Parliament for Radikale Venstre and the former head of the green think tank Concito would become the new Minister of Climate, Energy and Buildings.

6.2. NEW GOVERNMENT INCREASE CC MITIGATION SALIENCE (2012-2014)

This sub-chapter starts off with a short introduction of the new energy minister Martin Lidegaard and the 2012 energy agreement, which he would steer the negotiations for. Then follows some general concerns about the costs of the energy agreement in the following years. The sub-chapter ends with the passing of a 2014-law, wherein De Konservative join the left-wing parties to establish the Climate Council.

6.2.1 A New Energy Minister lands historic agreement

The new actor in charge of energy was Martin Lidegaard from the party Radikale Venstre. He was a communications-professional by education, who had worked six years as head of communications in the Danish anti-poverty NGO Mellemfolkeligt Samvirke / MS Action Aid. Lidegaard had been energy and climate spokesman for Radikale Venstre from 2001 to 2007, where he left politics to found and head the climate think tank Concito from 2008 to 2011 (FT.dk, 2017c)[140]. Lidegaard had

[140] Lidegaard had by colleagues on both sides of the isle been described as a well-liked, detail-oriented and competent politician on matters related to energy and climate. Despite the fact that some colleagues considered him ideologically invested in the climate change mitigation cause, Lidegaard was apt at formulating himself in “direct quotable phrases”, and thereby able to keep the attention of people who felt less strongly about the cause (N. T. Dahl, 2011).

during the early 2000's worked with Svend Auken to bring back the ambitious energy plans which defined the 1980's and 1990's, of which he considered the 1996 plan "Energi 21" to have been the last (J. S. Nielsen, 2012b). In a 2009 anthology, Lidegaard described how he saw it as the government's responsibility to set the direction, especially as the environment had become a political battleground.

> "Since the end of the 1980's, the environment has been a political battleground, where policies have dramatically shifted in character with the changing political majorities. Great achievements in one decade is lost in the other…There will of course always be legitimate opposition to from the "old" companies, politicians and organizations, which on the short term stand to lose on a modern, green development in Denmark. But they should only pose a small minority". (Lidegaard, 2009, p. 60)

Lidegaard had closely followed the negotiations around the Anholt wind farm and believed that there was a disproportionate focus on the societal costs of supporting wind power[141]. He was convinced that the environmental aspect had not been communicated well enough to create a strong foundation, and that the dramatic shifts in policy had been caused by a "small minority" of politicians and companies, which wielded high political power. But as the Global-coalition had gained momentum in previous years, he would prioritize bridging the differences and land a broad energy agreement.

Historically broad Energy Agreement expands offshore wind (2012)

Lidegaard would take outset in the VK-government's 2011 energy-agreement proposal, and add a number of initiatives to draft the new government's proposal "Our energy" (DKGOV, 2011b). Most notably among these were another 600 MW offshore wind Farm (Horns Rev 3), new targets for energy efficiency and targeted measures to help energy-intensive industries which could be particularly exposed to energy taxes (Kestler, 2012). The discussions up to the agreement would quickly come to revolve around the annual costs of the agreement by 2020. The VK-government's proposal was estimated to cost 3.6 bn. DKK in 2020, while Lidegaard's proposal would cost 5.6 bn. DKK, a cost which was unacceptable to

[141] Lidegaard explained his position on this in a 2012 interview: "The well-consolidated myth is that it is unbelievably expensive to invest in wind and renewable energy, but if you exclude our taxes, we are below the average (electricity price, ed.) in the EU. Then you can always discuss whether they (energy taxes, ed.) are too high, but they are part of the funding for the society, we have chosen (JP, 2012)".

Venstre. They worked under the mantra that "it should not become more expensive to be a Dane", and believed their 2011 proposal should be ambitious enough (Kestler, 2012). Lidegaard would then cancel some of the initiatives and reduce subsidies for new near-shore turbines, ending up at a proposal which had a cost of 4.6 bn. DKK in annual costs in 2020. Venstre and De Konservative were not willing to negotiate this proposal either, as Lilleholt announced that "if the government wants a deal" total costs should preferably "come down to 3 bn. DKK" (Ritzau, 2012a)[142]. Venstre was skeptical of the proposed target of having 50% of electricity consumption come from wind power by 2020, as the already anticipated 42% achieved in 2015 was considered appropriate (Rytgaard, 2012).

This grid-lock would eventually be solved by the Global-coalition actors outside the parliamentary walls. Venstre faced increasing pressure from the two large industrial organizations Danish Energy and Danish Industry. Danish Energy stated that it was now time that Venstre accepted the slightly higher cost of the proposal on the table, while Danish Industry had repeatedly encouraged an agreement on the basis that "it is not an option to do nothing" (Arnfred & Carlsen, 2012). Venstre expressed disagreement with Danish Industry, finding it odd that Danish Industry did not care more about the costs to Danish companies and consumers (Kristiansen, 2012). As Venstre became isolated in these negotiations, the party turned to its long-time allies in the agricultural sector. Lilleholt would promise Dansk Gartneri / The Horticulture Association, that he would work for higher subsidies for the pot that subsidies implementation of Renewable processes in companies (Danish: "VE til process"), and a targeted tax-relief of the PSO-tax for the horticulture industry (DG, 2012). Venstre was also facing increased pressure from several of their own mayors in Jutland, led by Esbjerg Mayor Johnny Soettrup (V), who argued for the potential local jobs created in the proposed Horns Rev 3 offshore wind farm (E. Ø. Andersen & Vangkilde, 2012; Brandstrup, 2012). In February 2012, Venstre finally softened their demand that costs should not exceed 3 bn. DKK, on the condition that the government redirected money from the wind power pot to support more biogas development (Jessen & Thobo-Carlsen, 2012)[143].

Following six months of hard negotiation, Lidegaard would in March 2012 sign the energy agreement, which was well received by the various industrial organizations (Ritzau, 2012b). When it came to wind power, the agreement included the Kriegers Flak of 600 MW, Horns Rev 3 of 400 MW, 500 MW of nearshore turbines and an expected onshore wind build-out of 1800 MW (DEA, 2012a). Several initiatives had been cut from the agreement, most notably 200 MW less on the Horns Rev 3 wind

[142] Lidegaard urged Venstre and De Konservative to recognize that the sharp rises in fuel prices and Europe's high dependency on fossil fuel imports, meant that there also was a cost to not making a deal. This would however not affect Lilleholt's position, as he considered those estimated benefits to be "airy money", whereas the added costs surely was "an extra bill" (Stampe, 2012).

[143] A members of Venstre's parliamentary group would anonymously tell journalists that he disagreed with the strong push for biogas subsidies, which was considered an agricultural subsidy (Brandstrup, 2012).

farm, which brought the total expected 2020 cost to 3.5 bn. DKK. The agreement was considered historically ambitious and was supported by all parties in parliament, with the exception of the small right-wing party, Liberal Alliance (J. S. Nielsen, 2012a). The agreement included 2020 goals to get 35% of total energy consumption from renewables, along with 34% lower CO2 emissions compared to 1990. A supplementary document, which only the government and its left-wing supporting party Enhedslisten agreed to, included a list of additional goals. These goals were 50% of electricity from wind power in 2020, a coal phase-out by 2030, 100% renewables in electricity and heat by 2035 and a complete fossil fuel phase-out by 2050 (DKGOV, 2012a).

These goals constituted the main difference between the government's goals of being "fossil free" by 2050, and Venstre and De Konservative's stated goal of being "fossil independent" by 2050[144]. The subsidy costs were connected to the PSO-tax, which was designed so it went up by 1 DKK for every 2 DKK the electricity price went down and vice versa. Therefore the total cost of the 2012 energy agreement was based on an estimate that was dependent on the electricity price. The electricity price forecast came from the DEA's 2011 prognosis (DEA, 2012b). In this prognosis, the DEA expected the electricity price to rise from the 2011 level of 300 DKK/MWh (40 €/MWh) to around 400 DKK/MWh (54 €/MWh) by 2025 (all in 2009 prices). This 25% price-increase was explained with the IEA's projections for rising fossil fuel and biomass prices, as well as ETS quota prices, which were expected to rise by 130% by 2025 – from 100 to 230 DKK (DEA, 2011a, p. 4). But these trajectories would not come true, as the following years saw a sharp drop in electricity prices, causing the PSO-costs to increase (NordPool, 2018).

6.2.2 Concerns about costs increase (2013-2014)

The 2012 agreement had for a moment gathered almost all the Danish actors in a historically broad consensus which framed wind power as the backbone of the future Danish energy system. But the strength of the coalition and the Valuation Network build around the agreed direction would be challenged as a material actor, the electricity price, did not act as projected.

[144] The difference was that fossil free meant that fossil fuels could not be used in the electricity-, heating- or transportation sector. Fossil independent meant that Denmark should be able to produce the equivalent of its energy consumption from renewables, but would still be able to consume fossil fuels by 2050. I will return to these definitions in more detail in sub-chapter 7.2.

CO_2 quota prices collapse and fossil fuel prices remain low

Less than one year after the 2012 energy agreement had been published, Venstre expressed a concern that the EU ETS CO_2 quota price had not risen as forecasted. In the 10 months that had passed, the quota price had fallen from €7/tCO_2 to €4/tCO_2, while the agreement was based on a 2011 DEA prognosis of around €18 tCO_2 (DEA, 2011a, p. 10; Winther & Ussing, 2013a). This caused Lilleholt to announce that the Horns Rev 3 and Kriegers Flak offshore wind farms could become “too expensive and therefore should not be completed” (JP, 2013). In the summer of 2013, Lilleholt outlined what Venstre’s response to the unexpected costs would be; “no one can give any guarantees for anything until the tender of the (Offshore wind, ed.) farms have finished (Winther, 2013a)” and that Venstre ”under no circumstance (would) agree to make the energy agreement more expensive” (Winther & Ussing, 2013b). The Kriegers Flak Offshore wind farm had already been postponed once and a new postponement was now being discussed (DKGOV, 2012b). The changed CO_2 prognosis made the right-wing business newspaper Boersen suggest a cancellation of Horns Rev 3 and Kriegers Flak to escape the “ideological straitjacket of a planned economy on the verge of collapse” (Jeppesen, 2013a). In July, the same newspaper invoked the DEC’s 2002 analysis and the “extremely expensive” Anholt offshore wind farm, as reasons to doubt whether the “jewels of the planned economy energy policy”, Horns Rev 3 and Kriegers Flak, would even be built (Jeppesen, 2013b). DF was ready to cancel at least one of the planned offshore wind farms and even De Konservative were considering to abandon the agreement (Brandstrup & Dyrskjøt, 2013). This caused Lidegaard (Brandstrup & Dyrskjøt, 2013; Winther & Ussing, 2013b) and the industrial organizations, Danish Energy, Danish Industry and the Danish Wind turbine Industry (Dyrskjøt, 2013; J. S. Nielsen, 2013), to call for a halt to speculations in cancellations and postponements, as political risks equals investor uncertainty, which could push bidding prices up. Lidegaard, the industrial organizations, wind turbine manufacturers and local industries, such as the rapidly growing Esbjerg harbor, emphasized the *Industrial* advantages of a large manufacturing bases in Denmark (Skouboe, 2013; Vestergaard, 2013), as seen in the below interview with Lidegaard.

> “Yes, it is right. Offshore wind turbines are considerably more expensive than onshore wind turbines, and they are not competitive. But should we then wait until 2025 to erect them? I do not believe so, because what drives the development and lowers the prices is the existence of a market. We cannot wait forever until we invest. Denmark produces every fourth wind turbine in the world. We have 100.000 employees in clean technology, and if we are to have any hope of being ahead in this, we must continue developing the future offshore wind market”. (Skouboe, 2013)

It is worth noticing that Lidegaard draws attention to onshore wind being the cheaper option, and highlights the need to invest to allow offshore wind to follow the same cost trajectory. Although offshore wind power in these years still only made up less than 5% of the world's total installed capacity, the growth of the sector was a large *Industrial* benefit to companies based in Denmark, which still delivered the majority of components. Figure 28 is a picture of the mould used to build the Siemens 75 meter blade, which was being developed in the Aalborg factory in 2012 (Source: SGRE).

Figure 28: Mould for Siemens 75 meter blade (2012).

The world's largest offshore wind farm in operation today, London Array (630 MW), is a good example of Denmark's presence in the offshore industry during these years. It has been installed by DONG Energy, and the wind turbines have been produced at Siemens Wind Power's Danish factories of Brande in Aalborg. Note that the London Array wind farm was commissioned in 2013 and therefore does not feature the 75 meter blade which was to be developed in the pictured mould from 2012[145]. The installation of London Array is pictured in figure 29 on the next page (Source: SGRE).

[145] The turbines at the London Array offshore wind farm are SWT-3.6-120 MW turbines, while the 75 meter blade would be used in the SWT-6.0-154 MW turbine, which was not commercially installed until 2015. London Array will continue to be the world's largest offshore wind farm until the British offshore wind farm Hornsea 1 (1218 MW) is commissioned in 2020.

Figure 29: Installation at London Array (2012).

The two main players in the offshore wind market at the time were wind turbine manufacturer, Siemens Wind Power and the utility DONG energy. These two players were also aware of the time pressure to bring down costs of offshore wind, something which was needed in Denmark, Germany and the UK. In July 2012 Siemens Wind Power and DONG Energy signed a large framework agreement for 300 new 6 MW turbines at an estimated worth of 2.5 bn. Euro (Murray, 2012). Lead by these two players, the industry would in the following year pledge to cut costs by 40%, so that a project reaching Final Investment Decision in the year 2020 would cost less than 100 Euro per MWh (Winther, 2013b). Senior vice-president at DONG Energy during this negotiation, Bent Christensen, explained the reasoning behind the pledge in the interview for this thesis hereafter.

> "If the industry had not communicated as it did what would the situation then have been? Then you as a government authority would have observed an industry that was apathetic and did not act. You would quickly grow tired of that…This was a vision that when we got to that point, we need to have found the right technical solutions...I don't know many other industries who think 6-8 years ahead and set a target for their *Technology Cost* to remain sustainable as an business" (Interview 4: Christensen, quote 5).

The need to bring down subsidy costs for offshore wind became increasingly clear in the following concerns raised about Denmark's planned offshore wind farms. The framing of wind power as a Global Advantage was solid in relation to the *Industrial* quality, but the *Subsidy Burden* quality was still present in the framing. Although the Global-coalition was a heterogeneous and powerful group, the wider Global Advantage Valuation network was vulnerable to the materiality of the electricity prices since these determine the size of the *Subsidy Burden*.

Venstre increasingly problematizes wind power build-out

Venstre and De Konservative became increasingly split on the valuation of wind power during 2014. Anders Fogh Rasmussen left for NATO, Connie Hedegaard left to become Climate Commissioner in the EU, and Lykke Friis left to work at Copenhagen University (Ritzau, 2013). But while De Konservative was only periodically expressing concerns about the energy agreement, Venstre was increasingly calling the offshore wind farms and the CO2 reduction goals into question.

Lars Loekke Rasmussen did, according to reports from the time, not share his predecessors estimated high value of a global scale *Industrial* business adventure, and protection from geopolitical threats, that had caused Anders Fogh Rasmussen's sudden embrace of wind power (Meilstrup, 2010, pp. 21, 104, 133). Lars Loekke Rasmussen's valuation of wind power depended to a much higher degree on how little climate policies disturbed Danish businesses and thus how low the subsidy costs are. This is seen in his answer to the topic in the below 2014 interview.

> "I am not running from the agreement about the 34 percent, but it has already created problems on its own, because the world around us has changed since we agreed to it. There is the shale-gas, the price of fossil fuels has dropped, the EU CO2 quota system has collapsed...real Danish businesses are reporting about real problems with their energy-bill. Danes, who get district heating, are reporting about real problems with rising district heating prices. The slaughter-houses are reporting about problems, that you cannot get the necessary raw goods delivered, and therefore slaughter-houses are being closed, and we should be careful that we do not, detached from reality, sit at Christiansborg (Danish Parliament, ed.) and just set new goals". (Termansen, 2014)

Lars Loekke Rasmussen considered the offshore wind power plans to be something that changes according to many different changes in condition ranging from shale-gas discoveries, EU quotas and what he refers to as “real” problems in “real” companies. As 2013 and 2014 passed it was clear that it was the very special conditions in March 2012, where the CO2 market was projected to recover and fossil fuel prices were still somewhat high, Venstre could accept the energy agreement in its current form. The DEA prognosis of 2011 was now highlighted as a broken promise of costs. As Lilleholt phrased it, there would be “no guarantee” that the planned offshore wind farms would proceed. A compromise was made in 2014 as the S-RV government agreed to lower the cost of the PSO-tax, which had a particular high cost in the energy-intensive industries such as cement-production and agriculture, by 13 bn. DKK from 2015-2020[146].

This compromise would however only momentarily bring stability. In the fall of 2014, it was revealed that the EU commission had raised concerns about the design of the Danish PSO-tax. The concern was related to the fact that the PSO-tax was paid on all electricity in Denmark, including imported electricity, but that onshore and solar subsidies were paid on a tariff-based way, which foreign suppliers could not bid into (Wittrup, 2014a). Foreign suppliers of electricity was therefore unfairly treated according to article 30 and 110 of EU competition law, as their product was subject to a Danish tax, which paid for subsidies they did not have access to (Wittrup, 2014b). It was a common challenge emerging in the EU, and the EU competitions commission therefore only required that Denmark designed future renewables subsidy-schemes, so that a minimum of 6% of the subsidy pot was opened to companies in one of the three countries which could deliver green electricity to Denmark; Sweden, Norway and Germany (DKGOV, 2014a, p. 11). The dispute was however heavily problematized by both Venstre and DF as it caused a delay to the lowered PSO-taxes, which were agreed in June 2014. Lars Christian Lilleholt called the PSO-case “a bomb under Danish energy and climate policy” (Tv2, 2014), while DF political-leader, Kristian Thulesen Dahl, stated that the EU commission had disqualified the financing for the Danish energy policy, and therefore they did not feel obliged to adhere to the 2012 energy agreement (TV2, 2014a). In December 2014, the Horns Rev 3 Auction was entering its final bidding phase, but both Venstre and DF questioned whether the Horns Rev 3 offshore wind farm should even be built. At a crisis-meeting the S-RV eventually persuaded the two parties to stay in the deal (TV2, 2014b), and three months later, the Horns Rev 3 farm would be auctioned at a record-low strike price of 77 DKK/MWh (€103/MWh), 26% lower than the subsidy ceiling (REnews, 2015). Nonetheless,

[146] The lowered costs were achieved by a number of measures but the majority of the savings came from wind power projects. The available subsidies for onshore wind turbines were reduced by 100 Mn. DKK while nearshore turbine build-out was reduced from 500 MW to 400 MW146, and the 600 MW Kriegers Flak offshore wind farm was postponed another 2 years. The farm, which originally should have been completely built by 2020, should now deliver first power by the end of 2022 (T. H. Hansen, 2014).

there was a need for enhanced stability as the Global Advantage valuation network depended on several material actors that were outside the Global Coalition's control. Venstre had in 2012 agreed to the broad energy agreement, but had shortly thereafter moved fully back to being the central political actor in the market-coalition. Just as it was the case during the Market Distortion period, the actors of the framing what had been disassembled were not completely gone. Although a Global Advantage Frame was dominating this period, the Market-Coalition's actors were still active in the valuation struggle. I have already mentioned CEPOS and L&F, but the Danish Economic Council would also publish several reports in an attempt to maintain the Market Distortion Valuation Frame.

The DEC continue to recommend theoretical market solutions

Throughout the Global Advantage period, the DEC would re-iterate their argument that it was not valuable to build wind power in order to achieve *CC Mitigation*, as a carbon market could theoretically solve this in a cheaper way. The DEC was not part of the dominant Global-coalition, but was still an authoritative calculative agency, which continually argued against Denmark investing in wind power to mitigate Climate change. In 2008, there were high expectations that the second reform of the EU ETS market would lead to CO2 quota prices above 25 €/TCO2, and thus the DEC concluded that the EU ETS market would function to bring forward CO2 reductions where they were cheapest. This was a reasonable assumption, since the CO2 quota price was high at the time of writing. The DEC argued that wind turbines would naturally become competitive, as other sources of energy such as gas and coal would become too expensive with a CO2 price of >25 €/tCO2. But something interesting would happen in the reports coming out after 2010. The EU ETS would not be adjusted in the wake of the financial crisis and significant amounts of excess quotas caused the CO2 prices to permanently stay under 8 €/TCO2. The DEC would however maintain their conclusion that trading in a functioning market would be the cheapest way to mitigate CO2. This is despite the fact that a purchase of quotas would not necessarily cause prices to increase as there was an oversupply. The DEC's conclusions about the ETS market's ability to deliver *CC Mitigation*, compared to the annual carbon prices are visualized in table 6. The table and a further analysis of the reports can be found in Appendix C. I have included the 2002 report and the later 2015 and 2016 report for overview purpose, although they are not technically within this chapter's period (DEC, 2002a, 2008, 2010, 2011, 2012, 2013, 2014, 2015, 2016).

Table 6: DEC statements compared to the average annual EU ETS price.

Report	Page	Average EU ETS price	Statement in English
2002	216; 217	Not started until 2005	Subsidies for wind turbines is the most expensive option....If Denmark is to honor its Kyoto commitment as cheaply as possible there are however other options than to bring down CO2 emissions in Denmark....They entail creation of trading in CO2-quotas.
2008	234	25 €/tCO2	A sufficiently tight CO2-regulation will make renewable energy profitable and thereby secure a high renewable energy share...Since the CO2-regulation adresses these two central concerns in energy policy, namely supply security and climate, an independent goal for renewable energy would require an explicit reason, which is not connected to these two concerns.
2010	352; 354	15 €/tCO2	If there through quotas and taxes a high and fairly stable price of CO2 is secured. Going forward, there is no longer any reason to subsidize renewable energy…There is no evidence for a claim that politicians and government officials generally are better than the market at picking ‘tomorrows winners’ (354).
2011	201	15 €/tCO2	A further taxation of CO2 in the quota-covered sector…will not lower the number of quotas and therefore not lower emissions of GHG’s at an EU-level. The same applies for other measures…i.e. subsidies for wind energy electricity (201).
2012	5	8 €/tCO2	Increased support for renewable energy in the quota sector in Denmark, will not lead to lower CO2-emissions on a global level (5).
2013	66	5 €/tCO2	From an economic viewpoint, the low quota price is therefore only a problem, if it does not reflect the political level of ambition, which can be caused by market uncertainty of whether the EU ETS will continue to exist…In addition, an intervention could provide further uncertainty in the market, as it can create an anticipation of other interventions in the future (66).
2014	32	5 €/tCO2	A higher renewable energy share, achieved through more support to renewable energy in the quota sector, does not benefit the climate and is associated with costs to Danish households and companies (32).
2015	305	7 €/tCO2	A cost-effective climate policy will among other elements constitute that reductions are made in those areas of the world, where it is cheapest. This requires a global solution, which as a starting point should be based on economic instruments
2016	12	7 €/tCO2	The combined emissions in the EU from the quota-covered sector, is controlled by the quota ceiling, and Danish initiatives within the quota-covered sector therefore have as a starting point no effect on the climate. Support for renewable energy and other initiatives within the quota-covered sector should therefore be argued for on other concerns than the direct effect on the climate (12).

The DEC argument has thus been sustained up to today, even though the EU ETS-price dropped after 2008, and has remained in the €5-10 per tons since. It can thus be argued that the creation of the EU ETS market has hurt the Danish wind power build-out, as the presence of the EU ETS comes to nullify the quality of *CC Mitigation* in wind turbines, and become a go-to narrative when market-coalition actors advocated for delaying action. A more elaborate walkthrough of the DEC’s reports between 2008 and 2016 can be found in Appendix C.

New 2014 law aimed at stabilizing Global Advantage Valuation Network

Despite the broad coalition of actors, the Global Advantage Valuation Network could still be shaken by the material conditions of the failed CO2 quota market and continually low electricity prices. In 2014, a new Climate, Energy and Buildings minister, Rasmus Helveg (RV), would aim to stabilize wind power world more in 2014, by setting up a framework to ensure that changing Danish governments stayed on track towards its long-term goals. He worked on this with the Left-wing parties and De Konservative during 2014 to enact the 2014 Climate act which should keep Denmark on track towards the long-term goal being a “low-emission society in 2050” with an “energy supply based on renewable energy” (DKGOV, 2014b)[147].

[147] Venstre was dissatisfied with the law, and felt that they had been left out of influence by Helveg and De Konservative (Oeyen, 2014). In the Climate Law, De Konservative joined the Government goal of 40% CO2 Reductions in 2020, as opposed to the original 34% goal, which could be agreed with Venstre and DF in the 2012 energy agreements law text. Lilleholt said that Venstre did not

The law set up a new advisory body, The Climate Council, which would publish reports on whether Denmark was on track for the long-term goal and what could be done going forward. The Climate Council would have an annual budget of 12 mn. DKK and be headed by Peter Birch Soerensen, a recognized economics professor from Copenhagen University, who was head of the Danish Economic councils from 2004-2009. Peter Birch Soerensen had assembled his team by early 2015, which included Katherine Richardson, head of the 2010 Climate Commission and Poul Erik Morthorst, contributor in both the 1996 AKF-report and the 2010 Climate Commission report. The Climate Council was created to challenge the neo-classical economic thinking and market-based assumptions that the Danish economic councils (DEC) had advocated for years. They would primarily become active in the next period, and are therefore not covered further here.

The 2012 energy agreement was a historical compromise, which planned for more than 1.4 GW of offshore wind and a 1.8 GW build-out of onshore wind. As Denmark's installed wind power fleet had just passed 4 GW in 2012, the plan thus equaled a more than 70% increase of the fleet's size over the next 8 years (When accounting for retired onshore wind turbines, ed.). The commitment would however quickly be brought into question due to continued low electricity prices and a rise in subsidy costs. The Market-coalition, represented primarily by Lars Christian Lilleholt, was interested in the *Industrial* benefits of wind power, but had a significantly higher concern for the *Subsidy Burden* that came with it. This period is defined by wind power becoming technically competitive with other energy sources, but entrenched meanings about high subsidy costs would entail. This is visible in the coming analysis of two 2014 reports on the costs of wind power.

6.3. TWO REPORTS CALCULATE WIND POWER AS CHEAPEST TECHNOLOGY (2014)

The Global Advantage period saw the publication of two reports, which would cement the strong positive impact of *Technology Cost*, but one of them would also re-use a Market-coalition way of framing wind power costs. The first report is the Danish Energy Agency's calculation on a research note called "Electricity Production Costs" (DEA, 2014a), which had a larger validation report by Consultant Agency "EA - Energy Analysis" behind it (EA Energianalyse, 2014). The second report is "The cost of producing electricity in Denmark" which was ordered by the Rockwool Foundation Research unit (RW) to be calculated by two economic professors from Copenhagen Business School (CBS) (Rockwool, 2014b). The two reports both came from authoring institutions with a highly credible image and had a

want to join the 40% goal, because although they "want new reductions, it should not cost jobs or money" (Oeyen, 2014). Since Helveg could not guarantee Lilleholt that the increased ambitions could be achieved at no costs and without any sectors losing one job, the new energy minister had decided to negotiate the deal with De Konservative.

stated aim of advising policy makers (EA Energianalyse, 2014, p. 4; Rockwool, 2014a, p. 2) regarding the societal costs of wind power. The overlap in that they both concluded that onshore wind power by far was the cheapest technology to build for Denmark (EA Energianalyse, 2014, p. 5; Rockwool, 2014c, p. 2). This shows the materiality of a high positive impact from the Technology Cost quality. But an additional counterfactual analysis in the RW report concluded that wind power had made electricity 13% more expensive than a business as usual scenario (Rockwool, 2014a, p. 6). The assumptions behind the two reports, as well as the public reactions to their conclusions will be examined next.

6.3.1 Danish Energy Agency: Wind is cheapest (2014)

The Energy Analysis (EA) Background report called "Electricity Production costs" was written in April 2014, but was not released until it could supplement a research note of the same name from the Danish Energy Agency (DEA), published in June 2014. The EA report is a 42-page validation report to the DEA's 8-page research note. The report and research note examine which of 10 electricity production technologies (wind, solar, coal, gas, biomass etc.) are the cheapest to build in Denmark, if Denmark would start from a green field energy system[148], and that the EU ETS CO2 quota prices would rise in the future according to projections made by the International Energy Agency. The report concluded that onshore wind power was the cheapest energy source to build among the 10 examined (DEA, 2014a; EA Energianalyse, 2014). In example, it calculated electricity production costs of onshore wind at 321 DKK/MWh, which was considerably cheaper than building conventional energy sources such as coal (534 DKK/MWh) and gas (606 DKK/MWh). The two objects of study will hereafter be referred to as the EA report and the DEA note.

Actor Profiles: Danish Energy Agency and EA

The Danish Energy Agency is an independent agency placed under leadership of the Danish ministry of Energy, Utilities and Climate, which is governed by the elected minister of the time (DEA, 2016a). It has approximately 300 employees, primarily of engineering background but also other professions, with responsibility for energy production and supply, transportation and consumption, as well as Denmark's energy efficiency and CO2 emission reduction measures (DEA, 2016a).

EA energy analysis is a well-renowned consultancy firm, which is frequently used to calculate energy-related scenarios and statistics for the Danish Government, Danish

[148] Green field means that the report assumes costs as if a country was building an energy system from scratch and there was no existing grid or capacity from the outset.

interest organizations (i.e. the Danish Energy calculation in 2006), as well as international bodies (i.e. the International Energy Agency). The agency employs around 25 full-time employees, with mainly economic and engineering backgrounds, and several senior staffers have prior experience from prior positions within the Danish government (EA, 2016b).

The DEA and EA calculate wind power as the cheapest available technology

The EA report is a technology cost comparison report, which resembles the 1996 AKF report, as it focuses on present *Technology Cost* and a high salience of the *CC Mitigation* quality of wind turbines. This is seen in the description of the overall purpose of the EA report:

> “The DEA has requested EA Energy Analysis to analyze costs of producing electricity from new plants from a societal-economic view...The plants are assumed constructed so that the first year of production is 2016...We are presenting long-term marginal production costs for new units, wherein capital-, operational-, fuel- and environmental costs are included”. (EA Energianalyse, 2014, p. 4)

Wind power is one of the ten examined objects, which are treated as a stand-alone technology to be measured on its specific construction and maintenance costs. It is thus not considered a supplementary source, but is evaluated on the same terms as conventional sources such as coal- or gas-plants. In the comparison, the generated heat revenue was calculated for conventional heat-power plants, while a balancing cost of 15 DKK/MWh was added to wind power’s costs. When measured on the technological costs without CO2 quota costs and other emissions, onshore wind (321 DKK/MWh) was calculated to be cheaper than coal (346 DKK/MWh) and significantly cheaper than gas (528 DKK/MWh). Offshore wind (582 DKK/MWh) was calculated as roughly on par with gas but more expensive than coal (EA Energianalyse, 2014, p. 13). So the quality *Technology Cost* was for the first time salient as a positive impact. Wind power was framed as the most competitive energy source without any coupling to *Future Potential* or *CC Mitigation*. It is deemed to have a strong positive impact on the Valuation Frame in the report.

The sources for the *Technology Cost* for the ten examined energy sources came from the Danish Energy Agency’s January 2014 technology catalogue (EA Energianalyse, 2014, p. 17), while the fuel costs were sourced from the IEA’s New Policies

Scenario (EA Energianalyse, 2014, p. 14). The discount rate for the investment was set at 4%, which was equivalent to the level of the discount rate for public investments in 2013. In 2013, it had been lowered from the previous level of 5% (DKGOV, 2013)[149]. The only system costs included was a balancing cost, which was as a charge of 15 DKK/MWh, less than 5% of the total costs. The authors add a cost to account for system-costs of short-term frequency balancing, but also for changes in output on days with unexpected output for wind power. This is however not the same as a cost for a back-up plant for capacity (EA Energianalyse, 2014, p. 22)[150].

In addition to the *Technology Cost*, the *CC Mitigation* quality and, to a lesser extent, the *Environment* quality, contributed to categorizing both onshore and offshore wind as a significantly more valuable investment than coal or gas. The *CC Mitigation* quality was present as a cost of 163 DKK/MWh for coal and 61 DKK/MWh for gas, which was a part of the total cost number for the ten technologies presented in the DEA note. The EA report used the IEA's prediction that the price of EU ETS CO2 emission quotas would rise from 7 € per ton in 2014 to over 30 € per ton in 2035 (EA Energianalyse, 2014, p. 10)[151], and extrapolated the rising trend from 2035 onwards to 2050 (EA Energianalyse, 2014, p. 4). The Environmental quality was also calculated as a societal costs for NOx (50 DKK/kg) and SO2 emissions (96 DKK/kg), based on the Danish Energy Agency's assumptions (EA Energianalyse, 2014, p. 16).

The EA report does not discuss reasons for the choices made as it mainly follows the general assumptions used in the Danish Energy Agency note. In the expectation of rising fuel prices and the extrapolation past 2035, the report envisions an energy system wherein wind power becomes more valuable as it functions as a hedge against future price increases of gas and coal.

The EA report and the DEA note both have a high salience on *Technology Cost* and *CC Mitigation*, while the qualities related to system integration costs are largely absent. By making this distinction, the report draws light to the materiality of the falling construction costs of wind turbines and frames wind power as the cheapest source of energy to build. The EA report uses the same basic assumptions as the

[149] As previously discussed, the lower the discount rate is, the more competitive investments with high upfront cost will appear. This is because long-term gains of those investments are valued higher, whereas a high discount rate would instead favor short-term gains over long-term benefits. The discount rate in any large infrastructure projects is thus very important, as renewable energy is more competitive, the lower the discount rate is (Eco-Council, 2013).

[150] In this periods wind power is calculated as needing more back-up capacity than a gas plant or similar. But a power-system will always need back-up capacity in some form independent of which power plant capacities are present. I elaborate more on this point in sub-chapter 9.1

[151] The report also calculated emissions of Methane/CH4 (25 DKK/MWh) and Nitrous Oxide/N2O/Laughing gas (295 DKK/MWh) into their CO2 equivalents and added costs for this to the calculation. These estimates mainly affected biomass-plants and were based on the Danish Energy Agency's assumptions on costs of these gasses (EA Energianalyse, 2014, p. 16).

International Energy Agency (IEA), which is among the worlds most quoted sources on energy projections. There is as such not many changes made to the calculations from what is in official DEA technology cost catalogue and IEA's projections. I will highlight two elements that are worth noticing.

EA perform a linear extrapolation of costs past 2035, which means that a coal plant built in 2016 will continue to see rising CO2 prices throughout all of its 40 year lifetime. In contrast, some of the previous energy prognoses from the DEA have seen CO2 prices flatten out sometime past 2030. So in addition to the choice of pricing in the expected CO2 quota price increase, the EA also extrapolate further fuel price increases in after 2035, which will cause coal and gas to become more expensive compared to wind power.

Additionally, the discount rate of 4% instead of the previous 5% also prices the *CC Mitigation* benefits of wind power higher, as energy sources that have high up-front capital investments are valued higher with a low discount rate. The assumptions of continued rising CO2 Emission quota prices and a lowered discount rate, translates into a framed energy system wherein long-term decarbonization benefits are prioritized higher than short-term affordability.

Reactions to the EA report and DEA note

I will hereafter describe how the report and the note were received in the media, the critiques raised, and analyze how the consultancy EA, as well as DEA perceived the process and reaction. The relationship between EA and the DEA is worth focusing on for a brief moment, as the DEA was asked to have their hypotheses validated by the EA energy analysis consultancy. But it was the DEA who issued the press release of their findings on their website along with the background report from EA. The EA authors thus consider themselves detached from the use of the report, and the following discussion, as explained in an interview for this thesis.

> "What they asked us for was quality assurance of something they had already done…We do many products, which someone thereafter chooses to present, if it supports something that they want". (Interview 7: EA Co-Author, quote 1)

It was instead the DEA authors who ended up dealing with the subsequent reactions to the EA reports findings. This media coverage would present challenges, since the dominant media narrative did not focus on wind power as cheapest, but instead now pivoted to a question of why wind power was still subsidized. Below is the DEA press release titled “New analysis: Wind is cheapest” (DEA, 2014b), followed by the headlines from the major national newspapers and the industry-media EnergiWatch. The exception to the rule was the centre-left newspaper Politiken, who placed salience to the same focus as the DEA’s press release. The press release (Gray) and the headlines are pictured in the table below (DEA, 2014b; E. Jensen, 2014; Johansen, 2014a; Ritzau, 2014a; Winther, 2014).

Table 7: Headline to the DEA Research Note.

Date	Newsmedia	Headline (Authors translation)
18.07.14	DEA Website - Press Release	New Analysis: Wind is cheapest
17.07.14	Berlingske	No more subsidies for cheap windpower
18.07.14	Ritzau, Information, Ekstra Bladet, Jyllandsposten (EW)	Subsidies for cheap wind is to end
25.07.14	Politiken	New Analysis: The energy from windturbines is by far the cheapest
29.07.14	Jyllandsposten (EW)	The DEA accused of fraud with wind energy prices

In the case of the DEA press release, the Berlingske newspaper published on the evening (17.07) before the actual press release from DEA was published (18.07). The Ritzau news note which followed quoted the Berlingske article, and the subsequently newspaper headlines reflected the focus on subsidies, which was not mentioned in the DEA press release. This phenomenon could be dubbed the “Ritzau machine”, wherein the first framed focus, the subsidy-focus of the Berlingske article becomes a central part of the coverage. Although the report and press note focus was on the result that in a green-field analysis, wind power emerged as the cheapest energy source, the press coverage pivoted to focus on a possible end of subsidies for wind power. This is an example of a story which plays into the entrenched meanings that wind power must be expensive because it is subsidized, while fossil fuel energy sources are framed as the conventional and unsubsidized energy. The notion that wind power should then be cheaper than other energy sources makes the subsidies appear as an unnecessary prosthetic device.

Furthermore, the finding that wind power was indeed the cheapest energy source to build would be met contestation. There was a critique raised about a week after the press release, which was covered in Energiwatch, under the title “The DEA accused of fraud with wind power prices” (Johansen, 2014a). The article was an interview with a retired long-time utility engineer, Paul-Frederik Bach, who was still known within energy circles. He questioned the assumptions behind the DEA’s conclusion that ‘wind is cheapest’.

PFB argued that the DEA did not adequately account for the fact that the market price are lower for wind power as it has to be sold, when the wind is blowing. In his critique, PFB argues that only the ‘market’ can show the true cost of wind power, as shown in the quote hereafter:

> “The natural fluctuations from wind and PV must also be equalized by other technologies…the market will reveal the cost when the share of wind power is high enough” (P. F. Bach, 2014, p. 2).

Paul-Frederik Bach noted that EA energy-analysis validation report had included a mention of the market costs, but consciously omitted it from the calculation, as the reports focus was production costs from a societal view. He goes on to call the DEA’s conclusion that wind was cheapest is ‘careless at best and misleading at worst’ (Johansen, 2014a), and proposed that the cheapest option was to prolong life of current coal plants.

> “Due to the subsidies for wind power, large coal fired units are being closed down in Denmark…Their production will be cheaper than for any of the alternatives mentioned in the report, even including the CO2-cost”. (P. F. Bach, 2014, p. 4)

Focus is here on the sunk cost of having to close down existing coal plants, and his argument is that even if Denmark payed its CO2 quota prices as they are projected in the EA report, it would still be cheaper to run the coal plants. Paul-Frederik Bach is here speaking outside the scope of the EA reports focus, but is using the argument of energy system cost to attribute a higher cost to wind power. His form of valuation of wind power bears the resemblance of an indisputable market logic, which cannot be ignored when a society is calculating costs. As he does not consider the phase-out costs of coal as a system cost, wind power is framed as the disturbing factor to the energy system. His critique is thus similar in nature to the DEC’s 2002 report. The high level of scrutiny concerning the underlying assumptions of the DEA note was something that the DEA authors had experienced both before and after the results were released, as seen in interview excerpts below.

> “Despite the fact that the calculations came out in a rather quiet news period (during the national summer holidays, ed.), there was actually a lot of reaction to it....It surprised us that it (back-up costs, ed.) ended up filling so much....There was a critique of the analysis only a few weeks ago (May 2015, ed.), that the CO2 price in the analysis was set much too high”. (Interview 8: DEA Author)

The DEA authors did actually include a caveat in the press release of the analysis, stating that they did not consider their analysis a stand-alone conclusion about what future energy scenario would be best for Denmark.

> “There is a caveat in the research note. If you look at combined scenarios and energy systems, then you cannot really use this analysis. But it can still say something about that under the simple conditions set up (the green field assumption, ed.), then the picture looks like this”. (Interview 8: DEA, quote 2)

The DEA authors experienced their conclusions being drawn into a larger context than the corner of the complex energy system they were planning to highlight. The framing that wind power had the lowest *Technology Cost* was faced with some resistance in the public forum and the press release framing that “wind is cheapest” was in several large newspapers turned into a narrative about wind power subsidies being too high. But a different report from 2014 would also reveal something about entrenched meanings in the valuation history of wind power.

6.3.2 Rockwool Report counterfactually removes Danish wind power (2014)

In November 2014, approximately four months after the EA report was published, the Rockwool Foundation would publish a large report about the cost of wind power. The reports main calculative comparison would reach the same conclusion as the EA report, namely that wind power was superior to alternative energy sources when it came to the quality of *Technology Cost*. The report would also contain a counter-factual calculation, which fit into the same entrenched meaning that encapsulated the critique of the EA report.

In the previously analyzed EA report, no distinction was made between wind power and other energy sources. In contrast, the RW report supplements the overall goal ‘to study the costs of generating electricity in the Danish power system’, with an additional counterfactual analysis aimed at discovering which addition to the total system generation costs, wind power is specifically responsible for (EA Energianalyse, 2014, p. 4; Rockwool, 2014b, p. 1,6). The underlying meaning was thus that wind power was an added cost to the energy system.

Actor Profile - The Rockwool Foundation

The Rockwool Foundation (RW) report called "The Cost of Producing Electricity in Denmark" was ordered and initiated by RW, an independent research body started in 1981 by six members of the Kähler family, which funded it through 25% of the share-value of Rockwool International, a Danish industrial producer of stone wool insulation (Rockwool, 2016). RW hires researchers on a project-basis and is well-renowned for delivering influential reports to stimulate debate within many societal areas. Two economics professors, affiliated with the International Centre for Economics and Business Research at Copenhagen Business School, were hired to create the two-set 180+ page report, which was published in November 2014 (Rockwool, 2014c). The stated main objective of the report was to "study the costs of generating electricity in the Danish power system" (Rockwool, 2014b, p. 1). In addition to this objective, the authors use the analyzed generation costs, to perform a counterfactual analysis, wherein they removed wind power from the Danish energy system in the period 1998-2011. This exercise was done to investigate how the "relatively quick introduction of non-conventional generating technology (wind turbines)" had affected the production costs of the Danish energy system (Rockwool, 2014b, p. FW 1). The results of the report can be summed up in three main points. Firstly, onshore wind power was found to be a cheaper power-generating technology than coal or gas. Secondly, the observed "extensive introduction of electricity" from wind power had not increased the average capital costs of the Danish energy system in 1998-2011. Thirdly, the counterfactual analysis showed that if the constructed wind power in the Danish energy system between 1998-2011 had not been built, total electricity production costs could have been 13% lower (Rockwool, 2014b, p. 6)[152]. So the counterfactual analysis theorized what the total system costs for Denmark would have been if no wind power had been built and all coal, gas, etc. plants had been run at a higher capacity factor to create the extra electricity needed. What is especially interesting to this study is exactly how this third result, produced from a counterfactual analysis, became the public medias' main takeaway.

The findings of the RW report

The overall purpose of the RW report was to "study the cost of generating electricity in Denmark", which entailed an elaborate comparison of *Technology Cost* combined with a counterfactual analysis. Before I examine the counterfactual analysis, the direct technology comparison will be presented. The comparison was motivated

[152] In the remainder of the article, the number 14% will appear several times. This is because the savings identified in the calculation became 14% when communicated in the press release from Rockwool although the report reached the conclusion that production costs without wind could have been 51 oere as opposed to 58 oere/KWh, i.e. 7 oere lower equal to 13 % (Rockwool, 2014b, p. 6, 2014c, p. 1).

from a certain historical assumption of wind power being more expensive than thermal energy sources (coal or gas plants), and as can be seen from the below excerpt.

> "Subsidies to electricity generated from a renewable energy source have been motivated historically by the conclusion that electricity generated from renewable sources is more costly relative to non-renewable generation (thermal generation, for example) which typically burn fossil fuels; a process which emits greenhouse gases into the atmosphere". (Rockwool, 2014a, p. 3)

The report ascribed the motivation for wind power subsidies as being *CC Mitigation*, and was concerned with highlighting the lost revenue of conventional generators, when their production was replaced with wind power.

> "The motivation for subsidizing investments in onshore and offshore wind power is to reduce CO2 emissions by relying less on thermal generation. However, it is important to think about the consequences of changing the generation profiles for existing conventional generators. If new capacity results in the crowding-out of existing generation this may well result in low capacity factors for conventional generators, implying that the average costs of these generators will increase. This could result in greater overall average costs…Over-capacity is a concern because it can potentially lead to inefficient generation levels for thermal technologies". (Rockwool, 2014a, p. 5)

The authors here turn over-capacity and the resulting worse business case for thermal generators into a matter of concern. They consider wind power as the added factor, which can be removed in order lower the overall aggregate costs of the system. So although wind power might individually perform better than thermal generation plants, wind power is framed as a supplement, which can be removed as it is non-conventional[153]. The foundation for the analysis is first laid out for exploring the individual technical generation costs for the various energy sources. Once these numbers are in place, the authors conduct this hypothetical experiment of removing the cost of wind turbines from the system. These two parts of the report will be explored next.

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153 It should be noted that the EA report also accounted for a heat-revenue from conventional generators in their cost comparison of technologies.

The authors emphasized that they did not have access to actual investment data of the already constructed Danish energy sources, but instead relied on technology manuals from which they would “apply estimates” for construction and maintenance costs (Rockwool, 2014a, p. 7). They would only produce values on what was framed as “pure technological costs (Rockwool, 2014a, p. 8)”, as they did “not include the social costs of emitting carbon dioxide, CO2, into the atmosphere” (Rockwool, 2014a, p. 7). The authors did however include the analyzed periods (low) CO2 emission quota prices in the years it was present, but did therefore not assess whether these prices reflected the real cost of emitting carbon (Rockwool, 2014a, p. 8). So the CO2 price set in the EU ETS carbon market is included during the analyzed period of 1998-2011. But this is considered a price that must be paid to supply electricity to the grid and thus not an estimate of what the damage of emitting one ton of CO2. As one of the authors revealed in an interview, they assumed that wind must have made the system more expensive.

> “When we started we imagined that it had become more expensive, as more wind power was brought into the system. But we have simply not been able to see this over the period”. (Interview 9: Rockwool Author, quote 1)

In the main analysis it was concluded that wind power was the cheapest of the available energy sources and had the best future prospects of price reductions. While wind power construction costs have fallen significantly, fuel costs have increased, as explained below.

> “It is evident that electricity generation is relatively expensive for thermal technologies, whereas it is relatively inexpensive wind power. Moreover, the gap between the two unit costs is increasing during the 14 year period. For thermal technologies, the increase is driven by increasing fuel costs, whereas the falling unit cost for wind power is driven by falling capital costs”. (Rockwool, 2014a, p. 25)

The conclusion of the individual technical analysis is not summed up further than the above in the report. But in the press note discussing the report, the second page was dedicated to the individual cost analysis in which it stated the following.

> “It turns out that the price of thermal production is high and rising, while electricity from wind is lower and falling...Electricity produced on oil, coal or gas was thus 33 percent more expensive than electricity produced on wind (in 1998, ed.) In 2011 the difference was markedly larger. While electricity from wind had a cost of 270 DKK/MWh, had the cost of thermal production risen to just below 870 DKK. Thermally produced electricity was thus 220 percent more expensive than electricity from wind.” (Rockwool, 2014c, p. 2)

The authors thus framed wind power electricity as costing less than a third of the production costs of the thermal plants (Rockwool, 2014c, p. 2). The Rockwool reports main analysis findings thus supported the EA reports finding that the Technology Cost quality had a positive impact on the valuation of wind power. This finding is important to keep in mind, as the attention of the analysis now turns back to the reports’ counterfactual analysis, which would become the main headline for the Rockwool press release.

Counterfactual analysis brings back old Fuel Supplement quality

As mentioned earlier, the report also contained a different analysis, of which the calculation of technical data had been necessary. Once the authors had the cost of the various plants, they would perform the hypothetical experiment of removing all wind power investments from 1998-2011 (Quote 1 below). The stated premise for this came in a distinction between conventional energy sources and added non-conventional sources, which among other places[154] can be found in in the authors’ foreword to the RW report (Quote 2 below).

> Quote 1: “A counterfactual analysis is carried out to investigate what the production cost would have been under the thought experiment that no wind power capacity had been introduced into the Danish power system”. (Rockwool, 2014a, p. 6)

> Quote 2: “How does the relatively quick introduction of non-conventional generating technology (wind turbines) into a national power system affect the cost of generating electricity?” (Rockwool, 2014b, p. Foreword 1)

[154] The authors describe the coal and gas plants as conventional on page 16: “We study seven types of thermal generators and two types of wind turbines. Conventional thermal generators include steam turbines, CHP generators consist of steam turbines (back pressure and extraction) as well as combined-cycle gas turbines and CHP waste (Rockwool, 2014a, p. 16).

Once wind power is categorized as a non-conventional generating technology, the price of lost production at conventional power plants (mainly coal and gas), become calculated as an added cost of total generation. This metric is derived from the categorization of wind as non-conventional energy source, which leads to an evaluation of the cost of wind as an added resource to an already existing energy system, consisting of conventional energy sources, i.e. coal and gas power plants. Somewhat similar to the Fuel-Coalition during the Unique Supplement period and the Market-coalition in the Market Distortion period, Wind power is again framed as a supplement to the existing energy system. The variability of wind power is brought to salience several times as the reason for this categorization, as seen below.

> "The intermittency and the non-dispatchable nature of wind power production have system-wide implications: In order to maintain a secure supply of electricity reliable backup generation must be made available." (Rockwool, 2014a, p. 14)
>
> "Wind power is an intermittent source of electricity. Electricity can be generated only when there is wind (or winds are not too strong). Intermittency of wind power has system-wide implications: In order to maintain a secure supply of electricity, reliable backup generation must be made available. Similarly, for power systems to be stable, the mix of generators must be able to supply base-load demand, mid-load demand as well as peak-load demand…. A mixture of different types of generation plants with varying degrees of responsiveness to changes in demand and supply (wind conditions) is needed to ensure system-wide stability". (Rockwool, 2014a, p. 33)
>
> "Reserve capacity will continue to be in demand as the penetration rates of intermittent wind power increases." (Rockwool, 2014a, p. 56)

Once the RW-authors have established the framing that wind power cannot stand alone in the analyzed energy system, they can remove it, as it is a supplement. The cost of wind power then become calculated as the savings in the Danish energy system, as if wind power did not exist between 1998-2011, and thermal power plants were used for more hours in the year. Wind Power is framed as something that can be removed from the energy system without consequences, because two particularly dry years in the examined period resulted in a high level of power exports from Denmark to Sweden and Norway. If power plants ran on such high capacity factors throughout the entire period, the electricity from wind power production could be artificially removed. This counterfactual analysis is built on a set of assumptions about what an energy system without wind power would look like, something the authors themselves call “unobservable” (Rockwool, 2014a, p. 91). They conclude that total system costs in the analyzed years (1998-2011) would have been between 8- 16% lower if no wind power had been in the system. The headline result thus become that Danish electricity on average would have been 13% cheaper without wind power, as the thermal generators would have had higher capacity factors and thus lower generation costs (Rockwool, 2014a, pp. 6, 92). In the press release, this number has interestingly increased to 14% as a calculative example became rounded down, despite the fact that the 14% number is not listed in the report. Before I turn to the media reactions to the RW report, I will briefly discuss the RW’s omission of the *CC Mitigation* quality in this report.

CC Mitigation quality is left out

One noticeable omission in the report is that the authors consciously place considerations about the need for decarbonization in the energy system outside of their framing.

> “We do not include the social cost of emitting CO2 into the atmosphere….We do not evaluate economic or environmental policies that influence the Danish energy system”. (Rockwool, 2014a, p. 7)

In the counterfactual analysis, the RW authors do not calculate the added cost of reaching the EU CO2 reduction goals through other measures, when wind power is removed from the system (Rockwool, 2014b, p. 7). It is by the omission assumed that EU would either waiver its unfulfilled CO2 reduction demands, or that Denmark would reach these goals without added cost to electricity generation system. There is no consideration of whether environmental cost of emissions should have been set higher than what the market quota price represented. This is along with several other elements considered a ‘political question’ as one of the authors stated in the press release for the report.

> “Some are of the opinion that wind turbines ruin the visual landscape, are noisy, kill birds and bats and are generally in the way. On the other hand, the advantages of wind are apparent; A smaller CO2-footprint, less pollution and less dependency on fuel. How much you consider that to be worth is a political question”. (Rockwool, 2014c, p. 1)

The RW author here equates the wind power advantages of "a smaller CO2-footprint" and "less dependency on fuel" with wind turbine disadvantages such as wind turbines being noisy or a danger to bats. By doing this, the RW-author ignores the vast difference in scope between mitigating climate change and local residents' concerns about bats flying into blades. The RW report appears to represents an attempt to present "clean numbers" and then designate a number of qualities such as "*CC Mitigation*", in a sphere of politics, which is not part of the calculation.

Reactions to the RW report shows powerful entrenched meanings at play

Despite the fact that the counterfactual analysis only occupied 14 pages out of the total 180 page two-set Rockwool report, it became the main headline of RW's press release, which read "Wind power makes electricity production 14% more expensive". The second page of the press release thereafter paradoxically read "A Megawatt from wind is cheapest and the price is falling" (Rockwool, 2014c)[155]. The following media coverage would also reflect the framing of wind power as an added cost, as can be seen in table 8 (Johansen, 2014b; J. S. Nielsen, 2014; Ritzau, 2014b; Rockwool, 2014c; Skovgaard, 2014)

Table 8: Headline reactions to Rockwool Report

Date	Newsmedia	Headline (Authors translation)
25.11.14	Rockwool - Press Release	Wind energy makes electricity production 14% more expensive
25.11.14	Ritzau, TV2, Information, Ekstra Bladet	Wind makes your electricity 14 % more expensive
25.11.14	Berlingske	Wind makes electricity 14% more expensive
26.11.14	Jyllandsposten (EW)	Wind makes Danish electricity 3 billion DKK more expensive
26.11.14	Information	For the fourth time: Onshore wind is cheapest

The RW authors' had in the report stated reservations towards their counterfactual analysis, which they called "unobservable" (RW, p. 91). This means that there are so many uncertain factors to account for in the counterfactual analysis, that it becomes a "what if we imagined" estimation exercise. These reservations are however not reflected in the media coverage. The counterfactual analysis of the supplementary costs of wind power became the main takeaway of the Ritzau press note, which several media outlets reproduced. The Newspaper Berlingske conducted a further calculation on the 14% numbers in the report and estimated that the added wind power costs were equivalent to 400 DKK for an average Danish household, and

[155] The second page of the press release has this heading, because the individual cost comparison of the technologies showed wind power to be cheapest. It was the categorization of wind power as non-conventional which allowed removing it from the energy system in the counterfactual analysis, and enacted a framing where wind power had cost something extra to Denmark.

would amount to 3 bn. DKK to society as a whole (Skovgaard, 2014). This new calculation of 3 bn. DKK became the headline of the industry media-outlet Energiwatch's (EW) coverage of the report. EW stated that "in the analysis, it is also noted that the higher production costs should have another 5-6 bn. DKK added annually as of the PSO-expenses of businesses and private households" (Johansen, 2014b). The PSO-tax is however not mentioned in either the RW report or press release and it is also not only used to fund wind power. The Berlingske article did mention that PSO-taxes of 5-6 bn. DKK payed for the "green transition", but this is not equivalent to EW's citation that the total PSO-tax of 5-6 Bn. DKK should be added as cost to wind power. The direct equation between wind power costs and PSO is thus inaccurate, as wind power subsidies only account for approximately half of the total PSO-tax (EnerginetDK, 2015b) [156]. The Danish news media's selected conclusions from the RW report could suggest that there is still strong support for the viewpoint that wind power is a non-conventional energy source, and therefore a *Fuel Supplement* which could be removed to lighten the general cost-burden to the Danish society. This framing is thus easily accepted in public discussions and calculated further upon, consistent with one of the RW co-authors impression of the reception of the report's conclusions, as stated in my interview with him.

> "What we have done (the counterfactual analysis, ed.) is almost banal in its approach and we are completely aware of that. But we wanted to show increasing returns to scale, this point that the more you produce the lower is your average cost....I don't know how much value it has apart from giving you an indication of what production costs are". (Interview 9: Rockwool author, quote 2)
>
> "I have no opinion towards the 14%, whether that is much or little. It was more to get that on the table and say "this is the cost, this is our best estimate…The reactions have mainly been about whether one considered 14% to be expensive or not". (Interview 9, Rockwool author, quote 3)

The author of the RW report argues that he did not intend to deliver a political statement regarding the 14% added cost of wind power, but merely aimed to get the numbers "on the table". In the public, the assumptions behind the numbers in the counterfactual analyses are not questioned[157], but instead the 14% quickly sparked further calculations, such as Berlingske who used the 14% to calculate added average household costs to be 400 DKK and 3 bn. DKK for society. This calculation

[156] Subsidies to decentral gas-fired plants, biomass and solar energy account for the remaining PSO-budget.

[157] With the exception of the left-wing niche newspaper, Information (22.000 subscribers) (J. S. Nielsen, 2014).

directly labels the 400 DKK an “extra annual expense”; despite the fact that the Rockwool counterfactual analysis actually stated that electricity prices could have been lower. So an accurate phrasing would have been to state that households could have saved 400 DKK per year (Skovgaard, 2014). This is an example of how the entrenched meaning about wind power being a cost burden resonates with given media-publics. The RW co-author naturalizes the production costs as the “real” numbers and then considers other “social” elements such as a CO2 tax or similar to be politically determined, and therefore not as solidified. This strengthens the narrative that coal and gas are the “naturally” cheapest options, despite the report’s conclusions that wind power had the lowest *Technology Cost*.

The “Ritzau machine” effect mentioned is also present in the RW case. It is seen in the case of the left-wing newspaper “Information”, which published the Ritzau news note the same day it was released. The following day, the same newspaper published an in-depth article with a different heading messaged “For the Fourth time: Onshore wind is cheapest” (J. S. Nielsen, 2014). The in-depth article was written by the experienced environmental journalist Joergen Steen Nielsen, who correctly cited the RW report to show wind power to be considerably cheaper than electricity produced on thermal plants (J. S. Nielsen, 2014). By the time the Ritzau news note came out on the evening of the 25th November 2014 several news media, including Information, merely quoted the highlighted conclusions about the 14% added cost. It was not until Joergen Steen Nielsen came into the office on November 26th that an elaborate article on the report was published. The only News-media which on November 25th wrote additional information to the news-note, was Berlingske and their added cost calculations. This happened on the evening of November 25th, indicating that they had the material available at an earlier stage than the other media-outlets (Skovgaard, 2014).

6.3.3 Summary: Two reports show wind power as cheapest technology

As we can see from the analysis, the main objectives of the two reports appear similar: provide calculations on the cost of producing energy in Denmark to determine societal value and costs of various options. However, the envisioned worlds, and the Valuation Frame they assemble end up being worlds apart. In the EA report, rising CO2 prices are framed as a given, and although some *Back-up Capacity* costs are included, they are small compared to the included decarbonization benefits (through a rising CO2 price ultimately surpassing 30 €/ton). When the quality of *CC Mitigation* is salient, wind power is highly valuable to society. System back-up costs to accommodate the variability of wind is accounted for with a small extra charge. But costs in the form of stranded coal and gas assets, is not calculated into wind powers costs, and is instead considered a cost, which the entire energy system must bear. So in the envisioned world the energy system must transition towards decarbonization and the majority of the incurred system costs are not connected to one single energy source.

The RW report enacts a framing which makes a distinction between conventional and non-conventional energy sources. The categorization of wind power as non-conventional enables the removal of it in the counterfactual analysis. As this is done with wind power in Denmark, the energy source is valued on the basis of how large a “cost burden” it places on an energy system, which is framed to be able to effectively function without wind power. The reason this energy system could function without wind power, is partly due to the disregard for the qualities of *CC Mitigation* and *Environment*, which are left outside of the frame. The RW Co-author states that they just want to get the numbers on the table, but by omitting environmental policies, the numbers are already assuming a given world. It is just a world where politics are already embedded in the existing electricity production prices.

In the case of the EA report, the conclusion that “wind power is cheapest” is challenged by some actors and reconfigured into a question of ending subsidies by others. The RW report proposes an argument based on an unobservable scenario, which equates to something like ‘removing wind power, without accounting for climate effects, could potentially have made our electricity 14% cheaper’. This conclusion is readily accepted by the majority of media outlets and the numbers are even further black-boxed in additional calculations by Berlingske. This indicates that calculative agencies and media publics are cultivated to think of wind power as an expensive cost burden. The Rockwool report and PFB’s critique of the EA report, shows that due to carbon lock-in (Unruh, 2000, 2009) it is possible to calculate a cheaper “continuation” solution, than to build wind power. The consequence of such a calculation is that a continuation strategy appears as the best possible option. That is of course under the assumption that the need to mitigate climate change is disregarded from the calculation. The RW report’s framing of wind power as a *Fuel Supplement* shows that this old framing that wind power is something supplementary and added could still be conceived of in 2014.

The EA report fits well within the overall framing of the Global-coalition. The RW report also calculates *Technology Cost* but the counterfactual analysis follows the methods of the DEC during the Market Distortion period. This small part of the overall report became the main take-away, and this showed that there was still active Market-Coalition actors for whom the entrenched meaning that wind power is supplementary resonated well. Despite this element, the RW report’s other conclusion did re-produce the dominant Global-coalitions framing that *Technology Cost* for wind power is a high positive impact quality. I therefore do not place the RW authors or the report in the listed coalitions, but included it here as it was beneficial in highlighting entrenched meanings in the valuation history of Danish wind power. I did spend a considerable amount of time on these two reports, as they show some interesting things about entrenched meanings. These findings can be summed up in the three key observations. Firstly, the speed at which news-media work enforce entrenched meanings. Secondly, there was still in 2014 resistance to the calculations showing wind power as the cheapest energy source. Thirdly, due to this resistance, the counterfactual calculation that resonate with entrenched meanings of wind power being an added cost to the system appeared to trigger the same or even less resistance than calculations showing wind power to be the cheapest technology. This third point happens despite the notion that the authors of the counterfactual calculation themselves label it as “unobservable”.

Although the EA and RW reports have significantly different assumptions and results, they both came to the conclusion that wind power is the cheapest energy source if one is to build and produce electricity in 2014. This is a rather decisive turn in the calculative history of wind power, and will form a large part of the dominant Global Advantage Valuation Frame. It therefore marks the end to this empirical period and hereafter follows the empirical summary wherein the dominant valuation frame and network will be presented.

6.4. GLOBAL ADVANTAGE: VALUATION FRAME SUMMARY

In this section, I summarize the empirical findings from this chapter, beginning with the new valuation frame, since no new qualities emerged during this period.

6.4.1 The Global Advantage Valuation Frame

The Global Advantage valuation frame reflected a return to the Climate Solution framing, but with the positive value drawn from more positive impact qualities. The Global Advantage valuation frame was therefore very different from the Market Distortion valuation frame. Although the shift was very gradual between 2006 and 2008, a valuation drama was unfolding, especially within Venstre, as some stuck to the old Market-coalition and others joined the new Global-coalition. But members of the other three major parties and several large private actors adopted the Global Advantage valuation frame, which thus encompassed the broadest group of actors during the five periods. The shift in Valuation frames is shown in Figure 30 (GBA).

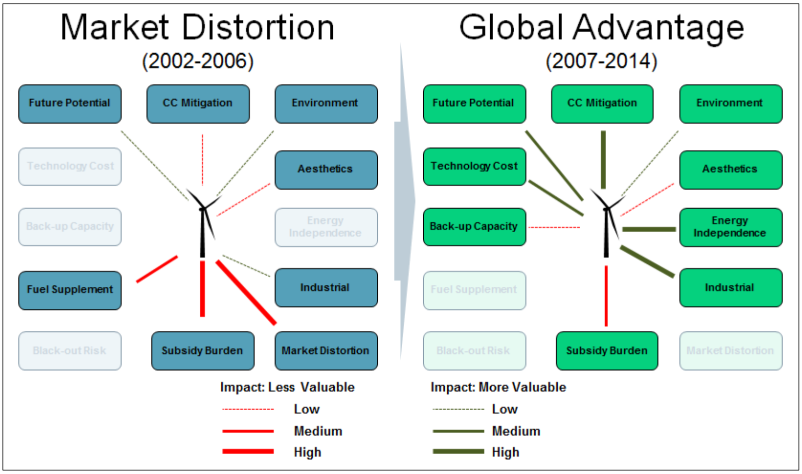

Figure 30: The third (MD: 2002-2006) and fourth (GA: 2007-2014) Valuation Frame.

Energy Independence provides early start to New Dominant Valuation Frame

As Connie Hedegaard attempted to persuade Anders Fogh Rasmussen to host the COP15 in Copenhagen, she emphasized Denmark's strained relationships with oil producing countries, where people were burning Danish flags in the streets in response to the Danish cartoon crisis. This element was highlighted by Anders Fogh Rasmussen in his 2008 "green speech," and was one of two key pillars (the other being *CC Mitigation*) motivating the Climate Commission's 2010 report. Although the quality of *Energy Independence* was not explicitly calculated in the calculative reports, it had a positive impact, especially early in the period.

Technology Cost Re-emerge with a Positive Impact

Whereas the Climate Distortion valuation frame did not measure *Technology Cost*, the Global Advantage valuation frame returned to the 1990's metric of LCOE; since *Technology Cost* for onshore wind decreased significantly during the 8-year period, the quality had a strong positive impact on value. The 2009 CEESA report, the 2010 Climate Commission report, the 2014 DEA report and the 2014 Rockwool report all calculated the technological costs of onshore wind to now be competitive with alternative energy sources such as gas and coal.

Salience of Industrial Quality Increases as the Market Distortion Quality Fades

Throughout the period from 2007 to 2014, the *Industrial* quality, as seen through a strong wind industry in Denmark has a high impact. This was especially salient during the COP15, when local businesses benefited from Denmark's exposure as a clean energy pioneer touted the industry's job-creating benefits. The *Industrial* quality was emphasized in the CEESA analysis and the Climate Commission's plan for the decades leading up to 2050. The number of jobs created was another strong lever in the discussions related to the two energy agreements (2008 and 2012) negotiated during this period. *Industrial* advantages were recognized throughout the period and the *Industrial* quality was the most broadly agreed upon by actors in the Global-coalition. *Industrial* advantages were touted by the large interest organizations DI and DE, while Esbjerg Harbor became increasingly involved in promoting the jobs created by the two offshore wind farms, the existing Horns Rev 2 and the proposed Horns Rev 3. Meanwhile, the *Market Distortion* quality, which was made salient in the 2002 DEC report, disappeared from the dominant valuation.

CC Mitigation Highly Salient, but Subsidy Burden Concerns Remain

The COP15 conference was, at its heart, a climate change mitigation conference. Although many other qualities played a role in forming the new valuation frame, *CC Mitigation* became more and more salient as momentum grew around the conference in 2009. *CC Mitigation* was a key quality for the influential minister, Connie Hedegaard, her predecessor Lykke Friis, as well as the two ministers from the S-RV coalition, Martin Lidegaard and Rasmus Helveg. The *CC Mitigation* quality was also salient in the calculations of expected prices for CO2 offsets projected in both the 2009 CEESA report and the 2014 DEA report. Yet, internal disputes and contestations over the strong connection between *CC Mitigation* and wind power expansion continued, especially within the Venstre party. Energy spokesman, Lars Christian Lilleholt represented a wing of the party, which together with actors such as L&F, viewed biogas and biomass as better solutions for the energy sector transition. Likewise, calculative centers that emerged during the Market Coalition period, such as DEC and CEPOS, continued to produce calculations which pointed to the distortive effects of wind power, yet were not able to destabilize the dominant valuation frame. Although the *Market Distortion* quality faded away, the *Subsidy Burden* quality remained in the framing. This was maintained by constant reiterations from actors outside the Global-coalition, such as CEPOS, L&F and the members of Venstre who were still part of the Market-coalition. This is most clearly seen in the negotiations over the 2012 energy agreement; Venstre members successfully negotiated to decrease wind power investments on several occasions, both before the agreement was passed and after it had become law.

Growing Salience of Future Potential, Non-Influence of Environment and Aesthetics

The *Future Potential* quality relates to increasingly lower costs and better technical performance of wind turbines over time. Offshore wind was framed as becoming more competitive, and in 2012 the wind turbine industry made a pledge to cut costs by 40% over the next 8 years. The calculative reports which formed the valuation Frame highlighted that onshore wind was now the cheapest new-build option, and that offshore wind could follow a similar trajectory. The *Future Potential* quality grew in salience, but was not the defining quality of the valuation frame, as current *Technology Cost* were used to justify wind power investments. Finally, both the *Environment* and *Aesthetics* qualities were mentioned in calculative reports at the time. In fact, an investigation into possible health impacts of living close to a turbine was initiated in 2014. However, neither of these two qualities played a central role in political negotiations or calculative reports.

6.4.2 The Global Advantage Valuation Network

As previously mentioned, the Global Advantage period was defined by a broad framing with several qualities around which a broad coalition of actors gathered. Although the dynamics of this period had many moving parts, I attempt to outline the key actors of the Global-coalition in the sub-sections that follow.

Shifting Coalitions and Broad Compromises

During this period, a combination of shifting alliances among actors and the materiality of a large-scale industry led to the creation of a new valuation network. The global coalition comprised a broad range of actors and was built on the notion that Denmark could address an international challenge (*CC Mitigation*) while creating positive societal benefits (*Industrial*, *Energy Independence*). Large Danish organizations supported the framing, which calculated investments in wind power as valuable to Denmark. The wind turbine industry had grown significantly, and was a major actor in the dominant Global-coalition, along with two previously neutral players, Danish Industry and Danish Energy. Another important actor in this constellation was the IPCC, which represented the international momentum built around the COP15 in Copenhagen. The conference had increased the salience of the *CC Mitigation* quality and the potential of the *Industrial* quality by promoting Danish wind power solutions to the international market to help prevent global temperatures from rising more than 2 degrees Celsius.

The Global-coalition encompassed several independent calculative centers. The DEA solidified the valuation frame by concluding in a report that onshore wind was the cheapest energy source. The engineering group IDA and their collaboration with the CEESA group at two universities, AAU and DTU, also exercised calculative agency in the dominant valuation network.

On the political side, De Konservative moved to an anchoring position in enabling this valuation network, through spokeswoman Connie Hedegaard. Even after she left the party to become EU Climate Commissioner in 2010, the party silently pursued the direction she had set. Together with the left wing parties, Socialdemokratiet and Radikale Venstre, De Konservative found common ground for collaboration.

The other governing party, Venstre, split into two factions. Anders Fogh set a new direction by beginning to value wind power more highly due to the strong positive impact of its *Energy Independence* quality, and prominent members of the Venstre party, minister Lykke Friis and environmental spokesman Eyvind Vesselbo, animated this perspective for some time after the COP15 in 2009. However, by the end of this period, both politicians had either left or were in the progress of leaving the party.

In contrast, Lars Loekke Rasmussen, Kristian Jensen and Lars Christian Lilleholt were hesitant to embrace the strong push towards wind power and represented a wing of the party which would hold on to the Market-Coalitions way of framing wind power. This wing would adhere to Venstre’s historic close ties to the agricultural sector and especially Lars Christian Lilleholt had produced framings wherein other energy sources were more valuable investments, such as biogas and biomass. As Lars Loekke Rasmussen assumed leadership of Venstre in 2009, these politicians moved to positions from which they would become central players in the period that follows hereafter. The Venstre party split into a “Global” wing, which was a key actor in enabling the Global Advantage valuation frame, and a “Market” wing, which attempted to destabilize it in 2013 and 2014. The party thus was divided, and the “Global” wing that supported Anders Fogh Rasmussen’s new direction had lost influence by the end of the period. The “Market” wing still adhered to the market-coalition’s framing, and was more closely aligned with the agricultural sector, whose report had also called for lower investments in wind power. The market-coalition’s view also continued to be expressed in the DEC’s calculations throughout the period starting in 2008, when it reiterated its 2002 argument for a CO2 market solution. The right-wing think tank CEPOS also met resistance to its calculation that wind power has no effect on the climate, based on logic similar to that of the DEC. These destabilization attempts were unsuccessful as work continued towards the negotiation of the 2012 agreement, which saw the largest approved expansion of wind power capacity in Danish history. The key actors are as usual pictured in figure 31 below (GBA). Green is the Global-coalition; Blue: The dispersed Market-coalition. The gray boxes are neutral actors.

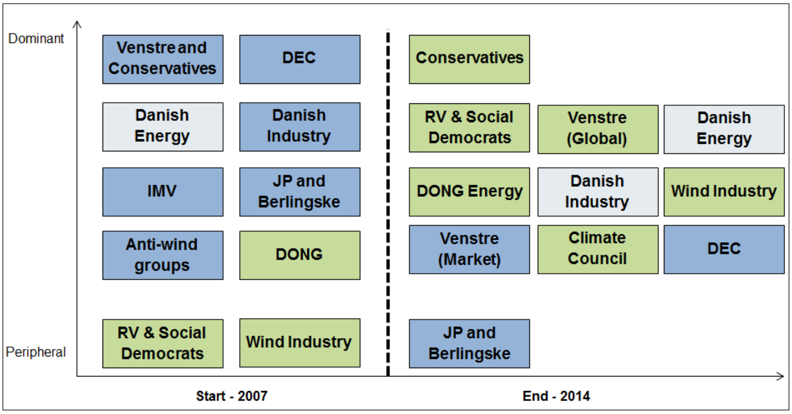

Figure 31: Key actors during the GA period; green: Global-coalition; blue: Market-coalition.

Materiality during the Global Advantage Period

The period from 2007 to 2014 was defined by the expansion of wind power capacity recovering from the near-stand-still in the early 2000's, to grow at an annual rate of 6% per year. This was driven primarily by three large offshore wind farms, Horns Rev 2, Roedsand 2 and Anholt, which collectively accounted for nearly half of the 1.7 GW of new added capacity. The Anholt offshore wind farm was negotiated into the 2008 energy agreement and was made possible due to the green momentum of the left wing and De Konservative. The explosive growth of exports observed in 2006 as the global wind markets started to take off continued until 2008, when the industry scaled back operations significantly in terms of both exports and employees in the wake of the global financial crisis. In 2014, after the first signs of recovery, the Danish wind industry consolidated further and maintained a foothold in several large export markets. The 2008 energy agreement restored stability to the onshore wind market through a reinstatement of the 25 Oere/kWh compensation to producers of wind power electricity. Thereafter, the period was defined by the approval of large construction contracts for offshore wind farms, approved in the 2008 and the 2012 agreement, which stabilized the emerging offshore wind industry. The materiality figures are shown in Figure 32 (GBA) on the next page (Appendix A).

Offshore Wind Farms (>30 MW)	Size	Approved	Commissioned
Horns Rev 2	209	2004 (1998)	2009
Rødsand 2	207	2004 (1998)	2010
Anholt	400	2008	2013

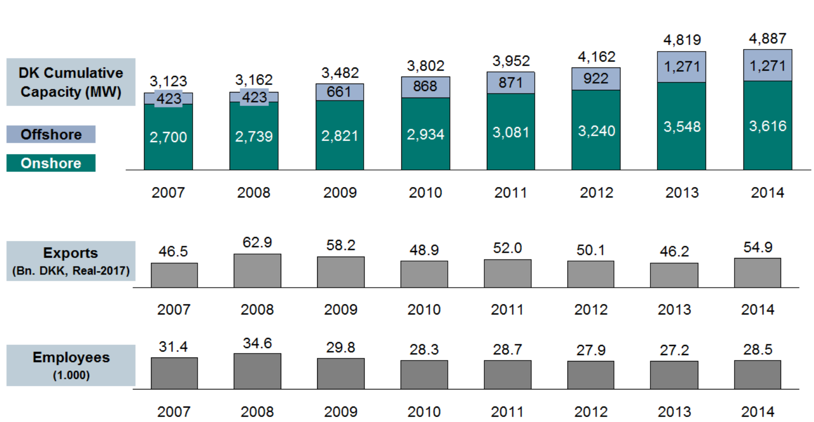

Figure 32: Capacity expansion during the Global Advantage period.

When the analysis moves into the last period in the next chapter, the offshore wind industry will come to play an even larger role in the framing of Danish wind power as there will emerge difference in framing of value between onshore and offshore wind power[158].

But there was oncoming concerns from changes to a material actor which also is of the Global Advantage Valuation Network, namely the electricity price (Energitilsynet, 2002; NordPool, 2018). The electricity price is affected by such things as the EU ETS CO2 quota price, and as this does not appear to increase in the prognosis near the end of the period the electricity price prognosis is also affected. In the year where the 2008 energy agreement was reached the annual average spot-price at the Nord-Pool market was 57 EUR/MWh, whereas it had fallen to 31 EUR/MWh by 2014, a 28% drop over 6 years (NordPool, 2018) The electricity price is an material actor affecting the Global Advantage valuation network, as the cost of subsidies rises when electricity prices falls. This is both due to the design of the PSO, but it is amplified by the build-out of offshore wind farms, which have subsidies that are set at a fixed strike price. This destabilization from the low electricity price will continue in the period that follows hereafter.

[158] I will however still keep onshore and offshore wind power portrayed within the same Valuation Frame model, although I recognize there are differences. These will be addressed in the text.

6.4.3 Key Takeaways from the Global Advantage Period

The shift away from the Market Distortion valuation frame is a significant moment of valuation, although it occurred more gradually than in the previous moment. *Energy Independence* became a salient quality, which again helped frame wind power a valuable geopolitical defense, especially in light of the 2005–2006 cartoon crisis. This quality was especially salient to the part of the network on the right wing of the political spectrum. The *CC Mitigation* quality was reintroduced into the framing, as Connie Hedegaard successfully lobbied to host the COP15 conference in Denmark in 2009. In subsequent years, the 2010 Climate Commission and the 2014 Climate Council (with overlapping team members, Katherine Richardson and Poul Erik Morthorst) continued to articulate the need to account for the value of climate change mitigation in the Danish energy system. Furthermore, industry growth began in 2006, and skyrocketed in 2007 and 2008. Like the rest of the world, the wind turbine industry was affected by the financial crisis, but recovered faster than other Danish industrial sectors. Accounting for nearly 5% of all Danish exports, growth potential in the sector was more broadly recognized than it had been in the 1990s. These three events—awareness of *Energy Independence* in the wake of the cartoon crisis, a focus on *CC Mitigation* through COP15, and a growing export market for the Danish wind industry—enabled the shift to the Global Advantage valuation frame.

There are large overlaps between the Global Advantage and Climate Solution valuation frames. Although the Climate Solution frame relied heavily on the *CC Mitigation* quality and on capturing *Future Potential*, by the Global Advantage period, this potential had been realized to a great extent. Thus, the new Global Advantage valuation frame encompassed a larger set of high-impact positive qualities. The closest wind power came to being “indispensably valuable” in this period was in the spring of 2012, when the most ambitious energy agreement in Danish history was passed with support from all political parties except Liberal Alliance. A very important factor to the stabilization of the Global Advantage valuation frame by the end of the period was the strong positive impact of the *Technology Cost* quality. Critiques regarding the competitiveness of wind power’s technical costs were not immediately silenced, but it would however come to signal a change over time. Both the DEA and the RW calculated wind power to be the most competitive energy source in technology comparisons, and in the years to follow it would not be the isolated *Technology Cost* that were contested. Major industrial organizations supported the overall positive valuation of wind power, and even the DEC softened its position on wind power during this period (Appendix C). Outside the valuation Network was the “Market” wing of Venstre, CEPOS and L&F, who disagreed with the direction taken, and pushed for a Valuation Network with a material configuration mainly based on international CO2 pricing and wind power subsidies which did not interfere with proximate sectors. Hereafter follows the final moment of valuation, Subsidy Burden (2015-2017), where the valuation drama would move from *Technology Cost* to *Subsidy Burden* and *Aesthetics*.

7. COMPETITIVE WIND IS FRAMED AS A SUBSIDY BURDEN

The final empirical chapter of the valuation drama will take its start in the summer of 2015, where a new minority government of the party Venstre takes office. The new administration would see an actor that Market-coalition wings spokesman in Venstre, Lars Christian Lilleholt, become Minister of Energy, Utilities and Climate. Hereafter would follow a number of significant shifts from the valuation frame during the Global Advantage period. The shifts in this moment of valuation are struggles between market-coalition actors who try to disassemble central elements of the valuation network that had been built up by the Climate-coalition and later the Global-coalition. This happens with varying degrees of success as the global coalition is still well-represented in both government and among private actors. Although the period only covers three years, it is a significant final piece in understanding the valuation history of Danish wind power today.

The first sub-chapter analyzes the shifts marked by the 2015 summer election and takes it starting point from an actor profile of Lars Christian Lilleholt and his signaled priorities as the new minister of Energy, Utilities and Climate. The sub-chapter concludes with a walk-through of a number of R&D cuts, here among to wind power research projects, enacted within a few months of the election. The second sub-chapter is about the 2016 campaign to abolish the PSO-tax, and how the near-shore turbines in the 2012 energy agreement were problematized as being too expensive despite a record low bid-price for their subsidies. The third sub-chapter is about developments in the onshore wind market and the emergence of the notion of technology neutrality. The chapter is as usual concluded with a summary of the new dominant valuation frame and network.

7.1. NEW GOVERNMENT SIGNALS GREEN REALISM (2015)

In June 2015, Denmark elected a new right-wing minority government formed by Venstre without any coalition parties. Venstre's energy spokesman since 2005, Lars Christian Lilleholt (LCL) became minister for the department of Energy, Utilities and Climate (hereafter just referred to as Energy). Hereafter follows a short actor profile of LCL which covers his campaign up to the 2015 election, as well as his prior activities outside of parliament.

7.1.1 A Market-Coalition spokesman takes office

Lars Christian Lilleholt (LCL) is a journalist by education, and came from a professional background of seven years as the first communications-employee and later Head of Communications for the Danish District Heating Association (DDHA), the union of decentral gas and biomass heat-power plants in Denmark (FT.dk, 2017a). He would then move on to serve as vice-chair of the DDHA board, which he would occupy the five years until he became minister in 2015.

LCL's experience with the energy sector also comes from his board-membership of several utilities, of which five years were at EnergiFyn (ENF, 2016) and three years at NGF Nature Energy (NGF, 2016). From 2014-2015, LCL also served as vice-chair of "Fjernvarme Fyn", a municipally owned district heating utility, where he, as a board-member in December 2014, agreed to buy the coal and biomass-plant "Fynsvaerket" from the Swedish utility Vattenfall for 600 mn. DKK (OKOM, 2014). Vattenfall had tried to sell the unprofitable plant since 2010 and had signaled that it would close the coal-bloc by 2019 (Wittrup, 2014c)[159]. This represented a problem for the many fruit-growers in Funen, who relied on the combined heat-power output of the plant. Lilleholt stepped in to serve as a board-member of the newly acquired Fynsvaerket (DKGOV, 2015a), and the consideration towards the Funen growers was clearly visible in the press release of the deal. Herein it was emphasized how any further green transition of the coal-plant should only happen under "consideration of the challenges that Funen businesses, such as the horticulture growers (gartnere in Danish), are facing" (OKOM, 2014, p. 1)[160].

Before the election in 2015, LCL was identified as the non-ministerial parliamentary member with the highest annual income at 1.2 mn. DKK, hereof roughly half from board-positions (Brandsen, 2015). In 2015 LCL would also break another record as he would spend between 800.000-900.000 DKK in what local media reported as a historically expensive election campaign (DR, 2015; Nyeng, 2015). Lilleholt would himself explain how he was "deeply dependent upon" these donations (V. T. Nielsen, 2016), of which a part came from the horticulture industry (Arnfred & Jessen, 2016, pp. 236–237). The overlap of interests was apparent within two days of LCL's appointment as minister, where he scheduled a meeting with the horticulture industry's political organization, Dansk Gartneri. At this meeting he reassured them that he would prioritize an industry-specific PSO tax relief (Seymour, 2015). In addition to the horticulture, cement and plastic industry, the agricultural sector in general (Drustrup, 2015; Ritzau, 2015a) was also pushing Lilleholt to lower or abolish the PSO-tax, which he also delivered as fast as

[159] Vattenfall had originally submitted a request to close the plant by 2016, but this was denied by the Danish Energy agency as it would hurt energy security and affordability of electricity in Funen.
[160] The Funen Plant burns approximately 750.000 tons of coal each year according to the previous owner Vattenfall' s estimates (OKOM, 2016). Fjernvarme Funen does not state the amount of coal burned in its annual report of 2015, but states that total emissions from Fjernvarme Fyn after taking over the Funen Plant was 1.200.000 tons CO2, due to a mild winter (FJF, 2016, p. 57).

legislation would allow it (EFKM, 2016b). It is important to note that the targeted tax relief was negotiated prior to the discussions about removing the PSO-tax started. It was however clear that the horticulture industry preferred to be rid of the tax completely, and this possible option was also written into Venstre's government manifest as the only exception to a promise that they would not raise taxes. In the manifesto it was stated that it might be needed to raise other taxes if EU legislation forced them to change the PSO-tax (DKGOV, 2015b, p. 8).

LCL can thus reasonably be characterized as a very locally oriented minister and has also in several surveys been identified as one of the most "unknown" ministers on a national scale (Budolfsen, 2017; Holstein, 2016). LCL has also publicly stated that he is not overly concerned about his anonymity as he ultimately considers himself liable towards the business interests and the voters in his home district of Funen, because they decide his future (Budolfsen, 2017). In summary, LCL is a spokesman for an actor-network of incumbent interests, which he represents in the form of several board-member positions within the gas industry, and a central role in the Funen municipality's purchase of one out of Denmark's two last coal plants. But what is interesting here is also his connection to a proximate field to the energy field, namely the horticulture and agricultural sector in general.

The Subsidy Burden quality is made highly salient

The first thing LCL did as energy minister was to scrap previously set goals for Denmark to remove coal by 2030 and remove gas by 2035. Additionally, confirmed that the Venstre-government definition of "fossil independent", and not "fossil free", meant that Danish companies could still burn coal, gas or oil in 2050. The only requirement for being fossil independent in 2050 was that renewable energy could produce the equivalent of 100% energy usage. LCL also emphasized that the goal of having 50% of Denmark's electricity come from wind power in 2020 was not something that Venstre had signed off on (Færgeman, 2015). Wind power was thus only seen as valuable to the extent that it does not disturb current fossil fuel infrastructure, upon which Lilleholt was a central player before he became energy minister. LCL's approach to energy policy appears to show a strong focus on reaching EU-mandated goals through the lowest possible costs. This is to be done through trust in an undefined market selection between what LCL considers generic and comparable renewable energy sources, as seen in the following three quotes by him:

> “(We will) ask the market to show how we in the cheapest way can achieve the goals (EU goal of 27% renewable energy in 2030, ed.)…If it is wind, solar or biomass – that is not decisive for us. On the contrary, we want to have it as cheap as possible”. (Færgeman, 2015)
>
> “We must choose cheaper solutions; Denmark cannot afford the Grand Cru edition in the long run”. (Heinskou, Færgeman, & Carlsen, 2015)
>
> “The goals must be pursued at the lowest possible cost and must not be accompanied by sacrificing the competitive ability of our companies on export markets.” (With, 2016)

LCL sees wind power as valuable through its quality to achieve a mandated EU-goal, at a cost that must be deemed cheap enough in the eyes of “companies on export markets”. In extension of this LCL has defined his role to primarily be a watchdog for consumers who worry about costs, as seen in the three quotes below.

> “As minister of supply, the concern to the consumer is the most important to me. I exist for the consumers..”. (Lilleholt, 2016)
>
> “As a minister, I am the spokesman of the consumers”.(Ritzau, 2016a)
>
> “As the consumers’ minister, I am concerned with getting the supply services delivered as effectively, cheaply, environmentally friendly and as safe as possible. This should be done by creating more competition, where it makes sense.” (Ritzau, 2016c)

This framing of the Danish citizens as being consumers which mainly are concerned about costs produces a framing of wind power investments from LCL’s perspective. There are a number of EU-mandated goals, which have to be met and LCL’s task is to protect the consumers from paying more than necessary in reaching those goals. As Danes are framed as consumers they become purchasers of a good, energy services, and not as citizens living in a society built on energy structures with certain qualities affecting the society they inhibit. Hereafter follows the first actions that LCL and the returning Market-coalition actors took, which impacted the valuation network of wind power.

7.1.2 R&D funding is halved and future wind build-out is problematized

In September 2015, a Venstre-government memo which detailed substantial cuts to green R&D and development aid programs was leaked to the press. Lilleholt justified the plan to cut funding with an argument that the government had learned that in 2016, there was 3 bn. DKK less in the public budget[161] than the previous government had budgeted with, and when one looked towards 2020, there was allegedly 8 bn. DKK missing (J. S. Nielsen & Stræde, 2015). The government argued that substantial cuts had to be made to avoid being penalized by the EU, and some of the hardest cuts were within environment and climate programs[162]. The portrayed imminent "budget crisis" was named as the reasons to propose substantial R&D cuts, most notable an 85% cut (from 385 to 57 mn. DKK) to the highly successful energy research program "Energiteknologisk Udvikling og Demonstration" (EUDP) (J. L. Hansen, 2015)[163]. The Global-coalition political actors of the opposition parties and De Konservative would however not allow such a drastic cut, and brought in reserve funds (127 mn. DKK) set aside in earlier years, to negotiate the total EUDP budget for 2016 up to 184 mn. DKK, roughly half of its average size the previous three years (DWIA, 2015b). Although the missing 3 bn. budgetary crisis was the argument for the substantial cuts to the energy research, the government had in the same budget allocated 4 bn. DKK to lower taxes, here among the tax on NOx emissions from 25 to 5 DKK (240 mn. DKK in annual costs) (DKGOV, 2015d). The cuts to energy research, herein included wind power research projects, thus appears to be a political prioritization framed as a "necessary" budgetary action.

The EUDP cuts did however also serve another purpose, as it helped the government get Denmark more cheaply into an international research collaboration called "Mission Innovation". In this collaboration of 21 countries, the government should commit to double their Energy R&D funding towards 2020. The baseline from which to calculate the doubling was calculated as the average funding for EUDP in

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[161] This was out of a final annual Danish expense-budget of 1105 bn. DKK in 2016. The "missing" 3 bn. DKK thus corresponded to less than 0.3% of the budget (DST, 2017).

[162] The numbers that should enact this crisis were disputed by both the Economic Councils (Ritzau, 2015d), and leading economists in the private sector such as Danske Banks Steen Bocian (Ritzau, 2015c). The critics stated that Denmark had a healthy economy and that there was not enough transparency around the government assumptions.

[163] The EUDP program was designed to help develop technical and system solutions that could enable Denmark to become fossil free in 2050 and was co-founded so that the public investments was supplemented by private actors who joined the various specific projects. An analysis ordered by the government TSO Energinet and published on the Danish Energy Agency's website showed the effectiveness of the program. The previous years' projects had shown that for each 1 DKK invested in EUDP, 2.7 DKK in added revenue was created among the participating firms. These firms were demonstrating new technologies and of the 2.7 DKK in added revenue, 2 DKK would be in the form of exports (EnerginetDK, 2015a). This report was available at the time of the signaled cuts, but the *Industrial* benefits of this program were not salient in the government's considerations.

the 2015 and 2016 budget. Since there were so significant cuts to the EUDP budget in 2016, the government got into Mission Innovation with a 2020 target of 580 mn. DKK in EUDP funds (As the target for participating countries was set as twice the average EUDP level of 2015 and 2016). In the 2017 budget the government would then cancel the research program "ForskEL" and move these funds into the EUDP program in order to show a small increase since 2016. Although the original EUDP budget was again being cut, the added 130 mn. DKK from the closed "ForskEL" program, made it appear as if EUDP funding grew in 2017. Even though the target of 580 mn DKK technically would be a doubling of the 2015-2016 level, it would not be much higher than the level of those two programs combined funding in 2013, 2014 and 2015. The figure below shows the developments described above and the 2020 Mission Innovation Goal (DE, 2016). The status at the end of 2016 was that in the two budgets under LCL, energy research funding was halved compared to its previous levels (DE, 2016; DWIA, 2015b)[164]. Figure 33 (GBA) is based on the reported funding levels quotes above.

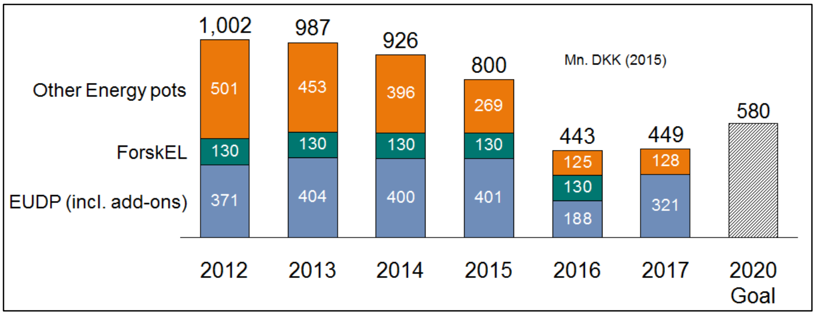

Figure 33: EUDP Funds and the 2020 Mission Innovation Goal.

The dramatic cuts in energy research were well in line the Market-coalitions framing and new narrative of "green realism". LCL had openly explained that he considered the green policies under Anders Fogh Rasmussen's last years in office to have been too big of a turn both in how Climate Change was discussed and the actions taken (Loevkvist, 2016). LCL argued that it was not beneficial for Denmark to build-out renewable energy too fast, concurring well with the Market Distortion Valuation Frame. LCL argued that if Denmark was too ambitious, other countries in the EU would lose their motivation as we would be "running too far ahead". This framing of

[164] Note that the numbers in the graph below include a set of smaller pots to the EUDP number, which is why the EUDP of 2016 is 188, although it was the 184 mn. mentioned in the text that it was negotiated up to in the political compromise. The graph is thus presented to show the rough size of the pots and how the Mission Innovation number was reached.

action on climate change, makes initiatives such as a coal-phase-out appear as symbolic gestures, something which LCL argued had never been the intention of the European Union. Instead, he argued that the EU wanted countries to run "roughly side by side" in the "marathon" towards the EU 2050 goal (Lillleholt, 2015). This was however in direct contradiction with the European Commission's position on the topic in 2008 when it argued that "targets should take account of national starting points and potentials, including the existing level of renewable energies and the energy mix" (EUC, 2008, p. 7), and in a 2013 Green, wherein the EUC called for a shared effort "with a lighter burden falling on lower income member states" (EUC, 2013, p. 12). In a 2015 country review, the EUC noted that Denmark in general had under-invested in energy infrastructure since the early 2000's (EUC, 2015), and was thus nowhere near "running" ahead of the field. Nonetheless, LCL upheld the focus on his main task of reducing costs. When asked what ambitions he had for his time in office, he replied that implementing 2012 agreement would be difficult enough, as seen below.

> "We have no plans to take further initiatives, build additional offshore wind farms or similar apart from what is already agreed in the energy agreement...I actually believe we are facing a very large task in implementing the agreement we signed in 2012" (Lynge, 2015)

The Market-coalition and LCL were however not successful in all attempts to disassemble the Global Advantage Valuation Network. LCL believed the public debate about climate change had become "too elitist" and early on sought to re-establish the Market-coalition actor Bjoern Lomborg as a government-funded public voice in the debate. This plan would however be halted by De Konservative, who denied LCL the votes to establish a new government-funded platform for Lomborg (Ritzau, 2015b). LCL did however manage to disassemble two successful research programs and signify green energy investments as both wrong from a domestic viewpoint (can we afford it) and from a foreign viewpoint (the EU does not want us to run too far ahead). These early initiatives bear resemblance to the actions taken by the Market-coalition in 2002, although with more limited success this time around. In this initial phase, wind power as an object is not discussed but a focus to cut various research programs supporting wind power is upheld to avert a constructed economic emergency. The Market-coalition's early focus was to decrease tax-levels for Danish businesses in general, and would after the first initiatives turn its attention to the goal of abolishing the PSO-tax completely.

7.2. ARTIFICIAL CRISIS IS INVOKED AROUND PSO AND NEARSHORE WIND (2016)

This chapter will cover the destabilization attempts towards the prosthetic device of the PSO, and the proposed nearshore build-out. These elements are part of the Global Advantage Valuation Network and would become a main point of destabilization for the Market-coalition now that it had regained the Ministry of Energy. The chapter will first discuss how the PSO became framed as a matter of concern, and after it is shown how the proposed near-shore turbines, agreed in the 2012 energy law, also became contested.

7.2.1 Proximate field actors argue to be burdened by PSO

Lars Christian Lilleholt (LCL) would within his first months in office define the PSO-tax as his biggest task, and signaled that his highest priority was "to bring down the expenses of the Danish industry to the PSO" (Brandstrup & Søndergaard, 2015). Before embarking on his larger project to abolish the PSO-tax completely, Lilleholt received EU approval to give a targeted tax relief of 1.1 bn. DKK to energy intensive businesses over five years, thereby shifting some of the PSO's costs of the Danish tax-payers (Stenvei, 2015)[165]. This marked the beginning of an exercise in splitting the bill differently, where the costs of financing green energy would move from companies to households.

Tax Ministry calculates benefits of removing the PSO-tax

The campaign to abolish the PSO-tax began in December 2015, with a §20 answer to the Ministry for taxation upon a question from the small right-wing party, Liberal Alliance. The question referred to a report from March 2011, during the previous VK-governments final months in office, which calculated benefits to lowering electricity taxes. The methods used were similar to the DEC's 2002 calculation methodology which considered energy taxes to be more distorting to society than income taxes. By using this method, the ministry for taxation calculated that if the anticipated annual 4.5 Bn. DKK cost of the PSO-tax in 2020 could be moved to the annual budget, it would give a "socio-economic benefit" of 1.5 bn. DKK (SAU, 2015, p. 2). This benefit came primarily from reducing "distortion losses" and thereby increasing anticipated household consumption. Although the answer in its

[165] The Public Service Obligation (PSO) is in DK charged as a fee on top of electricity prices, so that it increases by roughly 50% of what the electricity price decreases. It is used to finance DK's green transition, therein wind power. The PSO was in 2014 6.9 bn. DKK, 2015: 8.4 Bn., 2016: 7.4 bn. Wind power subsidies approximately make up 50% of the PSO-costs (EnerginetDK, 2017).

final paragraph emphasized that “It must be emphasized that there are uncertainties connected to the magnitude of the total benefits” (SAU, 2015, p. 3), the number in the note would be central to the mobilization of the Market-Coalition in the months to come.

In January 2016, a number of Market-coalition actors, the right-wing business newspaper Børsen, LCL, Liberal Alliance, but also the previously Global-coalition actors, Danish Energy and Danish Industry, would initiate a campaign to abolish the PSO-tax completely. It started with a number of Børsen articles with headlines such as “New numbers: Scrap PSO and score 1 bn. in BNP-growth”(Søndergaard, 2016d), “Billion kroner benefit to butchering green special tax” (Søndergaard, 2016c) and “Headache can be removed in two ways” (Søndergaard, 2016a). In these articles, the ministry of taxation calculation would be cited as proof that a 1-1.5 bn. benefit could be gained by removing the PSO-tax. The articles would find cases of Danish companies that would benefit from this, such as the plastic producing company Expo Net (80 employees), which annually payed 800.000 DKK in PSO-taxes. These payment could according to the CEO be translated into “a little more than half an employee every year” (Søndergaard, 2016c). The large Danish food producer and member of L&F, Danish Crown, would point to the unfair situation where “the people who build wind turbines are guaranteed a fixed price for 10 years”, while Danish Crown did not know what the future PSO-tax would be (C. L. Hansen, 2016)[166]. In February, Danish Industry and CO-industry (umbrella-organization representing unions for 230.000 heavy industry workers), wrote a joint Op-Ed with the title “the PSO is strangling Danish production”. In the Op-Ed, a Funen-located metal welding company Tasso (53 employees) was highlighted as an example of a company that suffered due to the PSO-tax. The solution was very explicitly identified as being a move to the annual budget. The OpEd cited the 1.5 bn. DKK benefit from the December ministry note. Likewise it would also be hinted that the EU should have declared the PSO-tax to be in violation of EU-law (C. Jensen & Dybvad, 2016), something which was the second leg of the destablization attempt.

The EU Commission is falsely said to have declared the PSO-tax illegal

The Børsen articles would in addition to the business losses also highlight that the PSO-tax was a “headache” that had to be dealt with due to the EU’s alleged problematization of it. Boersen referred to two ways of solving the labelled “headache”; 1. Moving the PSO tax to the annual budget and gain an alleged 1-1.5 bn. or 2. Give foreign producers of electricity access to Danish PSO-funds. The second option was not further explained in detail although it was being used in other

[166] Danish Industry would in the same article emphasize that Danish companies were disproportionately burdened by the PSO compared to its European colleagues.

EU countries. Boersen would only cautionary warn that “if foreign electricity producers can get their hands on Danish PSO-funds, there is a risk that the PSO-bill could rise further” (Søndergaard, 2016a). Through Boersens highly simplified version of the available options, the best choice is presented as obvious to the reader. The first is Boersens framed proposal that Denmark moves the PSO-tax to the annual budget and get an alleged huge gain in BNP while helping the struggling industries of Denmark. Alternatively Denmark could open up the tax-payer coffins to unspecified foreign electricity producers, and risk paying an even higher bill. At this early stage of the campaign, LCL was present in the discussion, but would not specifically mention which solution he preferred. He merely hinted that he found the annual budget solution “interesting” and commented on the “large growth-potential” in abolishing the PSO-tax (Søndergaard, 2016c, 2016d). Lars Aagaard of Danish Energy, and Liberal Alliances energy spokesman, Villum Christensen, would go one step further and mention the possibility to raise the income tax, in order to finance a potential removal of the PSO (Søndergaard, 2016b, 2016d). Although Lilleholt himself did not mention this possibility, the option to abolish the PSO-tax through raising taxes elsewhere, was present in the lines of the government’s 2015 manifesto. Although the Venstre-government had pledged not to raise any taxes in their term, they had a clause specifically exempting the PSO-tax from this rule, stating that “the government will not raise any taxes in this term…only if there are compulsive reasons, i.e. from a discrepancy with EU-rules…in the question of the future financing of the PSO-tax” (DKGOV, 2015c). So the option to do this was already accounted for back in 2015.

In the following months, the valuation network would continue their work to frame the “foreign option” as a dangerous risk to Danish tax-payers. Especially the utility actor, Danish Energy, had a lot to win by a removal of the PSO-tax, as it would make their product, electricity, significantly cheaper. Below are three of Lars Aagaards press statements with corresponding dates regarding the PSO-tax.

> Quote 1 - 19.01.2016: “The (EU, ed.) Commission demands that either the PSO-tax is put on the annual budget or we massively open up to sending subsidies out of the country. In the latter option we are no longer talking about a few million kroner. Then we are talking about several hundred million kroner”. (Søndergaard, 2016e)

> Quote 2 - 22.01.2016: “I have concerns about whether or not the public support will continue to be there, if we send considerable millions out of the country to build windfarms in Romania, Poland and the Czech Republic or wherever it could be.” (P1, 2016)

> Quote 3 - 15.02.2016: "All indicators suggest that Denmark will get a considerable climate challenge 2021-2030 and will be forced to make hard choices. It can be hard to do anything about the agricultural sector without hurting the business. Specifically, it is hard to make cows belch less. That is why transportation and heating will be a key...There is a billion-kroner large growth-opportunity in moving the payment for renewable energy, PSO, far away from the electricity bill...to lighten the toweringly high electricity taxation will have positive green and economic effects". (Aagaard, 2016)

Note that Lars Aagaard states that the EU Commission "demands" that Denmark "massively open up to sending subsidies out of the Country" (Quote 1 of the above). Secondly, he would in a later interview state that he feared that "considerable millions" to "Romania, Poland and the Czech Republic" (Quote 2 above). The option to open up the PSO to foreign bidders did however not entail a possible export of subsidies to eastern European countries. Firstly, access to subsidies could only be given to foreign electricity providers from EU-countries that could physically transport electricity to Denmark, and had an agreement with Denmark about exchange of electricity. Therefore Denmark could only be paying subsidies to renewable projects in Sweden or Germany and not Romania or Poland. Secondly, the EU had never stated that the PSO was "illegal", but had merely stated a concern about onshore wind and solar subsidies. If Denmark would continue to tax renewable electricity from foreign bidders, it was deemed fair that a portion of the auctioned subsidies corresponding to the amount of foreign renewable electricity going into Denmark was made available to foreign bidders. This amount would correspond to 6% for the two years of 2018 and 2019. The 6% would come out of the total auctioned pot, and could also be won by Danish suppliers. It would thus only be if a German or Swedish provider could provide electricity cheaper, that they would have a chance to wind 6% of the total tendered subsidy-pot (DKGOV, 2014a, p. 11; EUC, 2014)[167]. Despite the existence of these notes and calculations, LCL, the Danish prime minister and the Minister of Finance would on separate occasions hereafter state that the EU competition authorities had dictated that Denmark to abolish the PSO (Horn, 2016; Sunesen, Glerup, Mikkelsen, & Schmidt, 2016). In a May 2016 interview, Minister of Finance Claus Hjort Frederiksen simultaneously argued that the PSO was illegal, while stating that a removal was valuable as it gave a tax relief to businesses. When asked about the PSO-tax, Frederiksen jokingly wished that he could send the PSO-tax "out to the Universe", while stating that it was not an option to keep it on as an electricity tax as this would not allow the

[167] In the case that the amount of foreign renewable electricity flowing through Denmark would rise considerably, the percentage would also increase. This is however not something that will happen overnight, so the critical message that "millions" of taxpayer money immediately would flow out of the country does appear to be exaggerated.

government to "have a special help for *gartnere/gartners* or Aalborg Portland (a cement manufacturer in Northern Jutland, ed.)" (M. G. Jørgensen, 2016). It is from such statements clear that the leading quality desired from the removal of the PSO-tax is a lowered cost related to the quality *Subsidy Burden*, especially targeted to energy-intensive industries. Before I show how the campaign to abolish the PSO-tax was concluded it is now necessary to explain the destabilization attempt towards the near-shore turbines. This concurred simultaneously with the PSO-tax campaign, as the nearshore turbines were seen as an expendable project which could lighten the *Subsidy Burden* of the PSO-tax.

7.2.2 Electricity prices are used to problematize Nearshore wind farm

The second destabilization attempt against the existing Global Advantage Valuation Network would be against the planned near-shore turbines from the 2012 energy agreement. The 350 MW near-shore wind turbines were to be built 4-8 km from the Danish western shore and put into operation by 2020, receiving a 10-12 year subsidy in the form of a guaranteed strike price[168], which depended on the result of a competitive bidding process (DEA, 2015b)[169]. The dispute about the near-shore turbines would in March be connected to the PSO-dispute as the extremely low oil prices had caused electricity prices to drop to unprecedented low levels. The Danish Energy Agency would be asked to calculate a new electricity price prognosis on current future prices, and LCL used this prognosis to show an expected PSO-tax cost of be 70 bn. DKK from 2016-2025. This calculation would lead LCL to state that now the "party was much more expensive than expected" and conclude that he had to take action (Søndergaard & Hansen, 2016a). Global-coalition actors in the form of the left-wing opposition parties and the Wind Turbine Industry Association (DWIA) industry replied with a counter-calculation. This showed that the main reason PSO-expenses were 27% higher than expected in 2012, was that electricity prices had dropped 45%. They would argue that it was misleading to only focus on the subsidy costs, as consumers actually payed less in total for electricity than what was expected in 2012 (DWIA, 2016b). The Global-coalition would in this dispute find support in the new calculative center that was founded in 2014. The Climate Council would in April release a report stating that Danish electricity prices, including PSO, were below average in the EU and that less than 5% of Danish companies had their competitiveness affected by electricity costs (Klimarådet, 2016). LCL dismissed the Climate Council's report and stated that he wanted wind subsidies on the annual budget because "the green transition should be part of a

[168] The subsidy would then cover the difference between the current electricity price and the set strike price. It is therefore the size of the strike price which determines the size of the subsidy. Utilities and financial investors would then bid in a closed-envelope tender auction for the rights to construct the nearshore farms.

[169] The 350 MW near-shore wind turbines, were originally agreed in the bi-partisan 2012 energy agreement as 500 MW (DEA, 2012a), but was later downscaled as explained earlier.

discussion of priorities alongside hospitals, traffic and other necessary investments" (E. Ø. Andersen, 2016). Meanwhile, he would in a Boersen interview state that his strong determination for abolishing the PSO-tax was motivated by a goal to provide businesses with what he described as "the largest business-tax relief I can ever remember" (Søndergaard, 2016f).
Although it had unofficially been floated before, the proposal to cancel the near-shore turbines was proposed by the government's parliamentary support, Liberal Alliance, and supported by Danish Industry in early march 2016 (Søndergaard & Hansen, 2016b). The government took up the proposal and adopted it as its official policy to abolish the near-shore wind turbines by removing the funding for the turbines in their economic 2025 plan. This plan was presented five days before the bidding process for the near-shore turbine projects ended, but the prequalified bidders would nonetheless deliver their offers to the auction, having already spent millions of kroners to prepare the bid (Crone & Søndergaard, 2016). Despite the uncertainty created, the winning nearshore bid came in at 30% lower than the auction ceiling at a record-low level of 64 €/MWh (M. Nielsen, 2016; Steel, 2016b). However, when faced with this record-low project costs, LCL maintained that the low electricity price still caused the turbines to be too expensive to build (Domino & Sørensen, 2016). This was challenged by the Wind Turbine industry Association (DWIA) as distorting the discussion about the cost of wind turbines. The DWIA argued that the actual technology cost of the project was the cheapest ever in Europe, and that it would be paradoxical to cancel the project. The unusual low electricity prices made the gap covered by subsidies appear higher than it was expected in 2012. But the current situation would apply to all energy build-out and was not attributable to the near-shore wind turbines (DWIA, 2016b). The government was using the *Subsidy Burden* of the PSO-tax to justify cancelling the near-shore wind turbines.

As the criticism of cancelling a proposed wind farm at a record low strike price intensified, LCL would amplify a previously used argument, namely that the near-shore turbines would ruin the *Aesthetics* of the Danish coasts (DR.dk, 2016; Ritzau, 2016b)[170]. LCL would bring salience to the local protest groups consisting of beach-house owners in the area and highlight this as another reason he did not want the nearshore turbines. But the road to cancelling the near-shore turbines would increase in difficulty in November 2016. The Swedish utility Vattenfall had until then won both the Horns Rev 3 and the nearshore bid, and had now also won the auction for the third offshore wind farm of the 2012 agreement, Kriegers Flak (Wittrup, 2016b). If LCL was successful in cancelling the nearshore wind farm he would jeopardize relations with the sole supplier of all of Denmark's three future offshore wind farms. Furthermore, it was hard to LCL to praise the low bid price for Kriegers Flak while arguing that the equally low nearshore bid should be cancelled. This could hurt investor relations for future projects, and was by the fall of 2016 strongly opposed

[170] Nine out of Denmark's 13 installed offshore wind farms at the time were however all installed at similar distance or closer to the shore than the proposed Near-shore projects (Stenvei, 2016a).

by both the left-wing parties, Danish Industry and De Konservative (Ritzau, 2016d). LCL was thus not be able to maintain the coupling between abolishing the PSO and cancelling the nearshore turbines. LCL and the government did not want the near-shore turbines at any cost, and were willing to break the bi-partisan 2012 energy agreement to cancel them, but it could not be done without the votes of the six De Konservative members of parliament. The highly controversial PSO-dispute came to its end in November 2016 when the Venstre-government for other reasons was forced to resign, and depended on De Konservative to ensure a new tri-party government with them and the right-wing party Liberal Alliance. The government did manage to abolish the PSO, but was forced to accept the near-shore turbines (Ritzau, 2016e).

LCL generally praised offshore wind power for its *Industrial* quality and *Technology Cost* during this period. He would speak of wind power as an “adventure that Denmark should be proud of”, while he specially highlighted the low bid-price on Kriegers Flak as “the cheapest energy that can be made on Danish soil” (J. L. Hansen, 2016). Energy was in LCL’s words “Big business for Denmark” although the “prices for renewable energy” should be monitored, as they could become so expensive that they would “cost Danish jobs” (J. L. Hansen, 2016). Offshore wind is by these remaining Market-coalition actors now praised as cheapest on *Technology Cost* although onshore wind is cheaper to build. Offshore wind power represents an export opportunity, while is why that despite all of the valuation drama, the national wind power test-centers are still expanded during these years (Ritzau, 2017a). Denmark should thus remain open for business as LCL would refer to Denmark being an “exhibition window” for the world (Korsgaard, 2016). But as has been seen in this chapter, this praise only applied to offshore wind power, and there were still several destabilization attempts to onshore wind, R&D funding, the PSO-tax and the nearshore wind farms. It thus appears that the Market-coalition actors were proud of previous coalition’s achievements and praise wind power to the extent that it does not cost society anything in terms of investments. Wind power is in this paradoxical period framed as valuable through the *Technology Cost* and *Industrial* qualities, while the *Subsidy Burden* and *Market Distortion* qualities contributes to a framing of wind power as not-valuable. This position of Denmark being an exhibition window for the world is seen as materially manifested at the Østerild test site. The wind turbine industry’s pledge to lower costs meant that technology development was moving fast and several large industrial manufacturers were testing new larger turbines at the Østerild site. The front cover of this book shows the Siemens SWT-7.0 154 turbine, which was being tested at Oesterild throughout 2015-2017[171]. The picture is showed in its full size hereafter[172].

[171] The SWT-7.0- 154 has 28% longer blades and nearly double rated the power of the worlds most installed offshore wind turbine, the SWT-3.6 120 with 950 turbines (REnews, 2017, p. 21). The SWT-7.0 154 was named the 2016 turbine of the year Wind Power Monthly (Vries, 2016), and multiple manufacturers are already testing larger models.

Figure 34: SWT 7.0 154 turbine at Oesterild (2017)

[172] Image Credit and copyright for the picture: SWT-7.0 154 at Oesterild: Peter Lyhne Højberg.

But the decades of R&D funding that was becoming materially manifested in these giant turbines built on Danish soil was not enough to maintain the PSO. Once the abolishment became law, the *Subsidy Burden* would gradually be moved from companies to tax payers. Where the PSO-tax was roughly funded 50/50 between businesses and households, the new solution meant that households would carry the full cost on the annual budget[173]. Another important change from the PSO-abolishment was the phase-out of the so-called "green pot", a part of the current onshore subsidy scheme which funded 88.000 DKK per MW to local communities that agreed to have wind turbines installed in their area. These funds could then be used to build a park, improve the local library or other recreational improvements. The funds disappeared when the onshore subsidy scheme ran out in early 2018, and LCL pronounced that going forward "these costs should be calculated into the project" and settled between the owner and the community (Poulsen & Lange, 2016). The above described situation marks a paradoxical situation wherein LCL at the end of 2016 considered the PSO-abolishment his greatest professional achievement, while the failure to cancel the near-shore turbines was his greatest regret (J. S. Jørgensen, 2016)[174].

This destabilization attempt is a short moment of valuation wherein the Market-coalition attempts to bring salience to the *Market Distortion* quality which was introduced in 2002. This is especially apparent through the 'dynamic effects' that is calculated as a benefit from abolishing the PSO-tax. Wind power is through the prosthetic devices of the PSO framed as something which primarily should be valued by the *Subsidy Burden* and *Market Distortion* qualities. Danish Energy, and to a lesser degree Danish Industry, were very active in the PSO-discussions and were now not aligned with the Danish Wind Turbine Industry, as was the case during the Global Advantage period. When faced with the choice between getting lower electricity prices for businesses and ensuring stability for wind power build-out, the two organizations chose to prioritize the former. Danish Industry did however join the coalition that protected the near-shore turbines, once it had already been awarded to Vattenfall. So although the Market-Coalition was successful in removing the stability of the PSO-tax, the Global-coalition maintained the nearshore turbines. The above-described case is the largest valuation struggle of this period and mainly relates to the PSO and offshore wind. But the period would also see a number of valuation dramas around onshore wind which follows after a short segment on a new 2016 and differing visions of the future.

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[173] The government justified this with a calculation that calculated a dynamic benefit to the household which was larger than the increase in income taxes. This dynamic effect was built on an expectation that companies which payed fewer taxes would increase their wages and lower their prices, thereby helping the citizens through his role as an employee and a consumer. This way of calculating was highly criticized by energy experts and political opponents, but were nonetheless included as gains for the Danish citizen in the government's economic proposals (Stenvei, 2016b).

[174] Even well into 2017, when the nearshore project had developed further, Venstre would refer to the nearshore turbines as something that opposition politicians wanted to "pay excess prices" for in order to get "green power which no one is asking for" (Johansen, 2017).

7.2.3 New Government coalition would expose differences in ambition

The Subsidy Burden period has been characterized by a series of destabilization attempts of the Global Advantage Valuation Frame and the corresponding network. But before I move on to map the Subsidy Burden frame the Market-Coalition temporarily manages to establish, I will highlight the parliamentary situation for future energy negotiations. The Global-coalition actor De Konservative stepped into government with Venstre in 2016, and applies a significantly different interpretation of the word "low-emission society" than the rest of the government. This word appeared in the 2016 government manifesto wherein it is stated that the new government's long-term goal for 2050 is "a low-emission society, which is independent of fossil fuels", meaning that "Denmark should live up to the EU's goal of 80-95% reduction of GHG emissions in 2050" (VLAK-Gov, 2016, p. 74). As this goal is rather vague on specifics, LCL was later asked to specify what "low-emission society" and "fossil independent" meant to the government. In his March 2017 answer to parliament LCL specified that "fossil-independent" meant "that Denmark in 2050 should be able to produce enough renewable energy to be able to cover the total Danish consumption of energy". He thereafter mentioned that the government "additionally" had a goal of "being a low-emission society", which "encompassed emissions from all sectors", without specifying it further (EFKM, 2017a)[175]. As explained earlier, Denmark is centrally placed and thus functions as a transit country for a large degree of electricity. Denmark could technically build wind power to supply the equivalent of 100% of energy use in the electricity, heating and transportation sector. But if 50% of this electricity is exported to other countries, because Denmark had not yet integrated its heating and transportation sectors with the electricity sector, Denmark could still be burning large amounts of gas in the heating sector or be driving gasoline-fueled cars[176].

The 'low-emission society' phrase was not new when it was introduced into the VLAK-government manifesto, as it was used in the 2014 Climate Law agreed between the left-wing parties and De Konservative. In this law-document "low-emission society" is defined as "a resource-efficient society" with an energy-supply based on renewable energy and markedly lower GHG emissions from other sectors, which at the same time supports growth and development' (DKGOV, 2014b). The sitting energy minister in 2014, Rasmus Helveg, was back in 2014 asked whether the 'low-emission society' phrasing had changed their goals. To this he would reply that "we have not changed our goal. A low-emission society is a fossil-free society" (Djursing, 2014).

[175] This answer did not bring much more light to what low-emission meant apart from the point that it was additionally to "fossil-independent", which meant being able to produce as much renewable energy as consumption by 2050. This goal is still rather vague, as it does not specify if Denmark should be able to produce 100% renewable energy the whole year of 2050, for a month, or maybe just hit above 100% a single day.

[176] In comparison, the SRSF government had in 2012 set the 2050 target to be have a 100% renewable energy in 2050 and 'a full phase-out of fossil fuels' (SRSF-Gov, 2012).

Political spokesman for De Konservative, Mette Abildgaard would pick up on this term in a December 2017 Op-Ed, wherein she praised 'the important conservative victory' of getting the goal of a low-emission society written into the government manifesto. This may seem odd to the outside observer, as in Lilleholts march 2017 answer and the specific 2014 text appears as if 'low-emission society' has not been quantified but merely attached to the goals of whatever coalition De Konservative were signing agreements with. But Mette Abildgaard would in an attempt to highlight the green profile of De Konservative define 'low-emission society' as even more ambitious than a "fossil-free society".

> "Unlike a fossil-free society, a low-emissions society does practically not emit any CO2 – neither from agriculture or forestry, which is still possible in a fossil-free society. So like most of our neighboring countries, Denmark has a goal to transition to a fossil-free economy long before 2050". (Abildgaard, 2017)

The small government party thus considers it necessary to phase out fossil fuels "long before 2050", while the other two governing parties, Venstre and Liberal Alliance have no phase-out planned at all[177]. This short segment was included to show that the deep framing differences between Global-coalition actors and Market-coalition actors is not isolated to wind power, but to the sustainable transition as a whole.

7.3. TECHNOLOGY NEUTRALITY AND LOCAL RESISTANCE TO ONSHORE WIND (2017)

Following the abolishment of the PSO-tax in addition to a number of other programs, the Market-coalition had by 2017 a nearly open slate to change the programs for wind power subsidies after 2020. The next step was to bring salience to the *Market Distortion* quality by introducing the need for "technology neutrality", but only when it came to onshore wind and solar auctions.

[177] The manifesto also included a "stocktake" device so the parties on a running basis could assess the "speed of market maturity" of renewables "in relation to other forms of energy" and therefrom upscale, but also downscale the build-out of renewable energy (VLAK-Gov, 2016, p. 74).

7.3.1 New center of calculation is established to push tech-neutrality

In the spring of 2016, Lars Christian Lilleholt (LCL) he had established an energy commission with 9 members exclusively picked by him and his party (Skærbæk & Dalgaard, 2016). The team consisted of three senior business executives, a political scientists, two economists and two technical academics, of which only one had experience with energy systems (Gormsen, 2016). The team was composed primarily on economics and private enterprise, while energy systems analysis was thinly represented[178]. The Energy Commission was asked to explore how the EU flexibility-mechanism could be used to trade quotas instead of building more renewable energy capacity (EFKM, 2016a, p. 4), and how developments in neighboring countries could be used to pay for future renewable energy projects on "pure market terms" (EFKM, 2016a, p. 6). The 7-page mission document specifically directed the commission to avoid developing "quantitative goals for a new energy agreement" or "specific proposals" to achieve anticipated EU 2030 climate goals (EFKM, 2016a, p. 2,5). The commission was to focus on lowering costs, as seen from the five quotes from the statement in table 8 (EFKM, 2016a).

Table 9: Five quotes from the 7-page mission statement for the Energy Commission.

Page	Statement
2	The Commission's combined proposals may not have consequences for the state budget and may not increase the total socio-economic costs.
3	The government wishes to make energy as competitive and cheap as possible.
3	It is essential to avoid…a forced build-out of renewable energy.
4	There is requested an overall analysis of how Denmark as cheaply as possible can fulfill the Danish part of international commitments.
6	The analysis must contain an assessment of...how the socio-economic losses of subsidies can be minimized. It should furthermore be examined how it is possible to reduce the risk of wasted subsidies and subsidy-dependence.

[178] One member was Peter Brixen. A former long-time civil servant of the financial ministry (2002-2014), who in 2007 had refused to lower the publics discount rate and had been a leading figure in the controversial 2014 sale of part of the public ownership of DONG Energy (S. W. Nielsen, 2015).

There is thus a frame established wherein subsidies distorting the market and burdening Danish economy through todays “socio-economic losses of subsidies”. The market can allegedly be arranged differently so that the risk of “a forced build-out”, “wasted subsidies” and “subsidy-dependence” are minimized. The EK was also not allowed to propose new investments in the energy system unless cuts are made elsewhere. These premises are important to have in mind when analyzing the Energy Commission’s report (EK) from April 2017.

The EK’s 92-page report “Recommendations to future energy policy” was launched in April 2017, and would among its focus point introduce the notion of technology neutrality in build-out[179]. At the launch event, the chairman of the commission, CEO of Danfoss, Niels B. Christiansen, started his speech with an attempt to couple lower levels of investments with being ambitious. He also added that Denmark have had low electricity price despite having 42% of electricity coming from wind power. It was not further explained why he assumed that electricity prices were low despite a high level of wind power and not also because of wind power (Friis, 2017). Herein a classic entrenched meaning is revealed, namely that it is frames as if wind power usually would make electricity prices higher, which is actually not the case (Hirth & Müller, 2016).

Technology Cost and Future Potential recognized

The EK report re-iterates the positive impact of *Technology Cost* that was established in the EA and Rockwool reports in 2014. As such it was repeated that “falling costs” (D3: #1), “large drops in the costs” (D3: #2), make onshore wind “able to compete” (D3: #3) with conventional power plants. The low strike price bids for both the near-shore turbines and Kriegers Flak are also mentioned as a point of reference to show that offshore wind power has dropped in price (EK, 2017, pp. 34, 35). The EK report still sees further *Future Potential* in wind power as they consider the annual technology catalogue from DEA to be “too conservative” (D3: #4) in its predictions of future cost reductions, as *Technology Cost* are expected to “fall considerably” (D3: #5). The report frames wind power as being on par with conventional fossil fuel plants and expected to be cheaper still. But in the same report there is a notion that subsidies are expensive and distort the market.

[179] The full quotes from the report can be found in appendix D3.

Proposal of technology neutrality brings salience to Subsidy Burden and Market Distortion qualities

While the EK report highlighted the *Technology Cost* and *Future Potential* of wind power, it also brings salience to the negative impact from the *Subsidy Burden* and *Market Distortion* qualities. The report concludes that it does not “make sense” (D3: #7) to set out a course, since the “market should be used” (D3: #6), as opposed to risking “inefficiency” through administrative decisions (D3: #9). It is also noted that the burdening subsidies for “existing and expensive” offshore wind farms will be a relief to Danish society, once they expire in the future (D3: #8). The report cites renewables as being directly subsidized by 6.4 bn., but thereafter mentions the presence of “indirect subsidies through tax exemption” (D3: #10). It is not specified or calculated further what specifically these exemptions constitute.

In addition to the four major qualities in the report, *Technology Cost*, *Future Potential*, *Subsidy Burden* and *Market Distortion*, the report also contains a few minor mentions of other qualities. Among negative environmental qualities the *Aesthetics* problem of noise annoyance is specifically mentioned as an example of a yet unaccounted environmental factor (D3: #11). When it comes to ensuring the large degrees of wind power in the system the *Back-up Capacity* quality is also mentioned through the need for flexibility (D3: #12).

Reactions to the EK Reports and its relation to other actors

The EK report builds on the same notion that the DEC introduced in 2002. Namely that there is a perfect equilibrium market, of which the subsidies to wind power function as a distortion. The notion that there is an ‘equilibrium state’ within the energy market, that wind subsidies are distorting is also especially seen in quote 10, where the EK considers it to be a “subsidy” that renewable energy is exempted from paying environmental taxes[180]. A similar example of this assumption is found in a 2017 editorial from the right-wing newspaper Jyllandsposten.

> “There should not be a single wind turbine or solar cell constructed, which cannot be driven on market-terms without any form of direct or indirect subsidy. Where other producers of electricity must pay for the fuel they use, the wind and sun is free, and that must be ample subsidy.”
> (JP, 2017).

[180] This is a reverse understanding of the energy market compared to the IMF’s, wherein fossil fuels are considered to be subsidized, since they are not adequately taxed for the environmental degradation they cause (Timperley, 2017).

These examples serves to show a peculiar logic of the *Market Distortion* quality, as Jyllandsposten implies that it is unfair that a coal producer has to pay for coal to be mined, while the wind turbine owner gets his "fuel" delivered freely in the wind. The two large organizations who were part of the Global-coalition, Danish Energy and Danish Industry, applauded the EK report and agreed with Lilleholt's proposed paradigm shift towards technology neutrality (DI, 2017). DWIA were more critical and wondered why technology neutrality all of the sudden was presented as a necessary part of the future. The EK report had proposed technology neutrality without explaining how it should work in practice (DWIA, 2017c). Senior advisor Joergen Henningsen, of Global-coalition think tank Concito, would question why the EK insisted on leaving the future energy system in blind trust to the market.

> "It is however more problematic when the commission so strongly emphasize 'technology neutrality' and 'marketization' of the future efforts. Has the commission completely overlooked, that the elements, which were fundamental for the positive development so far, have been driven by the exact opposite? Or that the two EU-flagships, which are based on "the market", the liberalization of the electricity market and the CO2 quota system, both have been – diplomatically phrased – failures compared to what they should deliver". (Henningsen, 2017)

Henningsen's critique relates to the notion that the report did not provide any reasoning to why it should be cost-effective notion to use technology-neutral auctions, when it historically has been technology-specific auctions that has lowered the cost of the green transition. Despite the Global-coalition actors' critique of especially technology neutrality, it would be these exact points that LCL would design his future onshore wind policy around (EFKM, 2017b).

7.3.2 Onshore wind is thrown into a technology neutral experiment

LCL had in the time leading up to the EK report, ensured that existing solar and onshore wind subsidy schemes would be phased out by mid-2018 at the latest, and was thereafter ready to replace these schemes with a new "technology-neutral" device[181]. The new subsidy scheme should run for 2018 and 2019 until a new energy

[181] LCL had made several interventions to stop various solar subsidy programs (Bredsdorff, 2016; Wittrup, 2017a), and had meanwhile fended off multiple warnings about the market impacts when the current onshore wind subsidy program would run out by February 2018 (Ritzau, 2017b). By the middle of 2018, the established subsidy programs for both onshore wind power and solar PV would have expired or have been removed.

agreement would start in 2020. In the proposed scheme, onshore wind, near-shore wind and solar would compete for a pot of subsidies, which would roughly equate to a total 200 MW over the two years. This would limit potential build-out to less than a third of the previous two years[182], push out small local consortiums, and jeopardize the completion of large onshore wind-energy projects under development (Plechinger, 2017e). This scheme attracted criticism from several Global-coalition actors. AAU academics labelled it an "uncertain experiment" (Ritzau, 2017c), the Danish Wind turbines industry Association (DWIA) called it unambitious (Plechinger, 2017g), while the wind turbine owners association argued it would "reduce the market for new wind turbines beyond recognition" (Kærgaard, 2017). LCL would in an interview express that he was unfazed by this "whining" from the wind turbine industry, as his proposed scheme took on the important task of minimizing the *Subsidy Burden* wind power had placed on Denmark since 1979.

> "Overall, I am of the opinion that the wind turbine industry should start competing and show that they are actually able to deliver the cheapest solution….Instead of whining, one should compete and show that one is actually able to compete with other technologies. Wind has been subsidized since 1979. It is now time to show that you are able to compete". (Plechinger, 2017f)

LCL uses the Market Distortion framing that wind power is considered uniquely more subsidized than other energy sources. An energy source is according to this framing to be valued by how cheaply one kWh can be produced, but a low strike price is not a sign that a technology is cheap. So although the current electricity prices are so low that practically any new energy investments can only be introduced through subsidies, wind power is specifically problematized. Wind is not deemed valuable through low *Technology Cost* alone, but is instead proven valuable through "tough and fierce" [183] competition in the form of a technology neutral auction, wherein the build-out of either onshore wind or solar will be taken from the other technology. It is worth noticing that biogas and biomass is not exposed to technology neutrality. Only a few days before the proposal of tech-neutral auctions had been released, LCL received EU approval for a direct grant of 422 mn. DKK to cover 1/3 of the project costs of a new 1.2 bn. DKK biomass Bloc (129 MW heat, 25

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[182] The two years, 2015 and 2016, had seen a build-out of 468MW onshore wind, 193MW solar. Additionally the 350 MW nearshore turbines were agreed in 2016 and could also be counted in the comparison (Ravn, 2017).

[183] LCL Interview quote: "If we are to achieve it (the goal of 50% Renewable Energy in 2030, ed.), we must ensure that the cheapest technologies come forward. We must have a tough and fierce competition, and instead of arguing that it can't be done, one should show that wind is the cheapest. I can say the same to solar energy" (Plechinger, 2017f)."

MW electricity) at the coal-plant Asnaes-vaerket (Wittrup, 2017b). This subsidy was given in the form a direct investment aid payment, which, without any competitive bidding or media coverage, had been promised to the developer in December 2016[184]. This is a significantly more black-boxed way of receiving subsidies than the new frequently discussed wind power subsidy schemes.

7.3.3 The politics of drift – Onshore wind come to a halt in municipalities

The new onshore subsidy scheme was quietly accepted by Danish Industry and Danish Energy, who supported the general notion of tech-neutrality and did not further comment on the significantly lower expected build-out (Birkmann, 2017; Thure, 2017). The move to tech-neutrality did however blur out the *Industrial* quality of onshore wind as the new energy policy was not focused on generating jobs by specifically supporting either onshore wind or solar. This was a sign of an oncoming trend where the Market-coalition and the two private actors, Danish Energy and Danish Industry, would adopt different stances to offshore and onshore wind power respectively. Offshore wind power would be hailed as the energy sources which would make Denmark into an exhibition window for the world, while onshore wind would be subjected to the politics of drift.

Onshore wind farms had in 2016 and 2017 become increasingly harder to get approved. This development was partly ascribed to the fact that local municipal politicians abstained from approving projects as they feared backlash from local opponent groups (Lyall, 2017). In the Spring of 2017, Toender Municipality would scrap a proposed 80 MW Windfarm, shortly followed by Esbjerg Municipality cancelling plans for 127 MW onshore wind by 2020, and indefinitely cancelling future onshore build-out (Plechinger, 2017a)[185]. Viborg Municipality also moved to blocked all onshore wind proposals until absolute certainty could be achieved regarding that no one would be harmed, as explained hereafter by Viborg mayor Torsten Nielsen.

[184] Lilleholt used the transition from coal to biomass at the Asnaes plant as proof that there was “no need for parliament to push” for a coal phase-out in Denmark, since “companies themselves will show responsibility and phase out coal when it fits into their plans” (Korsgaard, 2017). This was said despite the fact that he had promised to cover 1/3 of the costs with tax-payer funded subsidies to transition the Asnaes plant to biomass, one element which was not mentioned in the announcement of DONG energy’s coal phase-out.

[185] Another planned onshore wind farm of 78 MW had been delayed in five years before being voted down 18-12 in Haderslev city council, where the two major parties, Venstre and the Social Democrats had split votes within the party (Plechinger, 2017h).

> "We shut down the process, but only because of the low-frequency noise. As long as we can't get documentation that it is harmless, I do not believe it….If a single person gets sick from having a wind turbine too close, it something I will never have in Viborg Municipality". (Lyall, 2017)

The burden of proof was thus placed the wind turbine manufacturers to prove that not a single person will get sick. A large investigation about any potential links between wind turbines and sickness was initiated by the Danish health authorities in 2014. The report was scheduled to be published by 2018, but is not likely to solve the local opposition, as explained by Esbjerg Mayor, Johnny Soettrup (V).

> "It has been coming some time now…The rapidly growing local opposition to onshore wind turbines. I have also been affected by the feedback that I get….Regardless of whether it (Health-report, ed.) acquits (Wind turbines) from the low-frequent annoyances, there is still something visual which greatly concerns people". (Plechinger, 2017b)

Despite the fact that less than 1% of properties in Denmark lie within 1 km of an onshore wind farm (Plechinger, 2017c), local opposition groups managed to gain the attention of politicians and media. The opposition to onshore wind farms appears to have increased as offshore wind *Industrial* benefits have decoupled domestic onshore wind build-out. One example of this is Esbjerg Mayor Johnny Soettrup, who during the Global Advantage period and this period was a strong advocate for future offshore wind build-out[186].

The *Aesthetics* quality has thus grown in salience through several local debates using the narrative that an oppressed group of people is fighting a David vs. Goliath fight against a powerful wind turbine industry. The municipality of Mors has in the past had several onshore wind farms, but a Social-democratic candidate for mayor would in 2017 promise to stop all future onshore projects, arguing that "the time of wind

[186] Esbjerg Municipality would of course stand to gain more by an offshore wind build-out compared to an onshore build-out. But there has also been examples of Venstre and Social-Democratic politicians who changed their stance to oppose further wind build-out in Ikast-Brande (Plechinger, 2016) and Aalborg Municipality (Plechinger, 2017i). Both of these municipalities has decided to put further onshore wind build-out on hold, despite having wind turbine factories as the top municipal employer in both municipalities (Nacelle-factory in Ikast-Brande, and Blades Factory in Aalborg).

power on the island of Mors was over" as there is "a peoples movement" against it (Juhl & Aaberg, 2017). When Haderslev municipality in August 2017, decided to cancel a planned project it was presented as the conclusion of a year-long struggle for the local opposition. Peter Skeel Hjort, a long-time critic of the industry, would paint a near conspiracy-like picture of the wind turbine industry in a local news-station's coverage of the Haderslev decision.

> "The wind turbine industry tries to steamroll everyone, and in every situation they attempt to ridicule and marginalize people or organizations, which are of a different opinion. They even have an organization, which systematically surveys all opinion pieces in the newspapers and answers them. This is often done in a way that is far beyond the boundaries of decency". (Kallenbach, 2017)

The planning branch of the Danish churches would also halt onshore build-out in this period. The churches have a special option to veto onshore wind projects that are visible within 1-3 km of a church in Denmark, and they exercised this right multiple times in the years during this period (Munkholm, 2015a, 2015b; Plechinger, 2017d). Behind the majority of these vetoes was the central authority of the Royal Building Inspector Niels Vium, who oversees the country's 1500 churches. In a 2015 interview he justified his many vetoes with the argument that the "green wave is an excuse, which wind turbine owners use to generate money", and thus it was his adamant duty to halt wind turbines from ruining the view from the churches (Munkholm, 2015a).

As the majority of Danish municipalities paused, cancelled or stayed silent on the possibility of future onshore wind farms, the Subsidy Burden period is defined by an increased salience of the *Aesthetics* quality. But despite these oppositions to onshore wind, wind power was established as a competitive energy source of which especially offshore wind power featured a promise for future *Industrial* benefits. The Market-coalition was thus not able to re-impose the Market Distortion Valuation Frame. This framing was no longer possible due to the materiality of the low *Technology Cost*, the growing export markets, and the still strongly represented Global-coalition. Instead this most recent period would be defined by destabilization of existing frameworks, and a momentarily assembled Subsidy Burden Valuation frame. This fragile framing and the coalitions of this most recent valuation struggle will be summarized next.

7.4. SUBSIDY BURDEN: VALUATION FRAME SUMMARY

In this section, I describe the new dominant valuation frame.

7.4.1 The Subsidy Burden Valuation Frame

The Subsidy Burden valuation frame can be conceived as a peculiar hybrid between the Market Distortion and Global Advantage frames, shown in figure 35 (GBA).

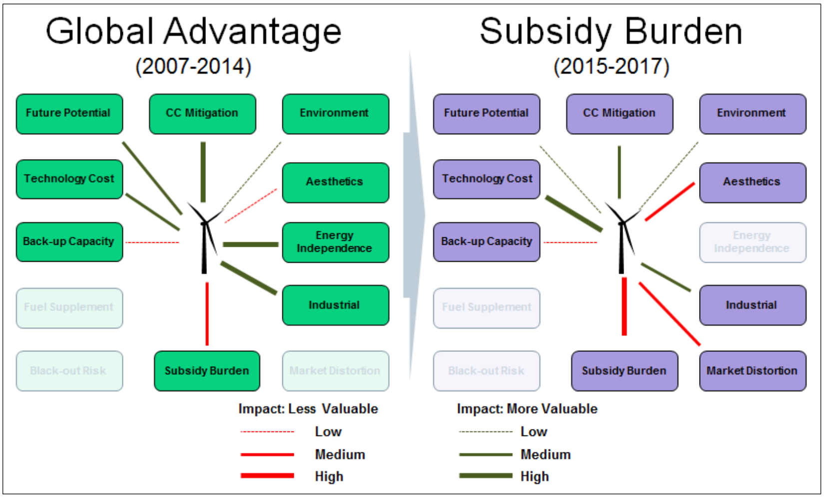

Figure 35: The fourth (GA: 2007-2014) and fifth (SB: 2015-2017) Valuation Frame.

Technology Cost Have Highest Positive Impact as both Onshore and Offshore Wind Become Competitive

Technology Cost had a strong positive impact on the frame, along with the *Future Potential* and *Industrial* qualities. Just as onshore wind costs dropped significantly during the Global Advantage period, offshore wind costs dropped significantly during the Subsidy Burden period. Thus, both proponents and challengers of the valuation frame appeared to agree on the competitiveness of wind power in terms of *Technology Cost*. The focus of the struggle over the framing of wind power's value thus shifted to how much capacity Denmark could afford to build, and how it could minimize the distortive effects of wind turbine subsidies.

Subsidy Burden Becomes More Salient when Coupled with Market Distortion

Despite the presence of several of the same high positive impact qualities, wind power was framed as being somewhere between valuable and not valuable during the Subsidy Burden period, as the subsidy cost of the PSO tax became more salient and the *Market Distortion* quality re-emerged. The long road toward the abolishment of the PSO tax and the Energy Commission's 2017 report reveals a framing where the prosthetic devices that enabled wind turbines were viewed as distorting to the market. Although the *Subsidy Burden* quality was certainly present in the Global Advantage frame, it was not as strongly combined with the *Market Distortion* quality. This is a significant difference. In isolation, the *Subsidy Burden* quality frames wind power as a cost to the Danish state and industries. This burden is measurable and can be compared to similar costs. To exemplify this, I have collected the data on subsidies, R&D grants and connection costs for the years 1979-2017 in Appendix A4 and estimated approximate added direct expenditures in the years where data is not fully available. The estimated average annual cost to the Danish society for enabling the existing wind power industry and constructing the 5.5 GW domestic fleet comes to be less than DKK 1.7 billion (Appendix A4) [187]. Even in recent years, where annual investment levels are around 5 bn., it is still less than 0.5% of the public budget expenditures (Public Budget expenditures in 2016: 1105 bn. DKK) (DST, 2017). This number can be compared against annual wind turbine industry exports of DKK 55 billion (2016), and total tax payments from Danish-registered companies and employees in the wind turbine industry of DKK 13 billion per year (DWIA, 2017a, p. 16).

However, once the *Market Distortion* quality is inscribed into the object of wind power, this calculation cannot be made. In that case, calculations are based on the assumption that companies and jobs in the wind turbine industry would have existed elsewhere in Denmark if wind power had not been supported. In the words of Financial Minister Thor Pedersen in 2002, Denmark could just as well have supported a banana industry (Dahlager & Rothenborg, 2007, p. 82). The understanding of markets underneath the *Market Distortion* quality is thus that the state cannot gain *Industrial* benefits by supporting selected industries. This quality also is prevalent in the Energy Commission's framing of wind power as well as the government's subsequent move towards technology neutrality in auctions.

[187] I acknowledge that this is a rough estimate, but I have yet to see a more accurate number performed by other sources. This is surprising as there appears to be many actors who mention that wind power has been subsidized since 1979. I am aware that I am now performing the same exercises as I am analyzing. But this is done for the purpose of bringing clarity to the point of references used by actors who bring salience to the *Subsidy Burden* quality.

Other Qualities: CC Mitigation and Aesthetics

CC Mitigation continued to be acknowledged and certainly was framed as a more Salient quality than in the Market Distortion valuation frame, but it was not as intrinsically coupled to wind power's value as in the Global Advantage valuation frame. This is because the Subsidy Burden frame is a frame where neither the Market-coalition nor the Global-coalition has complete dominance. The Market-coalition have a large framing power as it holds the Ministry of Energy, but there are strong human and material actors in the Global Advantage Valuation Network that resists a translation like the one that happened in 2002. It is after the Paris Agreement not possible to dismiss *CC Mitigation* as it was done in 2002. Furthermore, the technological competitive costs of wind power were crystallized by the two large reports in 2014 and by the bid-prices on offshore wind during the Subsidy Burden period.

Another unique change during this moment of valuation was the shift in the *Aesthetics* quality from non-significant to having a negative impact on the valuation of wind power. The Near-shore wind projects were nearly cancelled, with *Aesthetics* as a key argument once it could no longer be claimed that the projects were too expensive. Near the end of the period, several municipalities completely halted construction of onshore turbines, arguably due to local opposition or health concerns. So the *Aesthetics* quality appears to be growing in salience when it comes to near-shore and onshore wind power.

7.4.2 The Subsidy Burden Valuation Networks

In this sub-section, I map the coalitions of human actors and briefly summarize the material changes during the Subsidy Burden period in terms of physical capacity expansion and legislation.

Shifting Coalitions Fight for Dominance

During the Subsidy Burden period, two coalitions fought for dominance over the framing of wind power. Thus, it was not a single coalition that controlled the Subsidy Burden valuation frame, but a combination of actors from the market coalition and the global coalition. Green is still the Global-coalition and Blue is the Market-coalition. Gray equals actors that are neutral. The visualization follows hereafter in figure 36 (GBA).

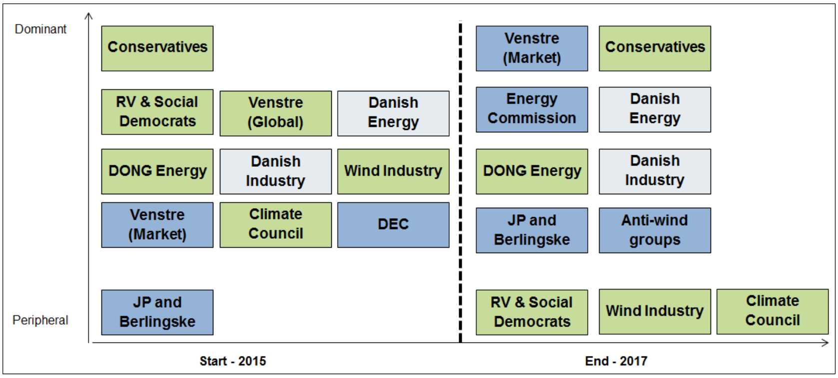

Figure 36: Key actors during the SB period; green: Global-Coalition; blue: Market-coalition.

During the Subsidy Burden period, a coalition once again formed around a combination of energy sector incumbents and actors from proximate fields. The new Minister of Energy, Utilities and Climate, Lars Christian Lilleholt, had formerly represented gas and coal plants and had strong ties with the local industry on Funen. This coalition focused primarily on reducing taxes; it formed a campaign to abolish the PSO tax and eliminate renewable energy goals that were destabilizing the business case of these proxy-field actors. Notably, two powerful actors, Danish Energy and Danish Industry had supported wind power during the Global Advantage period, but moved toward a middle position during the Subsidy Burden period. Both supported the abolishment of the PSO-tax, but opposed the cancellation of near-shore wind projects. Although they supported the expansion of wind power in theory, given the choice between that and lower taxes, they appear to choose lower taxes. De Konservative adopted a similar split position. They were willing to destabilize the world that had been constructed during the 1990s by eliminating the PSO tax and onshore wind subsidies, which in 2008 had been re-modeled after the system used in the 1990s. They did, however, support the established Climate Council in 2014, stop Venstre's proposed re-introduction of Bjoern Lomborg in 2015, and uphold plans to construct near-shore wind turbines in 2016. In some instances, the right-wing party De Konservative worked with the left-wing parties to form a new red-green majority, but they were not willing to enact what would be considered stretch and transform legislation, such as that which established optimum framework conditions for wind power during the Climate Solution period[188]. The wind turbine industry found it difficult to find coalition partners across the middle of

[188] One example of this is that De Konservative do not fight for the Wind turbine industry's proposal of holding technology-specific auctions for wind power. This is despite the fact that the proposal to hold technology-neutral auctions emerged from the Energy Commission which was exclusively selected by the party Venstre, and therefore not a commission which De Konservative had any influence over.

the political spectrum for onshore wind, but the large industry that emerged during the Global Advantage period enabled the global coalition to maintain stability around approved offshore and near-shore wind projects. This stability also emerged due to increasingly larger *Industrial* benefits generated by the sector; thus, it is not guaranteed that similar stability could be expected from this factor in other countries.

It was difficult for the Market-coalition to maintain the framing that wind power's devices were a burden to Danish society, as the wind industry was so pervasive in Denmark relative to the country's size. This also was recognized by Venstre, but applied mainly to results in the offshore wind sector. Moreover, a valuation drama unfolded regarding onshore wind and general research funds, especially in the fall 2015. Massive cuts were enacted and the market-coalition exerted intense pressure to return to the Market Distortion valuation frame.

Materiality during the Subsidy Burden Period

There was a significant slow-down in onshore capacity expansion in 2015 and 2016 due to a forecast for lower electricity prices and municipal opposition to onshore wind projects. The momentary surge in onshore construction during 2017 occurred because many developers were rushing to get their projects finished before the 25 oere/KWh onshore subsidy scheme expired in February 2018. Since only one small technology-neutral auction was scheduled for late 2018, industry officials do not expect any notable onshore expansion in 2018 or 2019 (From, 2018). Offshore capacity expansion also was stagnant during these years, but a 1.3 GW expansion was planned for 2018–2021 based on the energy agreement of 2012. All numbers in figure 37 are available in Appendix A.

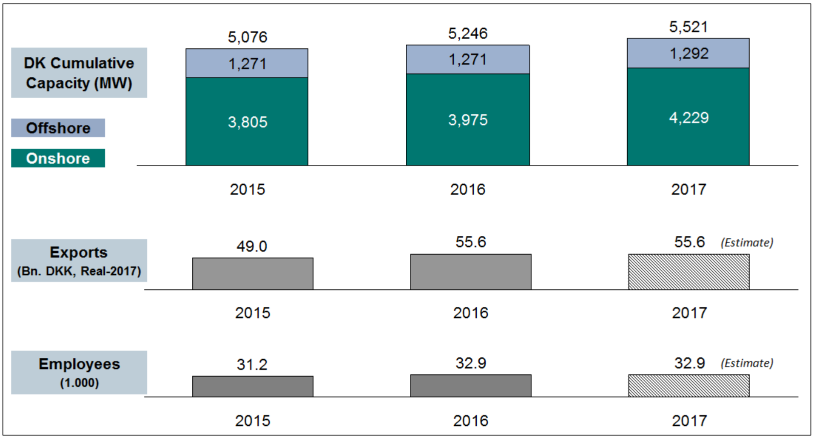

Figure 37: Capacity expansion during the Subsidy Burden period.

This period was an era in which the material frameworks of the Climate Solution period were disassembled. The PSO tax was abolished, R&D funds were cut, onshore wind subsidies were replaced with small technology-neutral auction tenders, and the "green pot" funding for municipalities which erected onshore projects was abolished. The only area with legislatively-mandated material expansion was test facilities for large-scale turbines. This corresponds well with the dominant coalition's agreement that wind power's value is derived primarily from the industry's ability to create exports and jobs.

7.4.3 Key Takeaways from the Subsidy Burden Period

During the Subsidy Burden period, remnants of three former coalitions fought over the right to determine the value of wind power. The Market-coalition, comprised of Venstre, proximate sectors such as the Funen horticulture industry (tomatoes etc.) and right-wing newspapers, attempted to re-establish the calculative centers that had been dominant during the Market Distortion period.. However, the Market Distortion valuation frame was not reassembled, as Conservatives and two powerful private sector actors, Danish Energy and Danish Industry, still ascribed to the Global Advantage frame. The Subsidy Burden valuation frame thus was a paradoxical hybrid based on a few points of agreement between the Market-coalition and the Global-coalition. The remnants of the Climate-coalition, who also were part of the Global-coalition in the previous period, worked with the dominant coalition when possible. This concludes the five empirical analysis chapters. I will hereafter bring the Valuation frames and observations about networks into a general discussion.

8. DISCUSSION

In this discussion, I summarize findings from my study of moments of valuation that demonstrate the historic role of valuation devices in the struggle to frame wind power as a worthwhile investment for Danish society. To address this overall problem statement, I answer research question 1 in this chapter:

Research Question 1: Which valuation frames and devices have dominated in the history of Danish wind power, and which key qualities were used to produce wind power as a valuable societal investment or not?

8.1. VALUATION FRAMES: QUALIFYING WIND POWER AS VALUABLE OR NOT

During the Unique Supplement period, wind power was framed through the device of break-even prices relative to fuel import costs for steam plants. Although some technical calculations were based on physical properties of turbines, such as capacity factors and life expectancy, the metric that ultimately framed the value of wind power was a break-even price relative to costs of fuel to power steam plants. Although the Fuel- and Unique-coalition struggled over framings, they agreed that wind power was measured as a supplementary energy source which could decrease fuel import dependency and create jobs. The main difference was that the Fuel-coalition framed wind power as creating problems for the energy system if implemented on a larger scale, while the Unique-coalition framed wind power as having a large *Future Potential*, if the technology was allowed to evolve. Hereafter follows the same five Valuation Frame shifts that have been visualized at the end of each of the empirical chapters. It is the same graphs as portrayed in Figures 13, 17, 24, 30, and 35, but are here closer to create an overview for the summary.

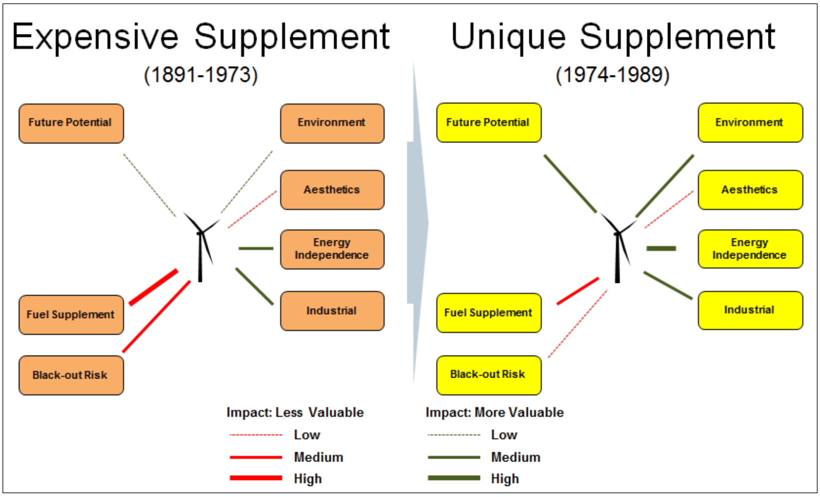

Figure 38: The historic (ES: 1891-1973) and the first modern (US: 1974-1989) Valuation Frame.

During the Climate Solution period, the *CC Mitigation* quality was decisive in the positive valuation of wind power, as evidenced by the new calculations of Energi 2000 and Energi 21 in 1990 and 1996 respectively, the first energy plans aimed at reducing CO2 emissions. Once CO2 emission could be counted, various future scenarios justified the expansion of wind power as valuable due to how much CO2 could be removed by building wind power instead of coal and gas plants. A new device for measuring technological costs and performance, levelised cost of energy (LCOE), also was introduced in this period. This metric combines *Technology Cost* with energy output and enables comparisons between wind power and other energy sources; for example, in the AKF 1996 report, an estimated cost of damage per ton of emitted CO2 was incorporated into the final LCOE result for coal and gas. CO2 thus was a significant factor in framing wind power as a valuable alternative to fossil fuels. During this period, wind power was framed as indispensably valuable as a climate change mitigation solution; even though it was more expensive on *Technology Cost*. The combined set of qualities framed it as an independent energy source with a large *Future Potential*.

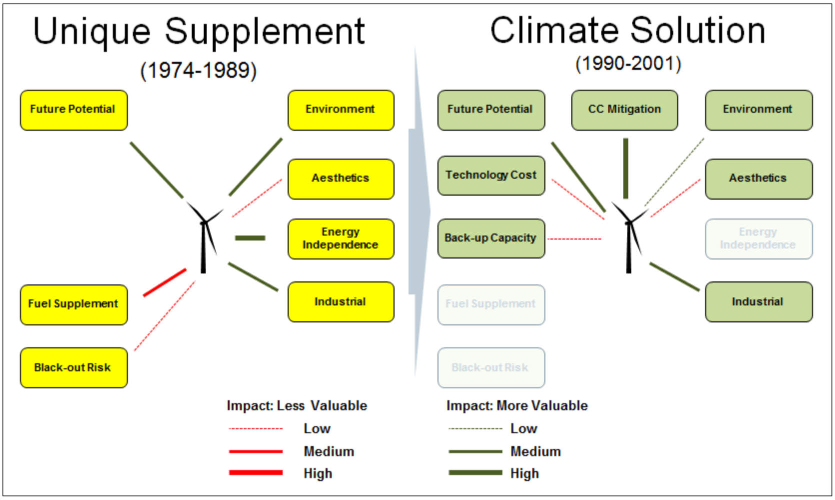

Figure 39: The first (US: 1974-1989) and second (CS: 1990-2001) Valuation Frame.

A significant shift in valuation occurred during the Market Distortion period (2002–2006), as LCOE and the included CO2 emission costs and *Technology Cost* were disregarded as devices for valuing wind power. Instead, wind power's societal value was based on economic calculations of subsidies, taxes and their effects on society rooted in the neoclassic economic doctrine of perfect markets. These calculations are evident in reports published by the DEC and the IMV. The valuation device shifted away from comparing the emissions and technical costs of wind, gas and coal power, and toward alleged distortive effects of supporting a given technology. The dominant valuation frame in this period was that wind power destroys value, since market distorting subsidies and energy taxes far outweigh its ability to mitigate climate change, which can be solved less expensively through what was framed as naturally efficient quota markets. Whereas the Climate Solution frame had focused on how emissions could be mitigated by implementing the technically best suited expansion plan from an engineering system perspective, the Market Distortion frame focused on how Denmark could either trade or build capacity to only meet the required EU CO2 targets in the cheapest possible way. In this framing, subsidies payed out to wind turbines became a matter of concern, and since an EU emissions quota system was under construction (to be launched in 2005), wind power was framed as an expensive way to reduce CO2 emissions. Proponents of this framing believed it would be less expensive, and therefore preferable, to buy carbon offsets on the new quota market than to build the infrastructure required to significantly expand wind power capacity. Wind power was thus more expensive, and required subsidies and taxes to stabilize its world in the prevailing market architecture.

However, unlike carbon offsets, the material construction of physical wind turbines actually lowers CO2 emissions when operating.

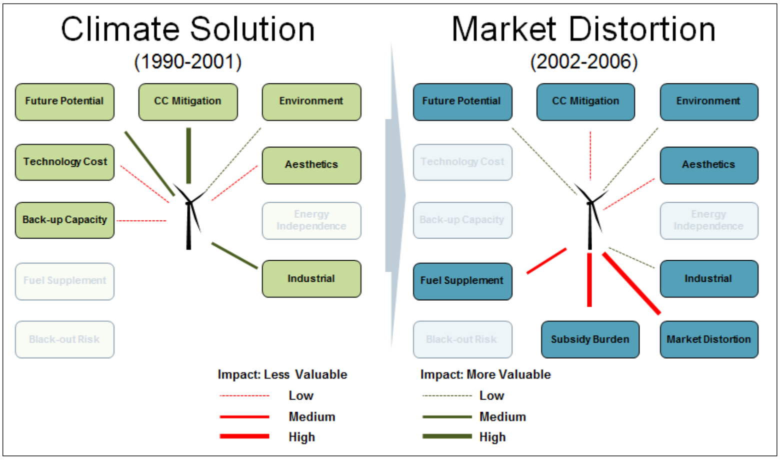

Figure 40: The second (CS: 1990-2001) and third (MD: 2002-2006) Valuation Frame.

From 2007 to 2014, wind power began to be framed as a Global Advantage, and the Market Distortion valuation frame slowly became less dominant. This moment of valuation was not as abrupt as the 2002 framing, but occurred over a period of years, as international focus on climate change mitigation intensified and export potential for the wind power industry increased significantly. Minister of Climate and Energy, Connie Hedegaard, worked hard to ensure the COP15 summit was held in Copenhagen. Combined with renewed attention to the advantages of *Energy Independence*, De Konservative and members of Venstre began to engage in broad collaboration with the left wing parties to promote wind power. Once again, CO2 emissions were used to estimate the value of wind power, and LCOE was used to compare sources of energy. *Technology Cost* became a positive impact quality as onshore wind became competitive with coal power, and potential for large-scale offshore wind farms became salient along with the considerable contributions to Danish exports. The Global Advantage valuation frame was maintained by a broad group of actors, who agreed that wind power was highly valuable as a climate solution for the world, as well as a path to become energy independent and build a key export industry.

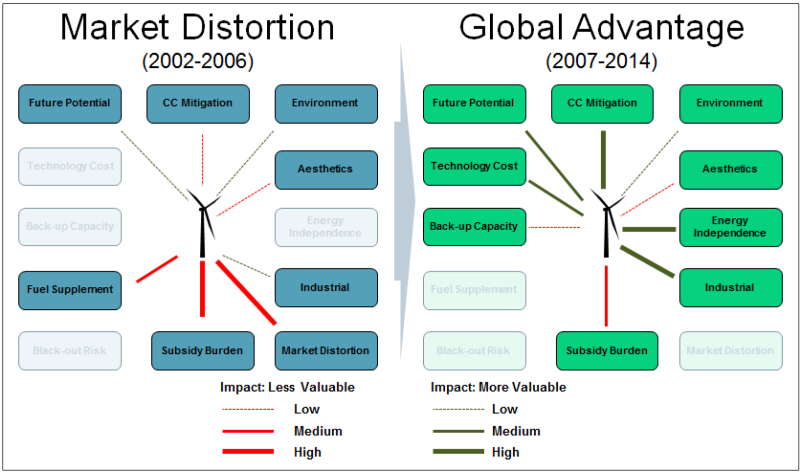

Figure 41: The third (MD: 2002-2006) and fourth (GA: 2007-2014) Valuation Frame.

Between 2015 and 2017, the paradoxical Subsidy Burden valuation frame emerged, wherein the positive impacts of acknowledged record-low *Technology Cost* for wind power were outweighed by the negative impacts of the Subsidy Burden quality. This is evidenced by a return to calculations on tax-costs for consumers and the tax burden for proximate field sectors. Although wind power was framed as a highly competitive technology with significant *Industrial* benefits, these qualities are counterbalanced by concerns that consumers and proximate industries were burdened through taxes and market-distorting wind power subsidies. The *CC Mitigation* quality still had an impact, but not as highly salient in this framing as it had been. Instead of being among the decisive qualities that justified wind power expansion, as seen in the Climate Solution and Global Advantage frames, in the Subsidy Burden frame it was merely part of a larger picture presenting an *Industrial* opportunity. Whereas the Global Advantage frame was the most stable during the studied period, the Subsidy Burden frame was the most narrowly assembled, and was already showing signs of destabilization in 2017.

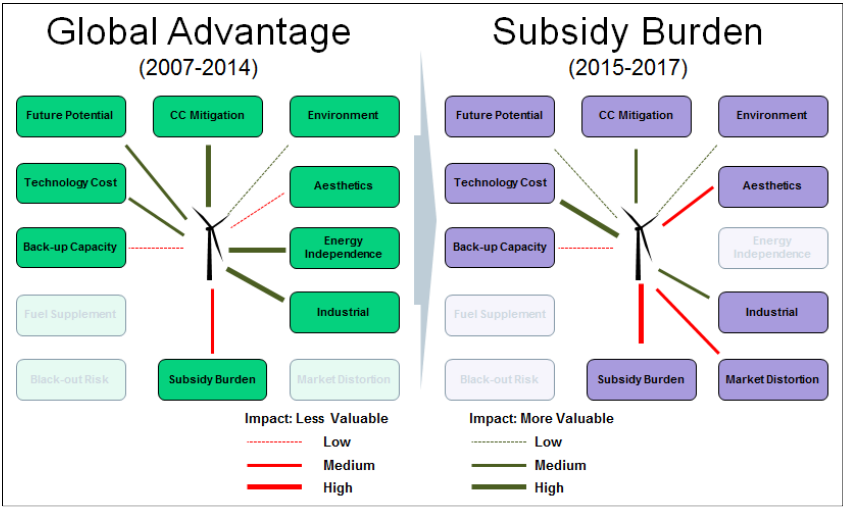

Figure 42: The fourth (GA: 2007-2014) and fifth (SB: 2015-2017) Valuation Frame.

All of these Valuation Frames become especially interesting once they are observed together. Figure 43 (GBA) is a visualization of the dominant frames in each period and how they valued wind power, ranging from value-destroying to indispensably valuable, during the 40-year period from 1977 to 2017.[189] The y-axis shows to what degree wind power was framed as valuable to Danish society, while the X-axis represents the 40 year period from 1977 to 2017 in 5-year intervals.

[189] I am aware that two reports in the chapter on the Unique Supplement period predate 1977. However, my analysis reveals that the valuation would not be placed any differently on the figure for the early exploratory years of 1974–1976. I therefore plot the x-axis at 5-year intervals, beginning with 1977 and ending with 2017.

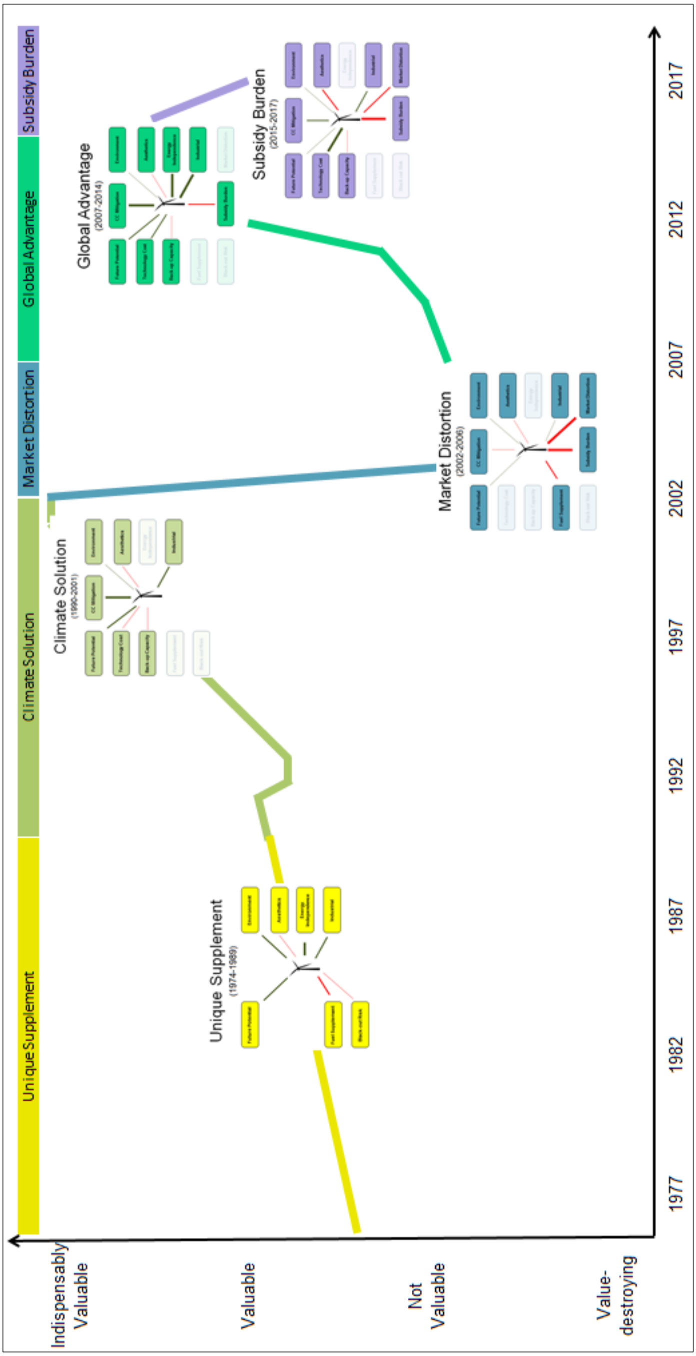

Figure 43: Overview of shifting valuation frames 1977–2017.

The Unique Supplement valuation frame elevated wind power from being an energy source not worth considering to being valuable for its supplementary benefits of *Energy Independence* and *Industrial* activity. After a failed destabilization attempt in the early 1990's, the rules of the game changed, as *CC Mitigation* became a decisive quality in energy source investments. The Climate Solution valuation frame ascribed wind power the status of an indispensably valuable energy source during the mid- to late-1990s—that is, wind power expansion was considered a necessary societal investment to mitigate CO2 emissions. A successful destabilization attempt followed, and a completely different framing, Market Distortion, was assembled to frame wind power as value-destroying to society. Not only was wind power deemed not valuable, it was framed as a distortion of the free market in terms of technology selection, an expensive way of mitigating CO2 emissions, and a burden to other sectors.

Beginning in 2007, wind power was framed as a highly valuable energy source, ushering in the Global Advantage frame. This frame was highly similar to the Climate Solution valuation frame, but differed by framing wind as valuable through more positive impact qualities (i.e., *Energy Independence*, *Technology Cost*). As such, the societal value of wind power was framed slightly less on the *CC Mitigation* imperative, and more on the global advantage to Denmark, *Energy Independence* and *Industrial*, which outweighed the negative impact of the still present negative quality, *Subsidy Burden*. The Subsidy Burden framing represents another attempt to destabilize wind power at the end of the study period. Beginning in 2015, wind power was framed as imposing a cost burden on proximate fields, and therefore not valuable. This valuation frame was a paradoxical hybrid between the Global Advantage and the Market Distortion valuation frames. It acknowledged the highly positive impact of the qualities *Technology Cost* and *Industrial*, but included the negative impacts of *Subsidy Burden* and *Market Distortion* qualities to frame wind power somewhere between a valuable and not valuable investment. Moreover, this framing distinguished between framing wind power as a valuable export, while it is simultaneously framed as a Subsidy Burden domestically. So while the *Industrial* quality of wind power is salient especially when it comes to offshore wind power, there is little-to-no value was assigned to expanding onshore wind power capacity in Denmark. Moreover, the *Aesthetics* quality, which was insignificant in the other framing, is for the first time salient enough to have an impact in the Subsidy Burden period, as seen through the stalled onshore build-out. Figure 44 (GBA) shows how the valuation frame periods correspond to the physical expansion of wind power in Denmark over the last 30 years. The numbers indicate wind power capacity installed and the arrows show the compound annual growth rate[190], indicating the average annual expansion of wind turbine capacity over the analyzed period.

[190] Compound annual growth rate means that the percentage shown on the arrow equals the average expansion of wind power as a percentage of existing capacity that year. To put the numbers into perspective, one gigawatt of offshore wind provides power to roughly 900,000 Danish households.

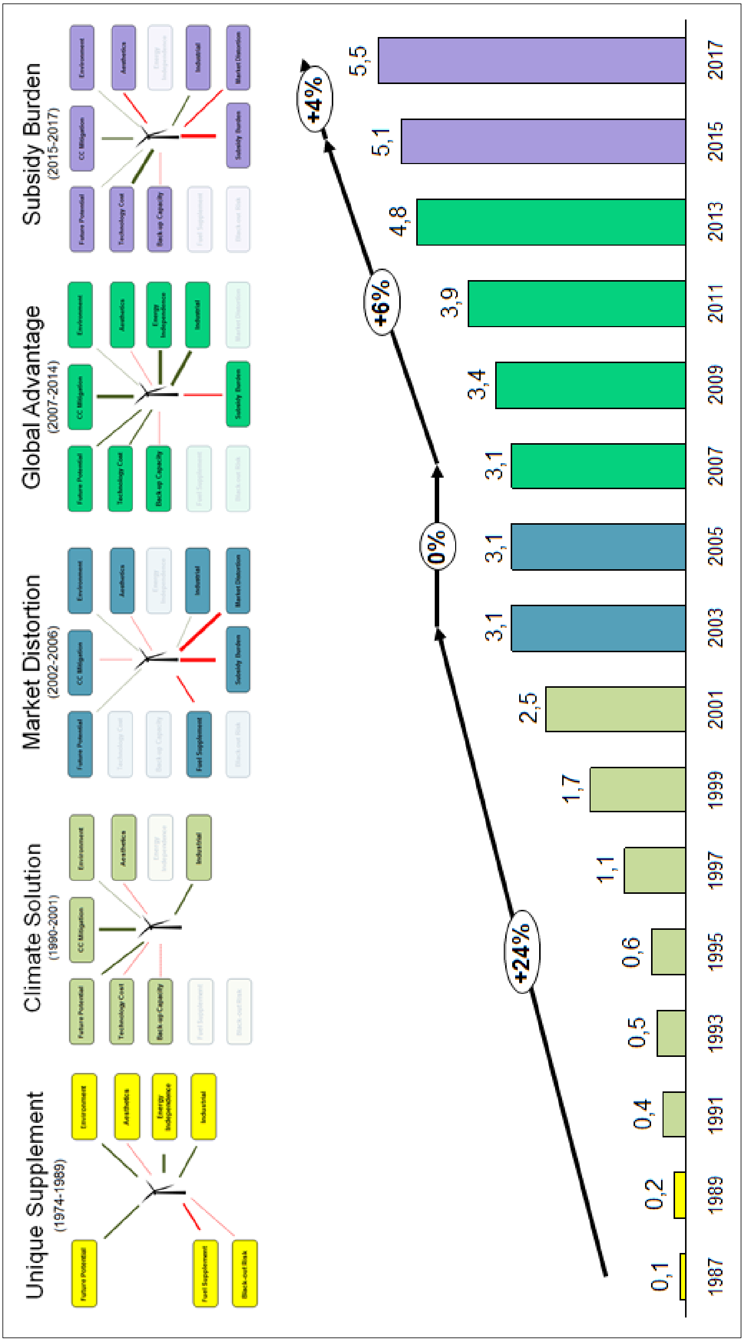

Figure 44: Valuation periods and Danish wind power expansion 1987–2017.

Upon reading Figure 44, it is important to bear in mind that installations do not show in the graph until 1-3 years after an investment decision are taken on them. The capacity build-out in the years from 2002-2003 stems from wind power projects in planning during 2000-2001. Strong growth occurred during the first two periods, Unique Supplement and Climate Solution. Such growth is typical when a new technology is deployed, starting from zero, as was the case during the Unique Supplement period. However, the high annual expansion to an already large onshore fleet during the last years of Climate Solution period is significant. In contrast, new installations nearly came to a complete halt during the Market Distortion period in the early 2000s. Since this trend was not observed in other European countries, it does not appear to have been caused by a general slow-down in technological advancement. It also cannot be attributed to a general economic recession, as the Danish economy still grew during the period, especially from 2004-2006, which saw annual real-BNP growth above 2% (DST, 2018). The build-out gradually recovered during the Global Advantage period, and then slowed down slightly during the Subsidy Burden period. It remains to be seen how the Subsidy Burden period will end, and what framing will emerge or re-emerge thereafter. The remainders of the Market-coalition is finding it more difficult to stabilize their framing as the Global-coalition are part of an even stronger valuation network, through the materiality of the low Technology Cost and growing *Industrial* benefits. Continued expansion during the Subsidy Burden period is however not only attributable to a decoupling of technology from the dominant framing. It is also a sign that the wind power proponent valuation network that was established in the Global Advantage period is finally beginning to take an incumbent position reflecting its share of production. Having discussed the frames and how expansion has evolved throughout the analyzed period, I turn my attention to the second half of research question 1 regarding qualities used in the valuation of wind power.

8.2. KEY QUALITIES USED IN THE VALUATION OF WIND POWER

Initially, wind power was considered to be a marginal *Fuel Supplement* and framed as a valuable way to improve *Energy Independence* and create *Industrial* benefits through jobs and exports. During the Unique Supplement period, the first seven qualities were present: Environment, *Black-out Risk*, *Aesthetics*, *Energy Independence*, *Industrial*, *Future Potential*, and *Fuel Supplement*. Of these seven it was most notably three qualities, *Fuel Supplement* (negative impact), *Energy Independence* (Positive impact, especially in the 1970's) and *Industrial* (Positive impact, especially in the 1980's) that determined the valuation of wind power. During the Climate Solution period, wind power was evaluated as a stand-alone energy source and two qualities, *Technology Cost* and *Back-up Capacity*, replaced the *Fuel Supplement* quality. Moreover, *CC Mitigation* emerged and became the key decisive quality in the dominant framing. Prior to the 1990, this quality was either absent from the framing or a component of the *Environment* quality in the specific case of the Unique-coalition’s framing. During the Market Distortion period from 2002 to 2006, two new qualities emerged that negatively impacted the value of wind power—namely, *Market Distortion* and *Subsidy Burden*. Hereafter, I briefly discuss the 12 qualities in three subsections covering technical (5), environmental (3), and societal (4) qualities.

8.2.1 Technical Qualities in Valuation

Initially, wind power was valued based on a break-even price relative to fossil fels, and was only considered valuable as a supplement to a fossil fuel infrastructure, not as an energy source on its own. This changed during the Climate Solution period, as the two qualities of *Technology Cost* and *Back-up Capacity* replaced *Fuel Supplement*. Wind power was evaluated as a stand-alone energy source through the LCOE device, and thus was not seen as purely supplementary. Once this occurred, *Back-up Capacity* costs were explicitly calculated, but wind power was not framed as a risk factor in maintaining grid stability, as had earlier been the case through the *Black-Out Risk* quality. During the Unique Supplement period, concerns revolved around how much physical wind power capacity could be connected to the grid without threatening short- and medium-term stability, as exemplified by the 1983 DEF report on overrun electricity. This quality faded away during the 1990s, as the grid was still functioning well with more than 14% wind power penetration by the end of the decade.

The *Fuel Supplement* quality which had disappeared during the Climate Solution period would reappear in 2002. During the Market Distortion period, the Danish Economic Council framed wind power as not valuable as a stand-alone energy source. This was argued from the point of reference that wind power was built on top of an already adequate amount of energy production capacity fueled mainly by coal. The Market-coalition’s way of calculating was still present throughout the Global Advantage period, through the additional reports by the DEC, the 2009 CEPOS report and partially in the use of the numbers in the 2014 Rockwool report, which counterfactually removed wind power from the Danish energy system[191]. The cost of wind power was then framed as an added expense to an otherwise functioning energy system. This is another example of calculating wind power as a *Fuel Supplement*, although it did not become part of the dominant valuation frame.

[191] Although the Rockwool Foundation may not has been as such a part of the Market-coalition, as the report also calculated *Technology Cost*, the way that the counterfactual number became the leading takeaway, illustrated how the entrenched meaning that wind power is an added cost to society still was present in the Global Advantage period.

This is one of the qualities made salient in opposition to wind power—namely, that due to its variability it cannot be considered more than a supplement.

The fifth technical quality is *Future Potential*, which was especially prevalent during the first two periods. The ATV valuation network built their promising calculations for wind power on ambitious estimates for technical development, for example a 35% capacity factor for onshore wind. This was a highly ambitious point of reference as the deployed turbines of the 1980s were still small and not yet optimized on the energy output-side. But the *Future Potential* could more easily be envisioned during the Climate Solution period, as large-scale future possibilities emerged, the size of turbines grew from 0.5 MW to 2 MW, and the first offshore wind demonstration projects were built. During the Global Advantage period, *Technology Cost* dropped significantly for onshore wind, and signals indicated that offshore wind could follow a similar trajectory. In 2012, key actors in the offshore wind industry pledged to reduce *Technology Cost* below an LCOE level of €100/MWh by 2020. This was followed by a 2016 pledge to reduce LCOE below €80/MWh in 2025. However, as shown in the Subsidy Burden period, *Technology Cost* of offshore wind dropped significantly faster than expected, and in 2017 an independent IEA workgroup declared the 2025 goal to have already been achieved (IEA-RETD, 2017, p. 9). It thus appears that the *Future Potential* goals of previous have materialized for both onshore and offshore wind today.

8.2.2 Environmental Qualities in Valuation

The *Environment* quality relates to local environmental benefits such as improved air quality, acid rain prevention, etc. These environmental benefits of better air quality and less risk of local environmental damage had an impact during the Unique Supplement period when the Unique-coalition fought against nuclear power. Although it was present in varying extents throughout all later framings, *Environment* was not a decisive quality in any of the five framings. It could however become decisive in the future as effects of climate change could come to have more local impacts even in western countries. One example could be that it would be more salient to calculate how much water an energy source uses to generate electricity. This has not been part of the framings so far, but has in recent years received more attention from international organizations such as the UN and the IEA (IEA, 2012a, 2016b; UN, 2016).

CC Mitigation, on the other hand, was a highly decisive quality in the valuation frame in the 1990s, when Denmark included a CO2 reduction target in its energy plan for the first time. Wind power was framed as valuable throughout the *CC Mitigation* quality due to its ability to generate emission-free electricity. The value associated with this ability was then negated during the Market Distortion period, when carbon trading markets were emerging. The Market-coalition argued that wind power was an inefficient way to reduce CO2 compared to buying carbon offsets. During the Global Advantage period, the *CC Mitigation* quality began to have a positive impact once again as Denmark hosted the climate summit and established both a Climate Commission and later a Climate Council, which served to keep Denmark on track towards fulfilling long-term climate goals. During the Subsidy Burden period, the new government called for Denmark to lower its ambitions, and decided to scrap a number of climate goals. Despite this effort to down prioritize climate goals, *CC Mitigation* remained a somewhat salient quality, as international summits and Global-coalition actors kept it in the frame.

The last environmental quality is quite different from the other two, who are more closely intertwined. The *Aesthetics* quality was present during the Unique Supplement period and calculated during the Climate Solution period to account for a very small and insignificant extra societal cost associated with erecting turbines. Starting in this period and during the following two, there have been small local groups of citizens, who have framed onshore wind farms as ruining the landscape, and thus not valuable. This quality has however not been significant enough to have any impact until the Subsidy Burden period. In this period, near-shore wind farms would be contested, while onshore wind farms would be vetoed by churches, or stalled by local politicians fearing retribution from their municipal constituency. Thus, the *Aesthetics* quality could have a future impact in the Danish struggle over the valuation of wind power, even though it was a marginal factor during four of the five valuation periods.

8.2.3 Societal Qualities in Valuation

There are four societal qualities present in the valuation of Danish wind power during the study period: the *Industrial* and *Energy Independence* qualities had a positive impact, while the *Market Distortion* and *Subsidy Burden* qualities had a negative impact. The *Industrial* quality covers the job and export benefits of having a wind turbine industry, and is one of the few qualities that is included in all five valuation frames. It was a key factor driving the Fuel-coalition’s engagement with wind power during the Unique Supplement period; even during the Market Distortion period, the *Industrial* quality had a positive impact on the valuation frame, albeit a slight one. The *Industrial* quality was among the decisive qualities of the Global Advantage period as the Danish wind turbine industry consolidated and a large export market opened up. Since job growth is among the strongest “currencies” for policymakers, broad valuation networks tend to form around it.

Energy Independence is the quality related to the value of long-term independence from foreign suppliers of energy fuel or technology. The 1973 oil crisis increased the salience of this quality as wind power was framed as a way to decrease Denmark's dependence on foreign fuel suppliers. This quality faded to the background during the Climate Solution period and even more so during the Market Distortion period. However, following the Danish Cartoon Crisis of 2005, awareness of the risks of dependence on Middle Eastern states for oil and gas increased once again. This increased salience of the *Energy Independence* quality helped usher in the Global Advantage period. This quality is evident in both Prime Minister Anders Fogh Rasmussen's 2008 green speech, and in the 2010 Climate Commission report. Both the 1973 oil crisis and the 2005 cartoon crisis highlighted the advantage of domestic power production, and the *Energy Independence* quality had a decisive positive impact in framing wind power as valuable to Denmark, kick-starting these two periods. It is worth noting that in the three periods which did not follow after some geopolitical crisis, the quality of *Energy Independence* appeared to fade or completely disappear from the framing.

The *Market Distortion* quality was introduced during the period named after this framing that lasted from 2002 to 2006. It is a quality which has a highly negative impact on the valuation of wind power in three ways: (a) the prosthetic devices of energy taxes distort consumption; (b) wind power subsidies, from a neo-classical economics perspective, displace jobs that would have been created in other sectors; and (c) wind power subsidies, from a neo-classical economics perspective, displace other technologies that theoretically could have emerged in a "perfect" market[192]. Although members of the DEC were the main proponents of the Market Distortion framing, it also influenced the Fogh government's exploration of quota purchases for CO2 reductions. The *Market Distortion* quality has a game-changing impact, since it both decreases the positive impact of the *Industrial* quality, and transformed the positive impact of the *CC Mitigation* quality into a small negative impact within the valuation frame. Once wind power's value to society was framed as sub-optimal for violating free market principles, the market-coalition brought forward the framing that wind powers *CC Mitigation* quality was actually slightly negative, as CO2 reductions theoretically could be achieved less expensively through procurement of emission quotas.

Although the *Market Distortion* quality is related to the *Subsidy Burden* quality, I treat them separately because the *Market Distortion* quality builds on a very specific understanding of a "self-adjusting economy" that emerged in Denmark during the early 2000's and then again during the Subsidy Burden period. In this last period, the quality had a negative impact on the valuation of wind power as the 2017 energy

[192] Explaining the flawed and problematic logic behind the neoclassical idea of naturally occurring perfect markets is unfortunately beyond the scope of this thesis. Readers who are interested in the topic are encouraged to seek out one of the many excellent publications on this topic (Chang, 2011; Davies, 2017; Mirowski, 2013). Specifically to the topic of energy markets can be re-designed to accommodate the needed transition, it is worth exploring the Danish research project Innovative Re-making of Energy Markets and Business Models (IREMB, 2017a).

commission report proposed technology-neutral auctions based on the notion that a supposed “neutral market” would choose the best solution. In this line of argument, a specific value ascribed to wind power would distort the markets choice and therefore render it less valuable. This quality is not present in the other three valuation frames, since the dominant valuation networks did not ascribe to this understanding of markets. It is thus a fairly new phenomenon that appears to be confined to the Market-coalition.

The *Subsidy Burden* quality, which is used to value wind based on the tax burden borne by Danish consumers and industries, also first emerged during the Market Distortion period. This quality emerged strongly in the Market Distortion period, reflected in statements such as “money blowing out of the state coffers,” and the notion that the overall competitiveness of Danish industry was weakened by excessive taxes. Once it was introduced, it continued to be present during the Global Advantage period, when the center-left government implemented tax reduction measures for heavy industry in 2014. It did however not outweighed the positive impact qualities enough to change the dominant valuation frame, namely that wind power was a global advantage for Denmark. The *Subsidy Burden* quality was, however, highly salient during the period named after it, wherein the preceding energy minister declared it his highest priority to reduce or remove the PSO tax to especially help the horticulture industry, cement producers and members of other energy-intensive industries. Several calculations were based on the cost of PSO-tax, yet competitive technical costs were decoupled in discussions of wind power’s value. Subsidy costs were calculated separately, and the history of subsidies for wind power was highlighted as a matter of concern.

This concludes my summary of the 12 qualities used to frame the societal value of wind power throughout the 43 years of valuation struggles[193]. Hereafter I discuss the valuation networks and actor coalitions in the valuation struggle of Danish wind power.

8.3. VALUATION NETWORKS AND THE MAIN POLITICAL PARTY COALITIONS

It is not within the scope of this thesis to map the power relationships among every single actor involved in wind power valuation, but it is relevant to map the political coalitions in power during each period since the energy market is highly politically

[193] Later in this chapter, I discuss insights associated with the development of key qualities. In Chapter 9, I discuss how some of the qualities with highly negative impacts (i.e., *Fuel Supplement, Market Distortion, Subsidy Burden* and *Aesthetics*) can be mitigated by an actor representing a challenger energy source, and how the positive impact qualities (*CC Mitigation, Environment, Industrial, Energy Independence* and *Technology Cost*) can be made more salient.

regulated. I therefore focus this part of my discussion of valuation networks on the four major political parties responsible for implementing energy plans and laws throughout the study period. Figure 45 visualizes shifts in the parliamentary power each of the four political parties had over policy decisions related to wind power. The y-axis reflects the power of a party, ranging from “in control” if it had the decisive votes to enact its valuation of wind power or influence through control of the energy ministry, and “outside influence” if it was not involved in wind power legislation. Between the two anchor points is the “in coalition” point, which signals the degree to which a political party was involved in political coalitions that shaped wind power policies. Such a map can of course never give a complete picture of the parliamentary power play, but I hope that it can help to visualize power relations in the period. Note that I use the Political parties’ logo’s to represent them. A = Socialdemokratiet (Social Democratic Party), B = Radikale Venstre (Danish Social Liberal Party), V = Venstre (Venstre – The Liberal Party of Denmark), C = Det Konservative Folkeparti / De Konservative (Conservatives). All logos are used under recognition that they are owned by the respective party organizations.

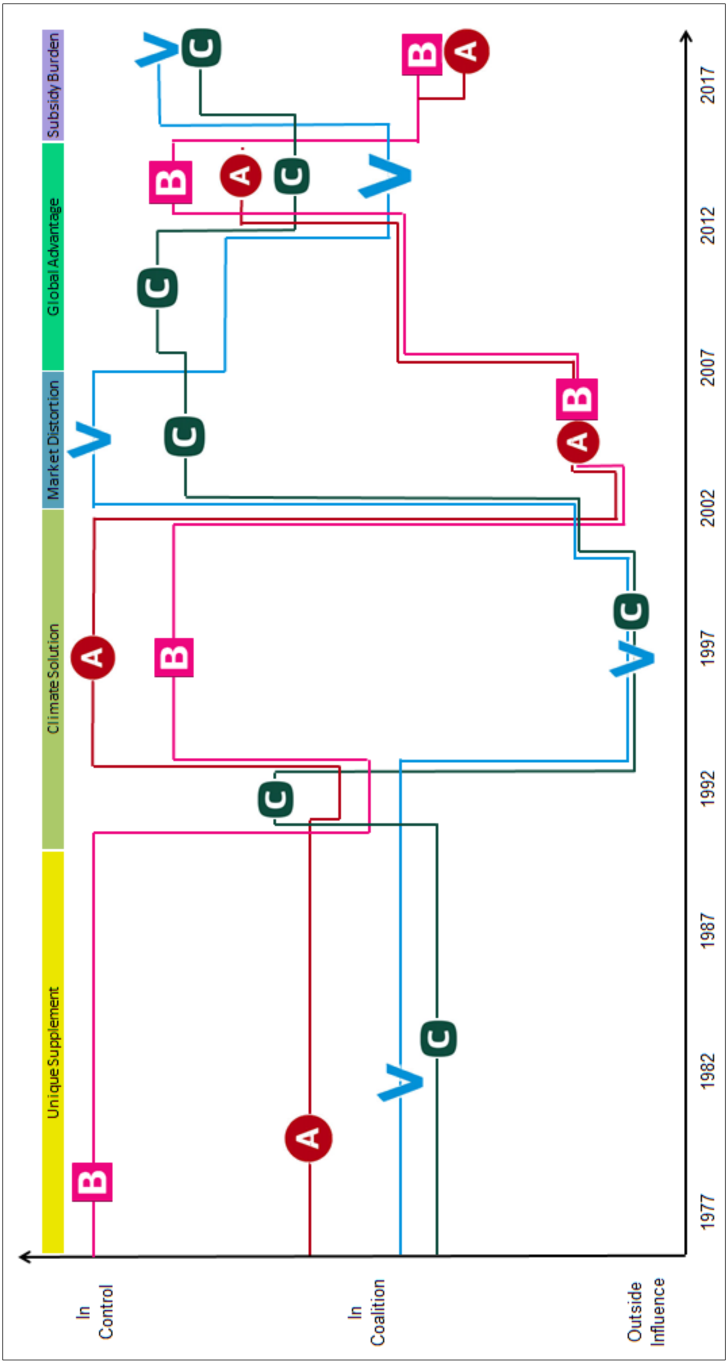

Figure 45: Power relationships between the four political actors 1977-2017.

As shown in Figure 45, with a few exceptions, wind power has not enjoyed bipartisan support; rather, it has been affected by dramatic shifts in coalitions of parliamentary dominance. This observation is not unique to wind power; in other studies, scholars have confirmed this phenomenon in the context of broader climate and environmental policy (Danielsen, 2015; Karnøe, 2012). The Radikale Venstre benefitted from collaborating with the left wing in the 1970s and 1980s, and thus found itself in a more powerful position than the other three parties, which all depended on votes from Radikale Venstre lawmakers. This was how the red-green majority was formed, which passed important legislation such as the law to abolish nuclear power. As shown in Figure 45, Radikale Venstre was the controlling party in the red-green majority that set the dominant framing near the end of the Unique Supplement period. After a failed destabilization attempt by a valuation network led by Conservative minister of business Anne Birgitte Lundholt, Socialdemocratic Minister of Environment and Energy, Svend Auken, would continue along the path set forth by Radikale Venstre Minister of Energy, Jens Bilgrav-Nielsen, in 1990. Capitalizing on momentum from Bilgrav-Nielsen's energy plan Energi 2000 and the red-green majority, Socialdemokratiet would actively shape the dominant framing of wind power during the Climate Solution period of the 1990's. Serving as a powerful spokesman, Auken continued to establish the Ministry of Environment and Energy as a calculative center by developing devices to calculate CO2 emissions reductions. This set the wheels in motion for an even higher valuation of wind power by incorporating CO2 emissions into the calculations determining the build-out parts for Denmark's infrastructure.

In 2002, the dominant Climate Solution frame was destabilized as the calculative centers within the Ministry of Environment and Energy was dismantled. Former calculative practices were replaced with neoclassical calculations based on the qualities of *Market Distortion* and *Subsidy Burden*. The Venstre party drove this new valuation of wind power by cancelling offshore wind farm projects, introducing uncertainty in the onshore market and establishing new calculative centers to form the Market-coalition. This coalition would lose its foothold in the valuation struggle in 2007, as several actors would begin to form a Global-coalition. Following Denmark's 2005 cartoon crisis, the Danish prime minister had become occupied with the value of *Energy Independence*. Furthermore, when it was announced that the 2009 COP15 meeting would be held in Copenhagen, *CC Mitigation* became salient once again, breaking ground for De Konservative to drive the creation of a broad energy agreement in 2008. In 2011, the keys to government changed hands, and Radikale Venstre reclaimed the ministry related to energy. Building on the bilateral focus on energy, the Global-coalition passed the historic energy agreement of 2012. During the Global Advantage period, all four parties were either in control or in coalition.[194] Finally, during the Subsidy Burden period, Venstre enacted a

[194] It is however important to note that these political negotiations are about prioritizing between which energy sources the parties find to be most valuable. When seen through this lens, Venstre generally prioritized negotiations for biomass and biogas, and only reluctantly supported the

larger number of political changes from the position of the energy ministry, but due to De Konservative's collaboration with the left wing, Venstre was not solely in control of wind power policy. The Subsidy Burden valuation frame is what the market coalition could get through in a field, where a strong Global Advantage valuation network resisted most destabilization attempts.

Radikale Venstre emerges as the most influential of the four political parties during the Unique Supplement period, and was identified by key actors as an important ally in introducing wind power into the public energy discussion. Socialdemokratiet then took control of energy policy through Auken's new calculative center in the powerful *Environment* and energy ministry. Radikale Venstre was still involved as a coalition partner with Socialdemokratiet at that time, but they were not the main drivers of policy. Venstre and De Konservative did not occupy a significant role during these two first periods. However, Venstre finally gained an opportunity to steer energy policy themselves, when they enacted a new dominant framing after the change in parliamentary power in November 2001. The Market Distortion valuation frame was driven by the newly formed Market-coalition, which dismantled the climate-coalitions centers of calculation. De Konservative played a larger role from 2007 onwards, as Minister of Climate and Energy, Connie Hedegaard, gained more political power and managed to obtain bipartisan support for the expansion of wind power. When governmental power shifted again in 2011, the new Radikale Venstre energy minister Martin Lidegaard built on the parliamentary collaboration around wind power to negotiate a historic 2012 energy agreement. The Subsidy Burden period that followed was defined by Venstre attempting to construct a valuation frame focused on subsidy costs of wind power. This framing was opposed on several occasions by the Global-coalition. So although Venstre was at the center of the remaining Market-coalition and had set forth the dominant framing, the valuation network of cheap wind power and a large industry that generated exports and jobs made it difficult for the Market-Coalition to keep their new Subsidy Burden valuation frame stable.

Three periods were defined by collaboration across the political spectrum but to different extents. During the Unique Supplement period, there was some collaboration over wind power policies, but Radikale Venstre was in a key position of control. During the Global Advantage period from 2007 to 2014, the De Konservative and Radikale Venstre parties each played central role; overall, this period was defined by a large degree of collaboration. Similar to the parliamentary situation in the 1980s for Radikale Venstre, De Konservative were able to drive

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expansion of wind power in 2008 and 2012 agreements. This is seen through their initial proposal for the agreement in 2008, which did not include a plan to expand offshore wind power capacity, and their negotiation position in 2012, where they generally advocated for less expansion. There are also differences when it comes to long-term planning versus short term target setting. Venstre is the only one of the four parties that did not join the 2014 agreement to establish the Climate Council to keep Denmark on track towards its 2050 goals.

collaboration with the left wing during the Subsidy Burden period, as seen in the fall of 2016, when they opposed the Venstre government to save near-shore projects.

In contrast, the Climate Solution and Market Distortion periods were dominated by one side of the political spectrum, with the other side almost completely excluded from influence. For most of the Climate Solution period, Venstre and De Konservative did not significantly influence the valuation of wind power. What little influence they did exercise was in opposition to the expansion of wind power; members of the Venstre party in particular opposed the subsidization of proposed new offshore wind farms. Similarly, Radikale Venstre and Socialdemokratiet are outside of influence from 2002-2006, with the exception of a 2004 agreement, wherein Venstre and De Konservative were forced to re-open a political agreement.

8.3.1 Broader Valuation Networks Involved in the Danish Wind Power Struggle

The four political parties were not the only actors in the valuation networks involved in framing the value of wind power, however. The utilities interest organization DEF (DEF during the first two periods, DE in the latter three periods) is a private incumbent actor that played a major role throughout the five analyzed periods. During the first period, DEF functioned as an almost exclusive knowledge center, and during the later three periods, it formed an influential coalition with Danish Industry, the industry's interest organization. Danish Industry did not participate in the valuation struggle until around 2000, but played an increasingly significant role during the last two periods, when it and DE served as the go-to sources for evaluations of government policy. These two actors valued wind power higher during the last two periods, as if to counter the Market-coalition, who had taken a strong oppositional stance to wind power.

The original challenger coalition emerged during the Unique Supplement period, when grassroots movements aligned with ATV academics and turbine-builders to gain a foothold in the periphery of the first two energy plans. During the Climate Solution period, some incumbent utilities and this Unique-coalition began to bridge the wide divide between them. Auken established a strong calculative center within the government, having the power to require the utilities to research more in renewable energy and establish offshore wind farms. The valuation network that was built around the new calculative center in Auken's ministry was not confined to new ways of calculating, however. It also encompassed CO2 taxation and a mandated build-out of 750 MW offshore wind power in the form of five large-scale wind farms. But this changed in 2002, when the powerful calculative centers within the Environment and Energy ministry were dismantled and energy became a subdivision under the business ministry. The climate-coalition lost their ally in the government, and wind power subsidies and market frameworks were problematized. This brought the expansion of wind power capacity almost to a complete halt for five years. In addition to dismantling the existing calculative center, Prime Minister Anders Fogh Rasmussen (V) created the market-coalitions new calculative centers such as the IMV institute and encouraged the formation of the privately funded think tank CEPOS[195].

Actors in the challenger valuation network that once were on the periphery began to become more powerful as the wind industry went through a number of consolidations during the early 2000s. The industry began to contribute significantly to Danish exports, and large utilities merged to form a global powerhouse in offshore wind power, Dong Energy. By this time, the Danish wind turbine manufacturers had consolidated into two global powerhouses, Siemens and Vestas. The influence of industry thus became more difficult to displace and a Global-coalition formed from climate-coalition actors, and actors who were previously neutral or market-coalition aligned such as De Konservative, Danish Industry and Danish Energy. The difference between the Market Distortion and the Subsidy Burden periods show how weakened the remaining Market-coalition actors were by 2015. In this latter period, this coalition has fewer actors, as it comprised of Venstre, Boersen, JP, Berlingske and select industrial actors from proximate fields. These actors especially emphasize the Subsidy Burden to other sectors and attempt to drastically impair existing frameworks and capacity expansion plans. This narrow valuation network disregarded the Global-coalition's calculative centers, such as when the climate council was labelled as "biased", and a new commission for energy instead was appointed. Despite heavy criticism, future onshore subsidies were re-designed as technology-neutral auctions and the budget for energy research was cut in half. Unlike during the Market Distortion period, it has during the Subsidy Burden period only been possible for the Market-coalition to partially construct a new valuation network. The market-coalition has mainly been occupied with disassembling the material actors established in the valuation networks reaching all the way back to the Climate Solution period, but also the Global Advantage. This is seen through the changes to onshore subsidies, the abolishment of the PSO-tax and the changes of goals going forward. But the Subsidy Burden valuation network met significant resistance to this framing, and several planned changes did not come to fruition.

[195] CEPOS did not deal with energy policy immediately, but in later periods maintained the focus on the *Market Distortion* quality.

8.4. RELATIONSHIP BETWEEN VALUATION FRAMES AND VALUATION NETWORKS

The next question to ask is how the relation between valuation frames and valuation networks form around the various energy sources, as it is central to understand who decides what gets counted[196]. Throughout the history of wind power, there has been a strong focus on technical qualities and demand for wind power to reach grid parity[197]. Since wind power became the cheapest available technology to build, proponents of wind power must focus on which other qualities are used to either strengthen or destabilize wind power. This study has shown that qualities related to the technological costs of wind power do not solely determine which valuation frames become dominant. The power of political party coalitions also determines part of the framing of societal value. Sociologist of valuation, Marion Fourcade similarly commented on whether or not superior performance on the technology cost metric such as LCOE could explain the success of a given technology:

> “In particular, I show that the mere availability of certain economic technologies does not guarantee their performative effects for the simple reasons that these technologies may not muster enough institutional and political support or that they may not resonate enough with the cultural claims they are supposed to represent”. (Fourcade, 2011, p. 1724)

Similarly, this study reveals that performative effects are not guaranteed. The wind turbine industry has adopted LCOE as the yardstick for comparison to other energy sources, and is now ahead of fossil fuel technologies in terms of Technology Cost. But as can be seen in the present study, wind power can be re-framed to appear as a non-valuable investment through several devices other than LCOE.

Despite significant technological performance improvements during the Climate Solution period, wind power capacity expansion was still brought to a near-complete halt during the Market Distortion period. Even in the Subsidy Burden framing, wind power was recognized as superior to conventional fossil fuel technologies in terms of *Technology Cost*, but not necessarily deemed valuable to the coalition in power. As Fourcade explained during a personal interview, the ongoing need to quantify

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[196] An example of this can be found in the forthcoming article “Framing the Deal Framing the Deal for Hinkley Point C in the UK: Performing political valuation of economic reality for new nuclear power” (H. B. Mortensen & Karnøe, 2018 Forthcoming) wherein “baseload” is highlighted by a dominant coalition as a necessary quality for the Hinkley Point C nuclear plant. If the UK energy system can function reliably without Hinkley Point C, the power plant’s framed value of providing assurance against the negative impact of the *Black-out Risk* quality is diminished.

[197] Grid Parity has either been defined as cheaper production costs than electricity prices or cheaper production costs than competing electricity sources. I discuss this further in Chapter 9: Insights.

intangible characteristics into costs can be an attempt to align imagined policies with understandings of the market's construction.

> "You could not say that you have the policy and then you value; it is actually reverse. It is because you value in a certain way that you can imagine the policy, because then the policy makes economic sense….When it [i.e., nature] is priceless, it has no price and therefore you can't advocate for it in a way that is relevant. Basically, there are two possible ways to advocate for environmental policies. One is, you just do it because it is common sense to do it [e.g., precautionary banning of fracking in Europe]…the other way is to put a value on more and more stuff". (Interview 12: Fourcade, quote 1)

As explained by Fourcade, it can be the case that the valuation networks in power already have a policy goal in mind and then they mobilize devices to realize this goal. In this study of wind power, it is clear that valuation networks mobilized "certain economic technologies" to assemble valuation frames that enact wind power as either valuable or not valuable to society. This relationship applies to the Climate Solution period; in the 1990's, the dominant valuation network framed CO2 emissions as an unacceptable byproduct of the Danish energy system, shaping the new valuation frame.

Likewise, the relationship is strongly apparent in the correlation between the Market-coalition and the Market Distortion and the Subsidy Burden valuation frames. This coalition framed the prosthetic devices that enable wind power as preventing the natural emergence of theoretically efficient market solutions, thereby creating a value-loss distinct from the quantifiable costs of direct subsidies. For example, during the Subsidy Burden period, even though near-shore turbines were auctioned off at significantly lower subsidy prices than expected, the dominant valuation network nonetheless framed these subsidies as too expensive. This shows how devices are mobilized to adapt to an entrenched meaning—namely, that wind power is too subsidized. Moreover, it is possible that the Market-coalition does not want wind power in the system at all as a matter of policy. This is never stated in the calculations, but whether or not it was the *Subsidy Burden* or the *Aesthetics* quality, all the presented conclusions appeared to point towards the same conclusion. It points towards a political coalition having agreed on a fate for a given project, and then adapting their valuation of it thereafter. This relates to a recent finding of researchers Beunza and Ferraro (2018) about fields that deal with politically loaded issues, such as how to value mitigation of climate change, calculative devices will face. In such fields, "exclusive reliance on calculative devices for performative projects faces normative resistance and proves ineffective" (Beunza & Ferraro, 2018, p. 3). This could indicate that a challenger technology cannot win over the world with the right calculations alone. Until wind power becomes the standard investment (together with other renewable technologies), it can still be framed as expensive, since it is being built into an already established energy system of 'sunk cost' power plant investments. I will return to the discussion about sunk cost in the following Insights chapter.

8.4.1 The Power of Valuation Networks

A central finding of this study is that when studying wind power's valuation history, there is no common logic behind the dominant framings of the valuation struggle and the evolution of the qualities and the points of reference used to ascribe value to them. During the first period, a number of negative impact qualities were associated with the technical elements of wind power and its integration into the energy system. However, there was an urgent need to achieve *Energy Independence* in the 1970s and the *Industrial* quality was highly salient because unemployment was a central matter of concern. This period followed a classic fit and conform structure, wherein wind power had to show that it could deliver the qualities required by the energy system. During the Climate Solution period, a new quality, *CC Mitigation*, was used to frame wind power as an indispensably valuable and necessary solution. The market thus shifted into stretch and transform mode, wherein the production of emission-free electricity became a priority for future build-out pathways. After this strong growth phase, there was a dramatic shift in valuation during the Market Distortion period. New calculative centers were created and two new qualities, *Market Distortion* and *Subsidy Burden*, came to define the dominant frame. In particular, actors used the *Market Distortion* quality to redefine how wind power was evaluated by dismantling the positive impacts of the *CC Mitigation* and *Industrial* qualities to reframe wind power as a value-destroying supplementary entity. This was followed by the Global Advantage period, when the *CC Mitigation* and *Energy Independence* qualities returned to salience. *Technology Cost* of wind power became competitive as the quality of *Future Potential* that was framed during the Unique Supplement and Climate Solution periods were realized. Against this background, the last moment of valuation is one the most puzzling. A new government and a narrower coalition manages to temporarily impose a valuation frame with *Subsidy Burden* as the overall defining quality, yet while it includes technical qualities with highly positive impacts on the valuation of wind power.

When the shift in valuation frames occurred in 2002, it was not as if the network around the Climate Solution frame disappeared; rather, it was placed outside of the network of influence. The grassroots and political players of the left-wing continued to criticize the directions taken, but they were temporarily unable to influence actions. Likewise, during the Global Advantage period, the Market-Coalition actor, the Danish Economic Council, continued to produce calculations showing how the quota market was the most efficient way to mitigate CO_2 emissions; another Market-coalition actor, CEPOS, and new actors, such as the Rockwool Foundation, also performed calculations that framed wind power as a supplement that added cost to the energy system. However, these calculations did not become part of the dominant framing. The dominant framing in a given period is thus not necessarily superior in terms of the qualities used and their points of reference; instead, it signaled that the valuation network upholding it had managed to impose its valuation on others:

> “A market implies the execution of these crossed calculations and includes only the agencies capable of performing them….Due to these asymmetries, the most powerful agencies are able to impose their valuations on others and consequently to impact strongly on the distribution of value”. (Çalışkan & Callon, 2010, p. 11,13)

As seen in the most recent period, Subsidy Burden, the framework around wind power can still be somewhat destabilized in the Danish market. One explanation for this could be that the above described “imposed valuations” of wind power as subsidized and therefore expensive has turned into an entrenched meaning. Such an entrenched meaning can be upheld by “powerful agencies”, which in turn make it difficult for new calculations showing wind power as the technologically cheapest technology to impact the distribution of value. Even in the Global Advantage period, the DEA calculation showed wind power to be the cheapest technology to build, and was initially criticized by some actors as being unrealistic. Wind power is still at times framed as a supplement to the energy system, and thus a cost. The 2014 Rockwool report provides an example of how the “business-as-usual” scenario is calculated. The calculation includes cost savings based on the assumption that wind power can be removed from the energy system without any significant impacts.

The notion that wind power subsidies and taxes distort an otherwise ‘free’ electricity market is built on a number of misunderstandings. Electricity prices occur because of the political frameworks which are set to economize certain energy sources in a certain way. It may appear that there are some energy sources, which are not subsidized, but this is merely because the subsidies not as easily visible as the PSO-tax. All energy sources have received subsidies or indirect contributions to their production costs (CAN-Europe, 2017; IMF, 2015; ODI, 2014; Timperley, 2017). So neither the electricity price nor the estimated LCOE of coal or gas power can be used to judge what a ‘market’ cost of a valuable energy source should be. It can however be used to see where wind power has to be cost-wise to outperform coal and gas in the currently skewed market. If one acknowledges climate change science, it is necessary to account for what a working group within the IMF labels as “post-tax subsidies”, which is where the state does not sufficiently tax the damaging effects of emitting CO_2 (IMF, 2015, p. 21). Once these subsidies are counted in, but also even if only direct subsidies are counted (Timperley, 2017), it is clear that there never existed such a thing as an undistorted free energy market[198].

But this notion of putting the numbers "on the table" and discussing whether or not societies can afford to mitigate climate change reverses the order of nature and economics (Latour, 2014, p. 6). This is one of the larger paradoxes of the Anthropocene epoch, which also comes through in the analyzed valuation struggle. While the scientific consensus of climate change can apparently still be cast in doubt by leading politicians and media-publics, the order of economics remains unquestioned, as explained by Bruno Latour below.

> "What is really remarkable is that during the last two centuries the very notions of the two natures have exchanged their properties: first nature has entered the Anthropocene where it is hard to distinguish human action from natural forces and which is now full of tipping points, peaks, storms and catastrophes, while only second nature [i.e., economics], it seems, has kept the older features of an indifferent, timeless and fully automatic nature governed by a few fundamental and undisputable laws totally foreign to politics and human action". (Latour, 2014, p. 6)

What remains outside the discussion is what should replace wind turbines if they are not built. This is unfortunate for challengers who seek change, while convenient for fossil fuel incumbents or proximate field actors, who seek to maintain status quo. All Danish parties have signed on to the Paris Agreement, and if the science behind this Agreement is acknowledged, a business-as-usual scenario is not a viable option. The calculated cost of adding wind power could also be framed as a necessary system transition cost, instead of as an additional cost to the system. I explore this topic further in chapter 9: Insights.

All valuation frames can be considered flawed by their exclusions, or in other words, correct within their assumptions and limitations, since "by definition, to frame is to make selective inclusions and exclusions" (Callon, 1998, p. 8). Framings which make economic calculations based on sunk costs may appear more realistic and intuitively correct since it is based on cost of capacity that may appear as historic and given. Some energy sources may therefore appear to be the most economic because calculations are based on a locked-in framework that includes a

[198] One example is two of Denmark's main import countries for Coal, Russia and Colombia. Russian coal has had the extraction cost subsidized by the Russian state (ODI, 2014), while Colombian coal is extracted through controversial methods which have been shown to damage the local communities near the mines (Sommer, KLJE, & Frandsen, 2016).

large amount of sunk costs (Mitchell, 2009; Unruh, 2000, 2009). But in a world where facts and opinions become "even more mixed up," it is important to reflect deeply on which actors to align with (Latour, 2011, p. 7).

8.4.2 CC Mitigation is not a system-dependent quality

The present analysis indicates that rather than only technical cost competitiveness, struggles over societal qualities will also determine the future of wind power. After substantial drops in Technology Cost, wind power was the least expensive option for capacity expansion during the last period from 2015 to 2017. Nevertheless, wind power continued to be problematized due to costs of the framed *Subsidy Burden* affecting other sectors. The qualities that negatively impacted the value of wind power during later periods (i.e., *Fuel Supplement*, *Market Distortion*, and *Subsidy Burden*) depend on perceptions of markets and the general regulatory framework architecture. The main positive impact quality of wind power, *CC Mitigation*, on the other hand, is not a system-dependent quality. Electricity from a wind turbine does not harm the climate no matter how the power is used.[199] If we focus this same lens on a coal or gas plant, the qualities become reversed. Coal and gas power have until recently been framed as cheap, because their damaging effects to the climate are not taken into account. Thus, the main positive impact quality used in framings of fossil fuels, appearing to be the cheapest technological option (at least until recently), is market dependent. But the main negative quality of coal and gas power, that they emit CO2 and thereby cause climate change, is a quality that is physical and not dependent on the market arrangement. Stored carbon is locked in the fuel; no matter how the power output is used, this carbon negatively impacts the climate. This thought about the qualities that are market dependent and the qualities that are inherent in the energy sources themselves presents an interesting choice when combined with the moral imperative to act in response to the Paris agreement.

The valuation frame approach can reveal the assumptions and reference points behind the qualities that make up the valuation frame which produces a given meaning. By adopting this approach, it is possible to more accurately challenge whether the high impact of a given quality is merited, or if a framing is constructed to "resist fundamental change" (Geels, 2014, p. 27).

[199] An offshore wind turbine has a life expectancy of 25 years and has compensated for the CO2 emissions used to produce it after 9 months of operation (Siemens, 2014).

8.4.3 Wind Power as a Shaky Incumbent

Do the most recent developments mean that wind power has achieved some sort of incumbent status? Even though the market had shifted into stretch and transform mode during the Climate Solution period, wind power remained a challenger, accounting for only 14% of electricity consumption at the beginning of the Market Distortion period. Despite rapid domestic expansion in a homegrown industry which accounted for 50% of the global market share of wind turbines, the domestic market was still brought to a near-complete halt during the Market Distortion period. Frames were used not only to institute change or resist this challenger technology, but also to derail its stabilization process.

However, by the time of the Subsidy Burden period, wind had become the single largest power source for electricity generation, satisfying more than 40% of the Danish electricity demand. The landmark 2012 energy agreement struck during the Global Advantage period called for significant expansion of offshore wind capacity, with the goal of increasing that share to well over 50% by the early 2020s. By all usual measures, this should reflect incumbent status. Yet stabilization remains paradoxically elusive for wind power, which continued to be challenged by remaining actors from the Market-coalition joined by proximate field actors such as the horticulture industry and other energy-intensive industries. These actors were loosely associated, but shared a disdain for prosthetic devices such as taxes and subsidies that support wind power stabilization. So, why do such setbacks occur after a technology should theoretically have achieved incumbent status? This is a question Neil Fligstein considered worthy of further empirical examination. In a 2016 interview, I had the opportunity to ask him whether he thought wind power in Denmark today was an incumbent or a challenger given the high share of electricity consumption. He responded:

> "That is a good question. It sounds to me like almost something that would have to be empirically established. At what point do they [i.e., the wind industry] stop being a challenger and start being an incumbent? Certainly, there was a moment where they were a challenger. They might maintain that challenger mentality, but who knows if it is real or not. I guess the way you tell is how the rules are written and who gets to say what". (Interview 11: Fligstein, quote 1)

The way to tell who is an incumbent and who is a challenger is based on "how the rules are written and who gets to say what." This shows that wind power was in the peculiar position of being an incumbent on paper, but in two out of five periods, the rules were re-written with destabilization to follow. Wind power is possibly in the paradoxical situation of being both an incumbent and a challenger. During the

Climate Solution period, the rules were re-written to frame CO2 emissions as something that needed to be eliminated. In this way, wind power could be seen as an incumbent. But unlike in the Unique Supplement period, incumbent actors in the energy market were not the primary actors that destabilized wind power during the Market Distortion and Subsidy Burden periods. It was instead the Market-coalition which comprised concerns from proximate fields such as the overall *Subsidy Burden*. This also points towards a higher exposure of energy-related matters in media coverage, and destabilization attempts from actors outside the field that wind power operates in.

8.4.4 Debunking the Myth of the Danish Consensus on Wind Power

As mentioned in the introduction, there are at times drawn a line between a few broad energy agreements and the conclusion that Denmark's position in wind power was built on a history of bipartisan agreement. But once the related proposals and plans are analyzed in depth, a different picture emerges. Although there has been an advantage to having broad energy agreements, such as during the Unique Supplement period (i.e., among Radikale Venstre, Socialdemokratiet and the left wing in 1984 and 1985) and the Global Advantage period (i.e., among all major parties in 2008 and 2012), there has never been consensus agreement about which direction to take. De Konservative was strongly opposed wind power in the early 1990s, but came to value it higher with the emergence of Connie Hedegaard on the political scene and the assembling of the Global Advantage frame. But prior to this fourth period, they are not visible in any coalitions that placed a high value on wind power. Venstre saw some potential in wind power as an export good during the Unique Supplement period, as exemplified by business minister Knud Enggard in the mid-1980s. Some factions of the party also expressed some support for wind power during the Global Advantage period. Yet, as it showed in the Subsidy Burden period, Venstre's overall framing of wind power investment appears to be that they are not valuable as long as there are subsidies involved. Thus, when it comes to energy policy, there were no periods of conflict-free agreement, only periods of compromise. What is important to note is that energy agreements and laws encompass many interests and pathways of other energy sources, such as biogas and biomass. There are several bipartisan laws and agreements that include wind power legislation in it, but this rather show a tradition of compromise when it comes to overall energy-sector legislation and not agreement over the value of wind power.

A bold conclusion could be that it appears as if the dominant parliamentary coalition is able to choose the calculation that fits their imagined future. This is not necessarily an easy task, as new framings are almost always challenged; for example, the Subsidy Burden valuation frame, which excluded several points of reference of the previously accepted framing, proved difficult to stabilize.

This concludes the answer to the first of my two research questions. The theoretical toolbox of valuation frames has been useful in opening up the black box of valuation, and maps the strategic interplay of political coalition in a dominant valuation network. By tracking how various qualities emerge and become central to valuation frames, one can reveal how valuation occurs. An important part of the strength of a given framing is the power of the valuation network. Mapping the simultaneous change in Valuation Frame qualities and the corresponding Valuation Networks makes the actors' assumptions debatable, and thereby makes it possible to discuss how the societal value of wind power is produced. According to Callon, no framing is an accurate representation of the societal value of wind power, or any other technology. There is thus no ultimate formula for the value of wind, but only different competing representations of it which reflects exclusions and inclusions from the calculative devices used and the network behind it. One must then ask which valuation networks one most closely aligns with. I have attempted to map five different framings through the most significant moments of valuation in Danish wind history. As Dewey stated, we can only describe the world through the tools we have available for our inquiry, and I am aware that this analysis will never be able to capture the full valuation history of Danish wind power. But I hope to have brought new things to light and have laid the early contours of a framework worthy of future research endeavors. In the next chapter, I address my second research question, which picks up where my first research question leaves off. Thus far, I have mapped and analyzed my way up to the current dominant valuation framing of wind power as a Subsidy Burden. However, it is possible for a challenger valuation network to contest this framing of wind power, which I unfold in the next chapter.

9. INSIGHTS FOR CHALLENGERS

From studying the microcosm of Denmark, I now turn the focus outwards towards the EU and the future valuation struggles to come. In this chapter, I address my second research question:

Research Question 2: What can be learned from the valuation struggle of Danish wind power in terms of stabilizing a field as a challenger energy source in Denmark and Europe?

I will in this chapter point to some of the potential upcoming struggles over value when it comes to wind power and attempt to leverage insights that are valuable in these struggles to come. I will discuss it from the qualities identified and try to highlight examples in the broader field of wind power and incumbent fossil fuel energy sources it still is in competition with.

9.1. WIND POWER CAN SERVE AS THE BACKBONE OF THE DANISH ENERGY SYSTEM

Wind power started out as practically all new technologies do, namely as a challenger in an established market. During the Unique Supplement period, it made sense to calculate several small and back then inflexible wind turbines as a *Fuel Supplement* to the overall energy system. The technology was not yet reliable enough for the utilities to count on wind power as a source that could generate a specific percentage of electricity. This changed during the Climate Solution period, wherein wind power accounted for 14% of Danish electricity demand without wreaking havoc on the system. Nevertheless, since 2002, several calculations performed wind power as a supplement that incurred a cost to an otherwise well-functioning system. These types of calculations were built on a framing that wind power costs should be calculated against a business-as-usual scenario.

However, if one accepts the science on climate change, it is clear that a business-as-usual scenario is not an option. The Transmission Systems Operator (TSO) which is responsible for the Danish grid, Energinet, does not view large degrees of wind power as problematic. During an interview for this thesis, two analysts from the

Danish TSO explained how they view the role of wind power in Denmark's energy system:

> "Energinet is of the clear opinion that we do not need capacity markets…we expect that the demand side will be established to an extent where the few hours in the year [when there is not enough wind or interconnectors], something will be able to disconnect freely…technically, we have enough solutions". (Interview 10: Energinet, quote 1)
>
> "Whether the wind-share rises a bit more and such, that is not what really costs something on the supply security side….If one talks about dispatchable reserve capacity the last 10 to 15 years, this has actually not gone up if you look at the northern countries as a whole". (Interview 10: Energinet, quote 2).

The amount of back-up capacity needed has thus not increased even as renewables share of consumption has grown significantly. As interconnectors are built, capacity can be reduced if participating countries are willing to do so. By developing effective sector integration combined with interconnectors to nearby countries, the need for capacity markets can be removed. These are smart energy investments, but they are at the system level and not connected to a specific energy source. Due to its location, Denmark is among the most well-connected countries in Europe. In the summer of 2017, a test performed by Energinet showed that the electricity system could run on renewables and interconnected capacity alone for several weeks, something which had been theoretically acknowledged as far back as 2013 (Wittrup, 2013, 2017c). These results effectively eliminated the previous justification for keeping old coal power plants on the grid to deliver energy security.

Outside Denmark, technical solutions are being developed to integrate large shares of wind power in other countries. In Texas, the U.S. state with the largest wind power capacity and where wind power fulfills more than 20% of electricity demand, state grid operator "The Electric Reliability Council of Texas" (ERCOT) has had very good results with wind power integration. In December 2015, ERCOT concluded that the grid was becoming more stable as wind, solar and gas capacity grew and replaced coal plants; in fact, they could more accurately predict wind variability than unexpected coal plant outages (Osborne, 2015). The important point here is that any electricity grid requires either back-up capacity, interconnectors or demand-side response capacity equivalent to that of the largest plant on its grid (i.e., in Texas, the W.A. Parish generating station has four coal-burning units for a total capacity of 2.6 GW). If one or more units of such a large plant go offline, a large amount of capacity must be replaced instantly. This is why all back-up costs in a grid are not attributable to wind power alone. In a 2015 report, the American Wind Energy Association revealed a cost breakdown for the 2.8 GW of immediately available reserves that was in ERCOT's grid: just 4% were attributed to the need to accommodate wind power variability, whereas 67% were attributed to the need to accommodate conventional power plant failures. The reserve needs for wind power are thus "far smaller and can be met with less expensive, slower-acting reserves" (AWEA, 2015, p. 14).

In the South Power Pool area, a 14-state region in the south-western United States which includes Texas, wind power briefly met more than 50% of electricity demand in March 2017; afterwards, South Power Pool VP Bruce Rew concluded that the area could "reliably manage" 50% wind penetration, adding "it's not even our ceiling" (DiSavino, 2017)[200]. Back in 2012, the National Renewable Energy Laboratories (NREL), which is a sub-department of the U.S. Department of Energy, had already examined whether or not the U.S. grid would be able to handle up to 80% renewable energy penetration. The conclusion was that a combination of renewable technologies and flexibility options already available today were "more than adequate to supply 80% of total U.S. electricity generation in 2050" (NREL, 2012). Although NREL had only been asked to examine a penetration up to 80% of electricity there are also studies of a complete transition for all sectors. Professor Marc Jacobson and his team of Stanford engineers have mapped how all of the world's major countries could get 100% of their energy from renewable energy sources (Jacobson & Delucchi, 2011)[201].

This does not mean that storage technologies should not be developed; quite the contrary, they are incredibly valuable in terms of building effective grids. In a June 2017 report, the European Academies of Science Advisory Council concluded that storage is not "fundamentally needed" to transition to a 100% renewable energy system (Simon, 2017a). The technological possibility of wind power as a backbone in the energy system is not impeded by its variability.

9.2. THE VALUE OF MITIGATING CLIMATE CHANGE IN DENMARK

One of the central understandings in the Market Distortion valuation frame is that it does not matter what Denmark builds when it comes to mitigating climate change, since Denmark only contributes about 0.1% of global CO2 emissions, and that

[200] There are also examples of small rural towns in Texas, such as Georgetown with a population of 50,000, who now rely solely on renewables for electricity production (Gross, 2015).
[201] In 2016, Portugal ran on renewables and hydro-power for 4 straight days (Nelsen, 2016), and in 2017, the Chinese Quinghai province (population 6,000,000) reportedly did so for 7 straight days (CAP, 2017).

Denmark instead should seek global market solutions to *CC Mitigation*. Even if this argument is not taken to its extreme conclusion of inaction, it is at times used to argue that whatever "market-like" price is set for CO2 by a device such as the EU quota system is the only price that Denmark should pay. This price then becomes a device to frame the value of wind power's *CC Mitigation* quality.

I find it peculiar and noteworthy that the neoclassical view of markets that is embedded in the *Market Distortion* quality can change the rank of the quality that, in my humble view, is the most important quality out of the 12, namely *CC Mitigation*. In Latour's words it appears that while the natures reactions to our pollution is highly disputed, the implications of the neoclassical economic devices paradoxically becomes regarded as "undisputed law totally foreign to politics of human action" (Latour, 2014, p. 6). As Latour points out these devices are of course human constructs but paradoxically are regarded as undisputable and apolitical.

If one follows the moral impediment of urgently mitigating climate change, I agree with the IEA's call for the world to take "urgent actions to steer the energy system on to a safer path" (IEA, 2014, p. 24), in the form of a "massive build-out of renewables", which would need to occur at an "unprecedented pace", which goes far beyond anything achieved historically or pledged so far in Paris (IEA, 2017a, p. 75)[202].

I argue that this urgency of mitigation means that the salience of the *Market Distortion* quality should be much more challenged in Denmark and elsewhere it may occur. It is remarkably surprising and troubling that the recommendations based on the DEC's neoclassical economic knowledge is so strong that it makes climate mitigation appear less important than preventing distortions based on a highly idealized version of economic markets.

Indeed, *CC Mitigation* is by many seen as the most important issue especially because of the need for urgency in mitigating it. There is a monumental difference between taking large steps to mitigate climate change within the next 3 to 5 years, versus postponing action another 10 to 20 years. In the words of long-time climate

[202] I herein include a short excerpt from the IEA's 2017 chapter on the needed actions in the Energy system: "To keep pace with the overall emissions targets of the 66% 2°C Scenario, unabated coal-fired power plants, i.e. those without CCS, would need to be phased out as soon as possible. The least-efficient coal-fired power plants are phased out by 2030 in most regions; and by 2035 in all regions…. The massive build-out of renewables is critical to the low-carbon transition in the 66% 2°C Scenario and would need to occur at an unprecedented pace – going well beyond the historic rates of capacity additions and those projected based on Paris Agreement pledges. Overall, the pace of renewables-based capacity additions in the 66% 2°C Scenario would continue robustly through 2050, surpassing 400 GW per year towards the end of the period. This level is four-times the average of new capacity additions worldwide over the past ten years and close to double the average level of additions reached in the New Policies Scenario (The Paris Pledges, ed.) (IEA, 2017a, p. 75).

activist and founder of 350.org, Bill McKibben, “Winning slowly is the same as losing.”

> “By 2075 the world will be powered by solar panels and windmills—free energy is a hard business proposition to beat. But on current trajectories, they'll light up a busted planet. The decisions we make in 2075 won't matter; indeed, the decisions we make in 2025 will matter much less than the ones we make in the next few years. The leverage is now”. (Mckibben, 2017)

The ultimate success of wind power may seem inevitable if one just let things go their path and wait a bit. But according to the IPCC’s projection (IPCC, 2007, 2014b) and the Paris-Agreements pledged contributions, we do not have time to wait. More than 80% of the world’s energy is produced by burning a finite supply of fossil fuels; if they are used at currently projected rates, by 2040 the world will have forfeited a 50% chance of staying below the agreed 2 degree warming limit (IEA, 2015, p. 12; IPCC, 2014a). To understand the fierce urgency of mitigating the climate crisis of the Anthropocene epoch, one only needs to examine the risk of tipping points, such as ice sheet collapse at the poles, or acidification of the world’s seas (Rockström et al., 2009; Schellnhuber, H. J. Rahmstorf & Winkelmann, 2016; WWF, 2015). Already, evidence suggests an acceleration of the pace of warming: 14 of the 15 warmest years on record have occurred in the 21st century in what the World Meteorological Organization has called an “alarming” trend requiring “urgent and far-reaching measures” (WMO, 2016). Jeremy Mathis, the Director of the Arctic Research program for the U.S. National Oceanic and Atmospheric Administration (NOAA), emphasized the urgency of the task ahead in a December 2017 presentation on the accelerated melting of the polar ice caps:

> "When we look at the darkening of the Arctic, reflective, icy surfaces are melting to reveal darker surfaces that absorb more of the sun's energy…And now we're seeing acceleration—a runaway effect that may eventually be a catastrophic runaway effect starting to take hold in the Arctic. They're facts—facts weighted in thousands and thousands of scientific measurements that have been validated and peer reviewed by a community of experts working in the area for decades”. (Gill, 2017)

The risks of these “catastrophic runaway effects” are hard to articulate and commensurate into numbers, as they would substantially change the world we live in. Several major intergovernmental organizations, thus agree that man-made climate change represents a high impact threat to the world that could lead to higher sea levels, longer droughts and stronger and more frequent dangerous weather events (IEA, 2015; IPCC, 2014a; WBG, 2012; WEF, 2016b). As phrased in IPCC's conservative language, the world face a "high to very high risk of severe, widespread and irreversible damage" (IPCC, 2014b, p. 13). In less conservatives language, Economist Lord Nicholas Stern compared the decision to try to stay under the 2 degree limit to deciding whether to play "Russian roulette with two bullets or one" (Stewart & Elliot, 2013). The majority of man-made CO2 emissions that cause climate change stem from the energy sector (IPCC, 2014a; WBG, 2012), the two main sources being coal (865 g/KWh) and gas (450 g/KWh) (IEA, 2012b).[203] These two energy sources will likely have to be completely phased out from the energy system within the next two decades to have a chance of staying below the 2 degree limit (Ecofys, 2016; Pfeiffer, Millar, Hepburn, & Beinhocker, 2016)[204]. But the difficult part is to figure out which countries that should phase out fossil fuels first and at what pace. Historical emissions data from the World Resources Institute indicate that Denmark is the 12th largest per capita emitter of CO2 from 1850-2010, and significantly richer than many countries who will feel the hardest impacts of climate change. Figure 46 compares Denmark to India and Nigeria, two of the fastest growing countries in the world today (WRI, 2015). The graph below the numbers was constructed by the author on the listed WRI data.

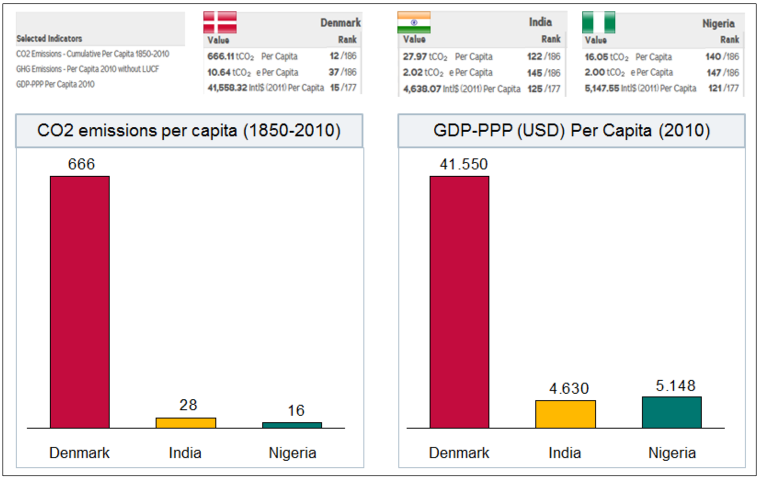

Figure 46: Emissions and GDP comparison of Denmark, India and Nigeria.

[203] Lifetime emissions for a wind turbine, including its construction, is 7 g/KWh and it produces energy equivalent to that used to construct it in the first 9 months of operation (Siemens, 2014).

[204] Renowned consultant agency Ecofys estimates a 2 degree scenario as incompatible with new coal plants, and would also require phasing out existing coal plants by mid-century at the absolute latest (Ecofys, 2016). Likewise, a recent Oxford University study found that additional gas plants could not be built after the year 2017 if the world was to stay under 2 degrees (Pfeiffer et al., 2016).

According to the Worlds Resources Institute, Denmark has historically emitted 20-times more CO2 emissions per capita than either India or Nigeria. Moreover, Denmark is more than nine times richer measured by GDP, and thus is better equipped to mitigate damages from the 1 degree of climate change that the world is already experiencing. The above graph highlights a historic responsibility. But even if we ignore historical emissions, it is possible calculate how much CO2 each country have left to burn. This is done by dividing the amount of carbon that can be burned without causing global temperatures to more than 2 degrees equally among the world's citizens. The Danish Ministry of Energy, Utilities and Climate was in 2016 asked to calculate this number, and concluded that each world citizen had a budget of 116 mn. tons of CO2 equivalents. This led to a budget of 660 mn. tons of CO2 equivalents for Denmark (EFK, 2016). According to the most recent data from the DEA's annual basis-prognosis, Denmark emitted 51.9 mn. Tons of CO2 in 2015, and is expected reduce emissions to 44.8 mn. tons by 2020. Denmark is thus eliminating roughly 7 mn. tons of annual CO2 emissions within the 5 years of 2016-2020, roughly cutting emissions by 1.4 mn. tons per year (DEA, 2017a, p. 223). Even if Denmark reduces emissions at a faster rate (2 mn. tons per year), it would exceed its carbon budget by 2035, and thereafter be forced to immediately achieve net zero emissions[205]. Current emissions would need to be cut in half over the next 13 years, and even then the carbon budget would still be exceeded if we do not achieve net-zero emissions in 2035. The problem is that this limited carbon budget is not reflected in energy planning, as noted in a 2015 special report on energy and climate change published by the International Energy Agency:

> "The projected path for energy-related emissions in the INDC Scenario means that, based on IPCC estimates, the world's remaining carbon budget consistent with a 50% chance of keeping a temperature increase of below 2°C would be exhausted around 2040…If energy sector investors believed that not only new investments but also existing fossil fuel operations would be halted at that critical point, this would have a profound effect on investment even today". (IEA, 2015, p. 38)

The above quote by the IEA refers to a possible future situation where the "rules of the game" would change significantly, and investments in coal and gas plants would be near impossible to gather a coalition around. It would have some similarities to the Climate Solution period where the rules of the Danish energy field were significantly changed. But on the European scale it appears as if this urgency to make renewable energy the standard investment (Baake, 2016) has not yet completely been established. Judging from the analysis in this thesis, one of the

[205] It is also worth noting that to achieve this, Denmark would have to reduce annual emissions to less than 25 million metric tons by 2030.

reasons for this lack of urgency could be that the *Market Distortion* quality prevails in valuations of energy. Namely that only global market solution can solve it and that it therefore thus not matter what actions individual countries take. I will hereafter discuss why I consider this understanding is flawed.

If Denmark's decisions did not matter, then it would be even more foolish for the local Danish municipality, Soenderborg, a region of only 75,000 people, to pursue their ProjectZero strategy of carbon neutrality by 2029. They are investing heavily in becoming carbon-neutral before the rest of the country, even though no international treaty or national law is forcing them to do so. In the spring of 2017, Soenderborg municipality was visited by a delegation of civil servants from the Hebei province in China who wanted to learn more about the ProjectZero initiative (Rathje, 2017). Although Hebei's population of 75 million is more than 13 times the population of Denmark, it is less than 5% of China's population. To understand the difference in size, Figure 47 (GBA) is a visualization of Soenderborg, Denmark and Hebei in cubes each representing 100,000 people below (Statista, 2017)[206].

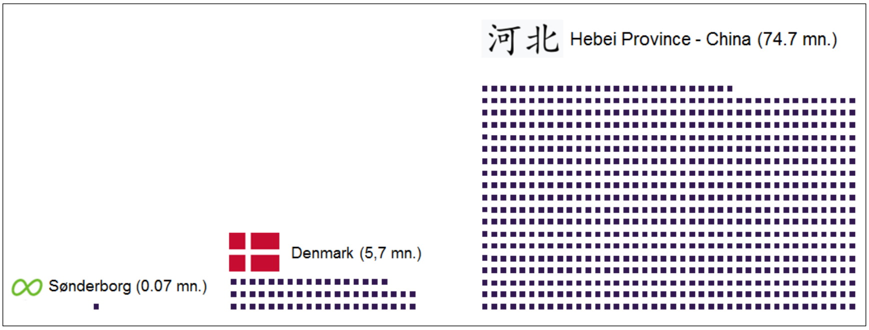

Figure 47: Comparison of Soenderborg, Denmark and the Chinese Hebei Province

The civil servants representing the 75 million residents of the Hebei province also could think their actions do not matter. They are only 5% of China, which is only one country (albeit a very large one) out of many. But if Hebei's emissions are negligible, so are those of major countries in the EU with similarly-sized populations (yet much larger CO_2 footprints). If an individual's actions reflect his or her desire for universal law, the moral obligation of the individual to help collective action move forward is high, even though the impact of the individual's actions may be insignificantly small. Although Soenderborg's goal of achieving carbon neutrality

[206] It was my original ambition to include China on the same graph, but doing so would render Soenderborg and Denmark invisible.

by 2029 may not make a detectable difference in the global level of CO_2 emissions, its example may accelerate the actions of a Chinese province that is 10-times the size of Denmark, which in turn may accelerate the actions of a country 200-times the size of Denmark.[207]

It also appears unlikely that proponents of the "it doesn't matter what Denmark does" or "Denmark should not run too far ahead of other countries" logic would apply this consistently to other societal questions. If Denmark is too small to mitigate climate change, why do its citizens aim to solve other large problems in the world? If Denmark is so insignificant, why does the country invest in medical research to find cures for various diseases, or build the finest research institutions? Denmark does this because its citizens believe in their ability to make positive contributions to the world and to serve as an example for others. Energy scholars Morris and Jungjohann (2016, p. 2) referred to the industrial policies of the German Energiewende as a way to "make good for previous emissions." I believe that this also justifies why Denmark should develop its wind industry instead of buying the cheapest CO_2 emissions offsets available. If Denmark can help speed up the transition in other countries, the nation can begin to make up for both its historic emissions and its current carbon footprint.

9.3. WIND IS COST-COMPETITIVE, BUT SYSTEM TRANSITION COSTS EXIST

System costs represent another major issue that a challenger technology may face as the system built around a different incumbent technology will not be designed for the new challenger. Denmark is positioned to lead by example and is technically capable of building an energy system with wind power as its backbone (section 9.1), and there is an urgent global need to transition away from fossil fuel energy (section 9.2). According to several studies, this is also technically feasible outside of Denmark, but will not happen without substantial system investments (Connolly, Lund, & Mathiesen, 2016; Jacobson & Delucchi, 2011). But a complete transition to renewable energy requires going even further to view renewables as the new standard investment (Baake, 2016) and modify energy markets to fit renewable energy sources (Hopson, 2016). This means that system integration costs are not only technical improvements to the grid, but also costs to the business case of other energy field actors, and sometimes even actors in proximate sectors.

[207] The Chinese provinces, of course, may have different motivations for reducing CO_2 emissions. Regardless, they travel to other countries to solicit ideas and inspiration. Although China's system of handling climate change mitigation is different from a that of a Western liberalized open economy (Thornton & Goodman, 2017, p. 223), I believe actions in a small province can inspire actions in a larger province, and ultimately at the national level.

If Western nations are serious about their Paris pledges, renewable capacity, such as wind power, must be built with the attached integration costs that follow. Integration costs can be minimized if current market arrangements are modified to accommodate the large role of renewables (IREMB, 2017b). Inevitably, this will lead to stranded assets among conventional energy generators. This is not alone a technical challenge, but more importantly a political one. This grand challenge must be solved first in a country that can bear the cost of developing a sustainable energy system without compromising its energy security or industrial competitiveness. The key to a sustainable transition of our energy systems in time therefore depends on how we as a society frame the value of our energy choices. But if agreement on the value of wind power in relation to the ongoing green transition is a challenge for a pioneer like Denmark, it will likely be an even bigger challenge for other EU countries.

This is why it is important to learn from the microcosm of the world's wind power deployment. Looking forward, Denmark currently has an official goal to satisfy at least 50% of its energy demand from renewable sources in 2030, and to be independent of fossil fuels by 2050. To be independent, Denmark needs to be able to satisfy 100% of its energy needs from domestic renewable energy sources such as wind, solar, biogas and biomass (Biomass is considered renewable in the Danish target). As three to four new datacenters are being built in Denmark over the coming years, the demand for carbon-free electricity such as wind power will increase even more. Moreover, energy as a whole also covers large heating and transportation sectors. When one looks at energy across all three sectors, Denmark currently satisfies only about 25% of its overall energy needs with renewables. Therefore, heat and transportation systems must be transformed by incorporating components that use electricity generated from renewable resources (i.e., heat-pumps, electric cars). This requires that some old generating capacity is taken off the grid, in example coal plants. In Denmark this discussion is actually confined to a few central power plants, as I will hereafter exemplify. In 2016, Denmark had roughly 12.7 GW of installed power generation capacity, including approximately 2.4 GW of coal capacity (BNEF, 2017b, p. 7; DEA, 2017a, p. 50). In 2017, Oersted (formerly DONG Energy) announced that it would phase out coal from its four remaining central power plants by 2023,208 and Copenhagen utility HOFOR also has plans to phase out coal at the 250 MW Amager Bloc 3 by 2019 (DEA, 2017a, pp. 237–240). By 2023, a combined 1.6 GW of coal energy should have been retired or replaced by biomass. This leaves only two major coal power plants, Fynsvaerket (442 MW) and Nordjyllandsvaerket (410 MW), which were bought by municipally owned utilities, when the Swedish utility Vattenfall no longer deemed them profitable in 2014 and 2015 respectively (Brauer, 2015; OKOM, 2014).

[208]The four plants are Studstrup Bloc 3 (357 MW), Asnaes Bloc 5 (640 MW), Avedoere Bloc 1 (250 MW) and Esbjerg Bloc 3 (371 MW). Three plants are already in the process of phasing out coal; intentions are to phase out coal from Esbjerg Bloc by 2023, but a concrete plan has not yet been made.

It is interesting for a moment to consider how powerful a proximate actor can become in shaping specific topics of energy policy, as exemplified by the case of the Funen horticulture industry. This industry's annual exports total approximately 3 billion DKK for the floral industry, which employs 10,000 people, and is concentrated primarily on Funen Island. The floral industry on Funen consumes 25% of all the heat delivered by Fynsvaerket, and the central Funen municipality of Odense has specified that "coal is cheaper than straw and other biofuels," so a transition to biomass would entail "substantial price increases for the heat [delivered] to the horticulture industry" (Odense.dk, 2017). In the DEA's energy prognosis, it is specifically noted that the municipally owned utility that owns Fynsvaerket does not seem interested in converting to biomass due to pressure from the horticulture industry (DEA, 2017a, p. 240). As was noted in the Subsidy Burden period, this industry was also specifically named in the press release that announced the purchase of Fynsvaerket, and managed to obtain substantial reductions to its PSO payment before it was eliminated. This case is anexample of the powers of actors in proximate fields, as the floral industry operates in a tightly interconnected geographic cluster which enables it to mobilize considerable influence, as evidenced by close relationship to LCL (Arnfred & Jessen, 2016; Christiansen, 2015).

But how should this challenge of local sub-optimization of the energy system be approached? To make the transition to a fossil free energy system a reality, it is necessary to engage with proximate fields of the energy system itself. One way to do this is to cast more light on how costs are split between government and the private sector. Subsidies come not only in the form of direct payment to an industry, but also in the form of relief from fees to offset costs of pollution. It is necessary to compare the costs of facilitating an energy system transition for the horticulture industry with the costs that they incur by continuing to use coal well into the 2020s.

Within the next few years, building new capacity for Danish wind and solar is expected to be cheaper than operating existing coal plants (DE, 2017, p. 4). Moreover, as more technical solutions become available in terms of converting wind electricity to heat, using excess heat from data centers, etc., there appears to be few to no economic arguments left for the continued use of coal for energy in Denmark past 2025. In other industrialized countries, concerns over supply security in the case of a coal phase-out may be legitimate, but Fynsvaerket is an example of a plant that appears to primarily be kept open due to local concerns. In a 2015 analysis, the DEA calculated the societal cost of phasing out coal by 2025 to be between DKK 0.5 and 1.8 bn., but that included all of Oersted's power plants (DEA, 2015a). Since Oersted and HOFOR will close their plants by 2023, only two other major plants will need to close, Fynsvaerket og Nordjyllandsvaerket, and the costs are thus likely to be less than DKK 1 bn.. There is thus not an insurmountable societal cost to phase out coal by 2025, but the last few plants may stay open to secure low heat prices for Funen Horticulture, and heavy industry such as cement producer Aalborg Portland (Arnfred & Jessen, 2016, p. 33,207).

A risk going forward is that energy system investments, such as interconnectors or phase-out plans for coal plants, become framed as actions that must be taken to support wind power. One recent example of this is the DKK 8 bn. funding of Viking Link, a 740 km long interconnector cable between Denmark and the UK. The interconnector was by Minister of Energy, Utilities and Climate, Lars Christian Lilleholt, framed as a necessity due its ability to export large amounts of Danish wind power; highlighted in October 2017 when the storm Ingolf caused the Danish wind turbine fleet to produce more than 100% of Danish electricity demand (DR, 2017). This framing is problematic as the Viking Link will also be heavily used to export German coal energy to the UK, where it will displace British gas plants (H. Lund, Mathiesen, Hvelplund, Djørup, & Madsen, 2017). This is an example of energy system investments, where wind power is framed as one of the key reason that something should be built, while there are other reasons that may very well have weighted higher in the decision to invest in a project. It is a difficult proposition that wind power could come up against in the future. As it takes on a larger role in the energy system, more and more system improvements will in some way be related to it. Wind power as an energy source then risk having these system integration costs added as a negative impact on its value in calculations that frame it against the zero-cost of doing nothing in a business-as-usual scenario.

9.3.1 Wind Power Technology Cost and European Potential

When faced with the IEA prediction about the carbon budget running out around 2040 (IEA, 2015, p. 38), it is relevant to discuss whether or not the Danish difficulties of developing an exit strategy for fossil fuels also occurs in the EU. If wind power is to become the backbone of the EU energy sector, existing capacity will have to retire prior to its lifetime. It is therefore worth considering whether wind power on a European scale can compete with fossil fuels, and whether or not this fossil fuel capacity can be retired. The EU consists of several different national markets with intricate differences, as well as some overarching shared rules and goals. I therefore focus my reflections on *Technology Cost*, combined with the societal qualities comprising the theoretical framework used in the empirical analysis.

One of the major differences between the Danish valuation struggle and a potential valuation struggle in the EU is the technological advancement that has occurred through decades of political investment in the *Future Potential* of wind power. Having realized that *Future Potential*, *Technology Cost* will have a positive impact on the valuation of wind power, and concerns over the cost of *Back-up Capacity* will be low. In the next subsections, I briefly outline the current LCOE costs of onshore and offshore wind power. Thereafter, I discuss Europe’s existing fossil fuel sources, most of which must be displaced by wind power in the coming decades.

Onshore Wind – The challenger changes the rules of the game

When the Danish Energy Agency released its report on onshore wind in 2014, it highlighted a cost-trend that was emerging in several European markets. The International Renewable Energy Agency (IRENA), observed significant cost reductions in its database of installed projects from 2010 to 2016 across major EU countries: Spain (48%), Italy (43%), France (42%), Germany (31%) and the UK (10%) (IRENA, 2018, p. 87). The U.S. think-tank Lazard similarly observed a significant 67% decrease in onshore costs worldwide between 2009 and 2016.[209] Lazard estimates European onshore wind at an average level of €54/MWh making it competitive with gas (€51/MWh) even when framed without environmental impacts (Lazard, 2017, pp. 3, 9). In a report prepared for the annual Davos World Economic Forum (WEF) in January 2017, it was even more aggressively estimated that onshore wind *Technology Cost* had dropped more than 30% in the three years from 2014 to 2016 and stood at €43/MWh (WEF, 2016a, p. 5). This report estimated that wind prices had achieved grid parity with electricity prices in at least 30 countries, and an average annual rise in electricity prices of 3% would lead to 80% of the world's markets being at similar grid parity "in the next couple of years" (WEF, 2016a, p. 6).

But LCOE comparisons of capacity expansion costs for wind and gas power are becoming less relevant as a metric, as wind power now must compete with the operating costs of existing gas and coal capacity to justify early closures of CO2-emitting infrastructure. London-based think tank, Bloomberg New Energy Finance, estimated that in Germany, building new onshore wind capacity will be cheaper than operating existing gas plants around 2025, and cheaper than operating existing coal plants around 2030 (Liebreich, 2017, p. 62). The organization which throughout the years has upheld the LCOE yardstick, the International Energy Agency (IEA), has also acknowledged that LCOE will not be used to determine when it is valuable to build renewable capacity in the future. This was elaborated in a 2017 interview by IEA chief economist Laszlo Varro:

> "The key coming milestone, to my mind, is when we change our view of the competitiveness of renewables. On the level of average cost of electricity, that is the levelised cost of energy (LCOE), wind and solar is becoming more and more attractive. That's the good news. But the bad news is that at the same time LCOE is a less and less relevant metric for variable renewables. Increasingly, we have to look at cost at the system-level—and ask the question whether an energy system that has a significant volume of renewables is cost-competitive with one that doesn't. The answer increasingly is 'yes'". (Snieckus, 2017)

[209] The cheapest onshore wind measured by LCOE is found in the U.S. Midwest, where strong winds provide good annual energy production (Lazard, 2017, p. 10).

Although onshore wind has become the cheapest in terms of the quality Technology Cost, increasingly its value will be measured based on cost at the system level. If the developments seen in Denmark are to translate to the larger EU market, costs to proximate sectors will be a critical factor. Furthermore, if onshore wind is expanded significantly, the *Aesthetics* quality likely will play a more salient role in future valuation frames. So although the EU at the end of 2017 had 153 GW onshore and only 15.8 GW offshore wind installed (WindEurope, 2018, p. 7)[210], it is likely that offshore wind will take on a much larger role in the future.

Offshore Wind – The option that will lift the challenger to a European backbone energy source

Even more aggressively than for onshore wind, costs for offshore wind power has dropped significantly in recent years. The declines in costs of offshore wind power during the 3-year Subsidy Burden period (2015–2017) signal that the game has changed. When I began this thesis, I included the goal "to analyze how calculative standards in energy markets are established, maintained and challenged" in the main objective, thinking that the standard yardstick, LCOE, had to be challenged. I saw an example of how the wind industry measured its ability to match coal and gas on the metric of LCOE at the annual European Wind Energy Association's Offshore Conference in March 2015.

Attracting more than 7.500 participants from industry, it is the largest offshore wind conference in the world. The theme was "united industry" with a strong focus on attaining cost reductions as the main goal of innovation in the industry. In Table 10 on the next page, I present some of the phrases used to describe how important it was for the industry to achieve 40% cost reductions by 2020 and thus achieve the pledged LCOE below €100/MWh (EWEA, 2015). The statements are reproduced as heard by the author and later triangulated with the audio proceedings from the conference.

[210] The combined installed wind capacity of 168.7 GW equaled 18% of the EU's total fleet of power generating capacity (937 GW) and supplied 11.6% of electricity demand. On a global scale wind constituted a fleet of 540 GW capacity by end 2017, hereof 18.8 GW offshore wind (GWEC, 2018, p. 3).

Table 10: Statements about reaching the 2020 offshore wind cost goal.

Statement	Source	Company
If we do not succeed with cost-out, we will be out of business by 2020	Claus Hviid Christensen, VP	DONG Energy
Society cannot afford paying offshore wind at the level it is at.	Michael Hannibal, Head of Offshore	Siemens Wind Power A/S
We must act quickly to make sure we reach our cost reduction target for 2020.	Markus Tacke, CEO	Siemens Wind Power A/S
We are in a car with no road after 2020.	Jonathan Cole, CEO	Iberdrola Renewables Offshore
There is a significant end-customer pressure for lowering levelised cost of energy (LCOE) in the wind industry.	Henning de Haas, Head of Wind SCM Development	KK Solutions

Clearly, by the spring of 2015, leading CEOs in the offshore wind industry considered the industry to be at risk of being “out of business by 2020,” or metaphorically, “in a car with no road after 2020”. Despite the consensus building around the upcoming Paris summit during 2015, the actors in the offshore wind industry still clearly did not see their energy source having a stabilized future at this point in time. But things would change significantly over just three years, as the costs of offshore wind power dropped rapidly.

I have visualized the average LCOE of onshore wind, offshore wind, coal and gas, respectively, based on data from Lazard’s annual cost review reports for 2014, 2015, 2016 and 2017 (Lazard, 2014, 2015, 2016, 2017). Figure 48 (GPA) is a visualization which shows the central point of Lazard’s unsubsidized LCOE range converted to real-2016 EUR. For historical reference, I include 2010―the last year in which

Lazard estimated gas to be cheaper than onshore wind. Offshore wind was not included in Lazard's calculation at that time.

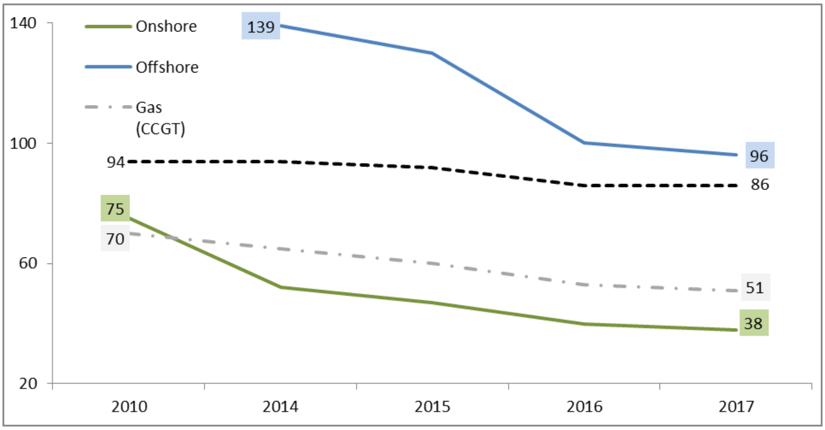

Figure 48: Lazard LCOE-levels for 2010 and 2014-2017 (€/MWh, real-2016).

The 31% drop in offshore wind cost over the five reports is significant and has the potential to fundamentally change the valuation network of offshore wind power in the EU as a whole. It is also worth noting that the most recent offshore wind auctions have not yet been factored in, as Lazard measures LCOE based on projects for which final investment decisions have been made. The IEA's Renewable Energy Technology Deployment research group (IEA-RETD) expects that the projects that were awarded subsidy contracts in 2016 and 2017 and are not included above, will show that the industry has "already exceeded its newly set 2025 cost target (€80/MWh, incl. grid connection) 8 years ahead of schedule" (IEA-RETD, 2017, p. 9). The notion that offshore wind has seen a major breakthrough is shared by IEA chief economist Varro, who in a 2017 interview emphasized that the offshore cost reduction was a bigger impact event for Europe than cost drops in solar panels had been for the world.

> "In my view offshore wind has certainly been a major recent breakthrough—cutting the cost by half in two years is clearly disruptive. In the context of Europe, the potential implications of offshore wind are even bigger than the impacts of the solar revolution we have witnessed in the last decade. In the European climate, there are geographical and climatic limits to using solar at very high shares, whereas offshore wind is very scalable in Europe". (Snieckus, 2017)

Thus, significant economies of scale advantages are on the horizon for offshore wind, and it approaches grid parity with electricity prices. On top of the already steep cost reductions, investment bank Goldman Sachs foresees another 50% drop between 2022 and 2030 and thus predicts costs falling below average European wholesale prices by the mid to late 2020s (GS, 2017, p. 5,7). Over the long term, the London-based think tank Bloomberg New Energy Finance, predicts that offshore wind costs will fall 71% from current levels by 2040 (BNEF, 2017a, p. 2).

It may seem as though I am spending too much time discussing the quality Technology Cost of offshore wind power, since onshore wind still by far is the cheapest solution and offers many of the same advantages as offshore wind power. However, the *Aesthetics* quality which played a more salient role in Denmark during the Subsidy Burden period could come to impact valuation in the EU as well. Early examples of this trend include the implementation of a policy to block the construction of onshore wind in the UK (Hill, 2017), or severe distance-to-buildings restrictions in Poland (O'Brian, 2016). Noting this increasing trend in both Denmark and other EU countries, it is worth exploring large scale initiatives that can continue to reduce offshore wind costs[211]. Europe has especially favorable conditions for offshore wind in the North and Baltic Seas; in a baseline case assessment, consultancy BVG calculated that there were enough attractive offshore wind sites to satisfy 80% of Europe's electricity demand by 2030.[212] Even if EU decided to only develop the most cost-attractive sites, estimated to be possible at an average LCOE of €54/MWh, offshore wind power could still supply 25% of Europe's electricity demand by 2030 (BVG, 2017, p. 10). The EU commission has not performed an in-depth study of the seabed, but in 2017, it did recognize the potential that the North Sea alone could satisfy 12% of the EU's electricity demand (DE, 2017, p. 56). However, if this potential is to materialize in time, some fossil fuel capacity must come off the grid.

9.4. INCUMBENT FOSSIL FUELS STRUGGLE TO MAINTAIN THEIR RELEVANCE

In the future, onshore and offshore wind power will be competing primarily against existing fossil fuel capacity, not new capacity expansion projects. This existing capacity has already incurred capital investment costs and may be subsidized through various subsidy schemes, such as national capacity market payments or

[211] One example of a cross-country collaboration that enables economies of scale is the North Seas memorandum which proposes the construction of the TenneT Power Island in the North Sea (Energinet.dk, 2017; Hopson, 2016; WindEurope, 2016b).

[212] On a global scale, it has been calculated that there are available waters within 200 km of shore with a minimum average wind speed of 10 m/s to supply the world's electricity demand in 2040 two times over (GS, 2017, p. 23).

infrastructure funding schemes from the EU. If Western industrialized nations are serious about fulfilling their Paris pledges, infrastructure for challenger energy source such as wind power needs to be built at a faster pace. Current market arrangements must be radically transformed, and some actors will need to redefine their roles. These profound changes to the modern energy system will inevitably have repercussions, including stranded assets among incumbent owners of conventional power plants (EY, 2016, p. 5; IEA, 2015, p. 38). This is not a technical challenge, but a political one.

The next two sub-sections are meant to set the stage for how a larger field of study related to valuation struggles could be identified. As mentioned above, BNEF envisions a near future (i.e., the mid-2020s) wherein it will be cheaper to build onshore wind and solar capacity than to operate existing fossil fuel infrastructure. At this point, the cheapest option for national energy planners will be to fill up their systems with as much "baseload"[213] renewables as possible, and supplement with flexible power capacity or non-plant demand-side response, integration or storage solutions (Liebreich, 2017, p. 62).

Once new-build renewables out-compete operating costs of existing capacity, there will be stranded assets at risk for the fossil fuel industry in the EU. To protect these assets the fossil fuel industry is today mobilizing its lobbying capacity, which significantly dwarfs the renewables industry[214], in an attempt to keep their framework conditions stable.

9.4.1 Coal Industry – Incumbent that is seeing its world destabilize in Europe

Although existing coal plants previously has been framed as the cheapest way to produce energy, coal is no longer a feasible build-out option in most EU countries. According to the London-based think tank Carbon Tracker, 54% of the EU's coal plants are running a deficit, and operations are maintained only through government subsidies such as capacity payments. Coal Tracker predicts that the percentage of unprofitable coal plants will increase to 97% by 2030 and the cost of keeping them running until then will be in the vicinity of €22 billion (Shanklemann & Morison, 2017).

[213] The term "baseload renewables" is a conscious provocative reversal of the common conception that renewables are added on top of "baseload" energy sources such as coal and nuclear power.

[214] According to the Brussels-based NGO Corporate Europe Observatory, oil and gas giants Shell, ExxonMobil, BP and Statoil are four of the top 10 spenders on lobbying in Brussels; combined, they spend more than €15 million annually and employ 47 lobbyists (CEO, 2017, p. 8). These companies do, of course, engage in minor activities related to renewables, but their major source of income is oil and gas production by far. Additionally, the top two spenders, the European Chemical Industry Council (€12 million, 82 lobbyists) and General Electric (€5.7 million, 18 lobbyists), align with the four gas giants on many issues (CEO, 2017, p. 8).

Some hardcore hold-outs, like Euracoal, feel “hated like slave traders,” and interpret the COP21 as an example of “the climate bandwagon” causing countries to allow the rule of law to be replaced by “mob rule” (Crisp, 2015). The influence of Euracoal and its allies is demonstrated by the difficulty associated with enforcing legislation on the 550 g CO2/KWh ceiling as a demand for receiving capacity payments in the EU. With this ceiling, only gas plants would qualify since nearly all coal plants in the EU emit more than 550 g CO2/kWh. If there was agreement to move beyond coal as soon as possible, a law to abolish subsidy payments to old coal plants should be easy to pass. Nonetheless, in December 2017, the EU Council of Ministers proposed that the law should not apply to existing capacity, but only to coal plants built after 2025 (Gutman, 2017). This, of course, is an arbitrary number, since no new coal plants will be built in Europe after that date anyway. In April 2017, Eurelectic, a lobby group for utilities in the EU, pledged not to expand coal capacity after 2020 in any EU countries except Poland and Greece (Neslen, 2017). The critical question about coal capacity that will affect the build-out of wind power is thus not how much capacity will be built, but how much of the existing infrastructure will be subsidized to stay on the grid. Apart from a few hold-outs in Poland and Greece, most of the large European utilities in the EU recognize that new coal infrastructure will not be built, and instead are instead focusing on gas. One example is CEO for German utility E.ON, Klaus Shäfer, who announced that Datteln, a 1.1 GW coal plant slated to be commissioned in 2018, would probably be the last one constructed in Germany. Shäfer did not begrudge this but instead emphasized that something had to be done to facilitate the construction of new gas infrastructure, since “security of supply is too important to leave to the market” (Renssen, 2017).

9.4.2 Gas Industry – Struggling to redefine a new role as least polluting fuel

As previously shown in Figure 47, onshore wind is already cheaper to build than gas plants, and offshore wind infrastructure is fast approaching that threshold. But what is more concerning for gas power plant operators is the fact that their LCOE levels are much more volatile than those of wind power. As fuel costs comprise approximately 2/3 of the lifetime LCOE of a gas plant, the gas plant business case is highly dependent on fluctuations in gas prices and CO2 quota prices. If a gas power plant is built today, the risk of quota prices going up within the 40-year plant lifetime would render it a significantly more risky investment than it was 20 years ago (Pedersen, 2017). Gas plant operators are therefore trying to re-categorize themselves as part of the renewables industry, or as a safety net that guarantees uninterrupted energy supply. This push was recently announced when the EuroGas lobby organization launched a large event to promote “renewable gas” as a new way of looking at biogas and power-to-gas.[215] These types of gas only constitute about 4% of the gas consumed in the EU today, but the EuroGas organization argues that if such gas could be given “a level playing-field” through a subsidy of €130/MWh, it would be able to compete (Simon, 2017b). Apart from this changed focus, the industry has been able to frame its societal value mainly from a supply security perspective, similar to the nuclear lobby’s efforts some years back (Garud, Gehman, et al., 2010). The NGO network CAN-Europe has calculated that in the years 2014-2016, the EU has on average annually spent more than €200 million on gas infrastructure projects (CAN-Europe, 2017), to lower the EU’s dependency on Russian gas imports (EUC, 2017a, p. 26). This is through the EU infrastructure fund, wherein pipelines and liquid natural gas terminals qualify to be funded as “projects of Common Interests” if they can be proven to “enhance security of supply” or merely “increase competition by offering alternatives to consumers” (EUC, 2017b). By funding pipelines and LNG terminals with EU taxpayer money, the EU decreases dependence on Russia, but increases dependence on natural gas in general. This strategy is dangerous, because too much new gas infrastructure can create a lock-in effect post-2030 (Pfeiffer et al., 2016).

Despite the EU’s support for infrastructure construction, the gas sector is under pressure due to low electricity prices throughout Europe. Two of the largest Western manufacturers in the gas industry, Siemens AG and General Electric announced substantial workforce reductions of 6,900 and 12,000 employees, respectively, in the last quarter of 2017, signaling a time of “disruption of unprecedented scope and speed” according to a Siemens AG press release (Hsu & Krauss, 2017). Finding investors for new gas plants is difficult, even in the UK, where electricity prices are among the highest in the EU. In 2014, the UK government offered the utility Carlton Power a capacity payment contract to build a new 1.8 GW gas plant in Trafford near Manchester. The subsidy contract stipulated a fixed annual payment of €22/kW installed, equal to ~€40 million per year. The contract was for the first 15 years of the plant’s operations, so the total subsidy would amount to more than €500 million (Gosden, 2016). Despite this lucrative contract and after two years of dedicated effort, Carlton Power was unable to secure investors and had to give up the subsidy contract. They would instead try to bid again in a later capacity auction to receive a higher payment per KW (Reuters, 2017). This shows that even traditional benchmark competitors for wind power find themselves in a market that does not guarantee their expansion.

[215] Power-to-gas is where electricity from some electricity producing facility, which could be wind or solar power, is turned into gas to be pumped into the gas grid at a later stage. Currently, it is very expensive because conversion losses are high; however, in the future it could be a way to convert renewable electricity into fuel for heating that can be stored in the gas grid. It is also a way for current gas operators to continue to stay on the grid.

9.5. ENERGY INDEPENDENCE – THE FORGOTTEN QUALITY

The *Energy Independence* quality helped frame wind power as a valuable energy source both in the 1970s and the mid-2000s. Nonetheless it appeared to fade into the background after impacts of geopolitical shocks weakened and lawmakers collectively began to focus on other issues. This is a geopolitical mistake, as energy distribution shapes country interdependencies to a great extent. The EU today imports 53% of its fuels (gas, coal and oil), and 67% of those imports are gas. Russia is the prime exporter, delivering around 30% of each source of fuel. This is shown in figure 49 is edited which I have edited to show only total dependency and natural gas dependency, while supplier graphs are edited to show only the top 5 suppliers. The graphs are all sourced from page 24 and 26 in the European Union's Commission Statistical pocketbook on energy (EUC, 2017a, p. 24,26).

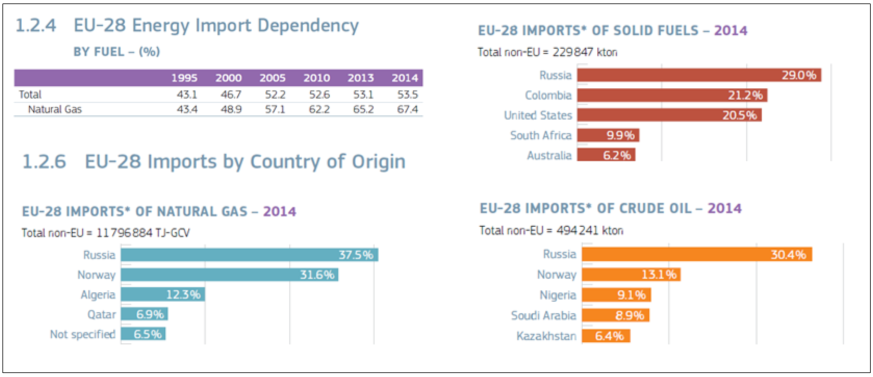

Figure 49: Energy import dependency by fuel and supplier.

As mentioned previously, a large portion of Europe's infrastructure funds is spent to subsidize the construction of new gas infrastructure to reduce dependency on Russia. Once this infrastructure is built, the EU will nonetheless remain dependent on gas imports, just from different sources (i.e., liquid natural gas shipments and non-Russian oil and gas fields). Thanks to oil and gas fields in the North Sea, Denmark is one of a few countries in the EU with very low import levels of these liquid fuels. Nevertheless, Denmark is affected by the geopolitical compromises made by the EU, as evidenced by the ongoing dispute over the Russian-German consortium gas pipeline, Nordstream 2 (Beim & Arnfred, 2017). In 2017, the Danish parliament enacted a law that specifically allows the Ministry of Foreign affairs to deny infrastructure proposals due to geopolitical risks. The Russian-German consortium behind the Nordstream 2 pipeline felt directly targeted by this law, and in a letter to the Danish Energy Committee in Parliament hyperbolically asked if future permits to offshore wind farms should also adhere to the principle of L43 and be evaluated on how they affect supply security (FT.dk, 2017b, p. 4). To this question, the wind power industry could easily respond, “Yes, please.” If wind farms were compared with gas plants on the quality of *Energy Independence*, they would look quite favorable. *Energy Independence* was not translated into numbers during any of the five valuation periods studied, which likely explains why it appears to be somewhat forgotten after geo-political shocks. But in a world with increasing geo-political tensions (Sonne, 2018), gaining *Energy Independence* from other nations should be one of the highest priorities. The visionary entrepreneur Johannes Juul recognized this back in 1962, and it is worth re-stating his original question in a slightly re-framed way: Can we afford not to utilize our only domestic (sustainable and renewable) source of energy?

9.6. A FUTURE OF NEW VALUATION FRAMES

In the configuration of energy markets, the Wind power industry have had to show that the benefits and *Future Potential* of wind power make the investments required to cover the *Technology Cost* worthwhile. Coal and gas infrastructure was built decades ago when there was not much diversity or competition among energy sources. Their costs were black-boxed as the cheapest and no one calculated what it cost to integrate them into the grid or if there were *Black-out Risk* to doing this. Today, the variable nature of wind power is at times used in framings that aim to disqualify wind power from playing a significant role in the energy mix. But as sector integration and storage solutions have emerged, it has become harder for conventional plant owners to maintain the framing that they are necessary baseload suppliers. Denmark can serve as the example to the world where wind power is the backbone and not the add-on to the system. Wind Power can then serve as a reliable source of energy, which is cheaper to build than the incumbent actors that preceeded it. We today know more than we did when the old fossil fuel energy systems were built. We know that for every piece of coal burned, we are worsening an existential threat to our species’ survival. As wind power is materially cost-competitive to build and capable of system integration, it produces itself as the standard energy investment for the future.

But the road to get there is not straightforward or simple. Wind power will risk being framed as a matter of concern from the two existing incumbent fossil fuel sources. Coal and Gas face uncertain futures and large investments are at stake. In the near future, it could very well become nearly impossible for new coal plants to be built in the EU. Coal plant operators face an uphill battle to stay on the grid, as it is becoming cheaper to cease operations of current plants and build renewable energy capacity which will not face future CO2 emission fees. The gas industry will position itself as a peak-load specialist, and build a business case around capturing high market prices when renewable energy production is low. In the future, both existing coal and new gas plants will depend on various support mechanisms from nation states or the EU to continue operating. A new valuation framing for existing fossil fuel plants will no longer focus on cost, but on stability versus wind power. In this valuation struggle, it is important for actors such as Siemens Gamesa Renewable Energy to highlight that wind power supports long-term stability by reducing fuel imports, and that grid stability can be achieved through available sector integration and storage solutions. It is in this discussion that the quality of *Energy Independence* is worth highlighting. There are huge gains to having an energy source, which does not render the EU highly dependent on foreign states.

In this chapter, I have mapped the larger EU energy market and technology trends affecting it in an attempt to answer research question 2. I have identified some key future moments of valuation, highlighted some points of reference that are useful in dismantling negative impact qualities, and proposed a renewed focus on the societal quality of *Energy Independence*. Hereafter, I present my final conclusions.

10. CONCLUSION

In this final segment, I draw conclusions from my key findings to answer my problem statement:

What has been the historical role of valuation devices in qualifying wind power as a worthwhile investment for Danish society?

10.1. QUALIFYING WIND POWER AS VALUABLE OR NOT

My empirical analysis of the five moments of valuation reveals how three different devices have been used to frame wind power as a worthwhile investment or not. During the first period, Unique Supplement, wind power's value was calculated through a break-even price relative to coal imports. This means that the ultimate test of wind power's value was how cheaply it could support existing coal and oil power plants as a supplemental source of energy. This valuation device became outdated in the 1990s, as wind turbines had grown enough in size to form actual power plants, and the need to mitigate CO2 emissions became a central requirement for new energy capacity. In the Climate Solution and Global Advantage valuation frames, the preferred valuation device was the industry yardstick of LCOE, which enacted the value of wind power as a stand-alone energy source and enabled a large built-out. This stopped with the emergence of Market Distortion valuation frame. It signaled the final major shift in valuation practices, as a number of new devices emerged that did not base calculations on *Technology Cost*, but on the ratio of subsidies invested or taxes incurred to societal benefits (i.e., cost-benefit analysis). This frame transformed not only the device, but also the object of valuation from the wind turbine as a technology to the prosthetic devices that enabled wind power in the market, namely subsidies and taxes. During the last period of the analysis, Subsidy Burden, both LCOE and various cost-benefit-like calculations of subsidies were used to value wind power. Findings from this most recent struggle reveal that when LCOE is used as the metric, wind power is a highly valuable energy source compared to alternative energy sources; however, when the cost of prosthetic devices is the metric (i.e., costs of building wind power against a business-as-usual scenario or a theoretical quota market price), the high value of wind power is at risk.

10.2. COALITION INTERESTS APPEAR STRONGER THAN CALCULATIVE DEVICES

A key finding from the study is that there is no logical progression for how qualities are assembled in the valuation frames. The empirical observations suggest that rather than calculative devices shaping the perspectives of coalitions, coalitions shape calculative devices to support their perspectives. Some qualities appear to be inherently connected to certain coalitions. When the constellations of actors change within coalitions, the salience and ranking of qualities also change. The valuation frames wherein the *Future Potential* quality had an impact were created by actors from the original Unique- or Climate-coalitions. On the other hand, the *Market Distortion* quality is directly associated with Market-coalition actors, who incorporated it into the Subsidy Burden valuation frame despite evidence of large-scale subsidies for several other energy sources. Two significant actor movements exemplify this point. First, when the utilities began to invest in wind power during the Climate Solution period, the Climate-Coalition changed the market frameworks to make a strong Climate Solution valuation network as the Fuel-coalition actors dispersed or joined the Climate-coalition. The *Fuel Supplement* quality was no longer applicable until the Market-coalition introduced a completely different calculative device. The Market-coalition was not closely aligned with the utilities, but was comprised of actors from proximate fields. The second movement is when De Konservative left the market coalition in 2007 and become a central actor in the Global-coalition. This continued to create friction into the next period, where the political party Venstre tried re-introducing the market coalition's calculative devices to stop nearshore projects during the Subsidy Burden period. Since the Global-coalition remained influential, *Technology Cost* could not be ignored as a central quality in the Subsidy Burden frame. But the claim that wind power is not valuable unless it is subjected to technology neutrality is a sign of an entrenched meaning that traces back to the introduction of the *Market Distortion* quality in 2002.

My findings thus reveal that entrenched meanings connect certain qualities to certain coalitions. These meanings can persist over time and cause public discussions to be behind the materially proven technological developments. Wind power still appears to be a politically controversial entity in Denmark, resulting in the formation of coalitions with widely divergent views fighting to impose their valuations in the ongoing struggle. While wind power appears to be an incumbent when seen through the materiality of the build-out in Denmark, disparate entrenched meanings continue to inhibit the black-boxing of wind power as the standard investment when it comes to new energy infrastructure.

10.3. LOW COSTS, BUT SOCIETAL QUALITIES WILL DETERMINE THE FUTURE

I have identified 12 defining qualities, split among the technological, environmental and societal domains. My findings show that wind power is valuable when the qualities of *Technology Cost* and *CC Mitigation* have an impact on the framing. Nonetheless, the view that accompanies the *Market Distortion* quality may interfere with the *Future Potential* for capacity expansion. Future frames that disqualify wind power will almost certainly be forced to build on the notion that wind power distorts some imagined market equilibrium. This will become increasingly prevalent as wind power begins to push conventional gas and coal plants off the grid. In this valuation struggle, it is important to highlight that current energy prices do not reflect the actual costs of damage incurred during energy production. If one acknowledges the urgency of climate change, *CC Mitigation* should as a result have a decisive impact on any future frame. Wind power's positive value based on this quality is inherent in its physical materiality. The opposite applies to any calculations based on the notion of *Market Distortion*. This quality is contingent on a specific way of viewing the market that is not anchored in the materiality of the technology. Coal and gas plants emit CO2 no matter how the market is designed. Their status as "conventional" power generation methods is not rooted in any evidence of superiority, but in historical precedence.

Although the *CC Mitigation* quality was heavily contested in the Market Distortion frame, it was recognized as having a positive impact in the most recent Subsidy Burden valuation frame. This means that the *CC Mitigation* quality is not as contested as it had been just 20 years ago. Nevertheless, there is a risk that environmental qualities will not be decisive factors in the wind power struggle to come. The *Environment* quality was present, but did not significantly impact any of the last four frames, despite the fact that air pollution data is clearly more measurable today than it was in the 1970s and 1980s. Furthermore, fresh drinking water will be scarcer in the future, which should prompt a move towards energy sources that do not waste vast amounts of fresh water to generate power. These points of reference are nonetheless absent from all of the valuation frames until now. The environmental qualities that impact wind power positively, *CC Mitigation* and *Environment*, appears to mainly be salient to actors that are already proponents of wind power. Meanwhile, the *Aesthetics* quality may grow in importance going forward, as onshore wind is becoming more contested.

My findings suggest that broad coalitions are most likely to form around the societal qualities, *Industrial* and *Energy Independence*. It is particularly surprising that it cannot be expected that the environmental quality of *CC Mitigation*, has not yet been the driving quality at the center of a broad policy coalition in Denmark. In the present context of concerns, a challenger technology which can mitigate climate change, such as wind power, may need to also draw salience to the two societal qualities, *Industrial* and *Energy Independence*, to achieve the needed build-out. The *Industrial* quality is present in all valuation frames and is especially strong for wind power, as production involves a high degree of manual labor. This quality is specifically valuable in Denmark, which has a large domestic industry, as well as in several European countries with the ability to expand existing manufacturing footprints. The other important societal quality, *Energy Independence*, was not as salient as the *Industrial* quality throughout the five periods, as it really only had an impact in the Unique Supplement and Global Advantage frames. Given recent geo-political tensions, EU member states are willing to fund gas pipelines and LNG facilities to obtain gas from several sources and reduce their dependence on Russia. But the *Energy Independence* quality and the potential for fuel-free energy to be used for heating and transportation purposes has not yet been adequately incorporated into valuation frames. With the potential to deliver an even better solution than merely diversifying sources of foreign gas imports, wind power proponents should focus on how to apply Denmark's infinite domestic energy resources to energy needs beyond electricity.

10.4. CONTRIBUTIONS

This study contributes by empirically elaborating the emerging field of valuation studies, which valuation studies scholars have situated at the intersection of "technology and organization" and "complex and/or rapidly changing valuation situations" (Kjellberg et al., 2013, p. 26). Power generation technologies such as wind power and gas or coal plants have inherent qualities. Some of these qualities are particularly salient to the grand challenge of climate change. Whenever *CC Mitigation* is salient as a quality, wind power is highly valuable. Surprisingly, in an era in which climate change threatens the very existence of the human species, a quality related to a particular understanding of a market (i.e., *Market Distortion*) can change the salience and impact of the quality of *CC Mitigation*. The case of wind power in Denmark is therefore especially well-suited to addressing "how organization and technology act as levers or impediments in the reconfiguration of value systems" (Kjellberg et al., 2013, p. 26).

My study has shown how valuation frames of wind power are established, contested, changed, maintained and reinforced over time. Moreover, my findings reveal how entrenched meanings can impede the stabilization of new technology networks. The struggle over the valuation of wind power as a societal investment is an intriguing line of research, as it reveals how policymakers justify the decisions they make on behalf of citizens. The value our society ascribes to societal investments is not only determined by votes every four years, but also through the active agenda-setting of influential actors exercising power through calculative asymmetries.

This study also contributes to Siemens Gamesa Renewable Energy and the wind turbine industry in general by proposing a model comprised of valuation frames and valuation networks that can be used to map future valuation struggles. As a challenger technology that is still highly politicized, wind power is not as stable as fossil fuels, and the dynamics that determine which valuation frames become dominant are important to monitor.

Although wind power recently has been framed and materially solidified as economically and technically superior to gas and coal plants, it will continue to rely on market frameworks set by lawmakers. This is also the case for gas and coal plants, but the market frameworks enabling wind power are not as black-boxed as is the case for the fossil incumbents. This study has shown that there is little logic to how the rules of the game are set, and that these rules are highly dependent on the coalition in charge at a given moment in time. The current system and market frameworks that wind power must compete within are indeed "historic, contingent and disputable" (Muniesa et al., 2007, p. 3), and it is time to mobilize a higher level of resistance to the remaining incumbent frameworks. As the wind turbine industry grows, it will be even more important to identify the key coalitions that set market frameworks and to have appropriate tools to understand their valuations of wind power. Looking forward from 2018, penetration levels for wind power in several European countries will likely match those achieved in Denmark throughout the last 10 to 15 years. Based on LCOE, onshore wind is already cheaper to install than other new-build capacity options in the EU, while offshore wind power is competitive with the new gas plants.

Technology Cost may become a less salient quality in future valuation struggles, and the LCOE valuation device will become less relevant. The central struggle will pertain to the comprehensive integration of renewables and associated system improvements. In this discussion, wind power proponents must challenge framings that place the costs of energy system improvements (e.g., sector integration, grid reinforcements) on wind power. The wind industry will face many obstacles if costs are measured against a business-as-usual scenario, or if the sunk costs of existing fossil fuel capacity are calculated against it. I hope that the empirical chapters can serve as a historical reminder of the significant struggle associated with the implementation and development of wind power. Some obstacles related to material limitations of the valuation network (primarily grid limitations during the Unique Supplement period), but others related to conscious framings of wind power as a disturbance to a fictitious market, or exaggerated problems of variability in energy production.

The most important contribution to me personally, is my attempt to set a research agenda around how we as a society value the entities that could help us mitigate the existential crisis of climate change. Since society is not an abstract entity, the "methodological situationalism" inherent to the valuation perspective requires researchers to identify the sites and tools used for valuation. Following this principle my study has improved the understanding of how society's investment decisions are qualified (i.e., by mapping the qualities organized in valuation frames), and how assumptions about technologies and the energy system can be examined. Once these assumptions are visualized, they can establish links between a given valuation frame and the valuation network upholding it. Certain valuation networks may inhibit the green transition, not only through material obstacles in the form of grid constraints or sunk costs, but also through coalitions of powerful actors, which impose their valuation frames upon citizens who may not share their views of the world. Here, it is important to identify valuation frames based on how the market devices that enable wind power are valued and changed. Influential actors may praise the competitive *Technology Cost* of wind power, yet destabilize the market structures that enable it. The rules of the game are still being negotiated for wind power although it may be approaching a shaky status as somewhere between challenger and incumbent. Asymmetries of power are still present in how wind powers costs can be framed against business as usual fossil fuel based scenarios, or have its climate change mitigation potential compared to a hypothetical functioning carbon market. According to valuation studies, there are no neutral valuations of objects such as wind turbines, gas plants or interconnector cables, as the existing energy system and market frameworks are designed with a certain valuation of energy sources in mind. It is important to open and challenge these assumptions to re-frame valuations and build a society free of fossil fuels and full of renewables.

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APPENDICES

Content

Appendix A contains a large number of key figures on wind power and the Danish energy system. It has exports, employees, estimated subsidies and investments, export markets and several other data. It also has a list of the ministers responsible for energy as these also determine the materiality of wind power.

Appendix B gives the background of the key actor interviews in this dissertation and the translation of the Danish quotes that are used in the dissertation.

Appendix C is a further discussion of the DEC's framing of wind power and carbon markets between 2008 and 2016. This is not critical for the analysis, but is still included as an appendix to show the development in this actor's position.

Appendix D features additional quotes for three reports in the analysis (AKF 1996, DEC 2002, EK 2017). These reports had several text-bites that I needed to refer to and it was therefore better to have the full quotes listed here in the appendix.

Note to readers: Note that although the Appendices contain figures and tables, I do not number or list them in the table overview, as this is only for the main thesis. The Appendices are individually not that long and the largest appendix is split into A1, A2 etc. It should be possible to navigate the figures and tables without numbering.

Appendix A. Materiality of wind power in the Danish energy system

A1: Wind Power build-out in Denmark

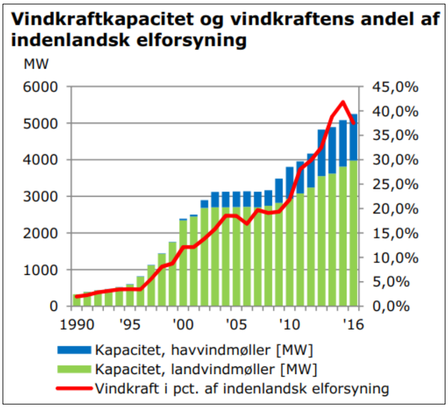
Below are graphs and source data on installed wind power reproduced from the Danish Energy Agency latest updated overview tables from 2018 (DEA, 2018). The first Gray columns are the total active capacity each year. The Green Columns are onshore wind and the blue columns are offshore wind.

Active Turbines (Total)			
Year	Number of Turbines	Capacity (KW)	Production kWh
1977	2	52	0
1978	13	813	120.492
1979	23	1.090	239.881
1980	68	2.666	2.235.719
1981	165	6.252	4.606.217
1982	259	10.605	11.924.214
1983	334	14.270	19.307.389
1984	439	19.903	25.648.341
1985	828	47.076	44.090.250
1986	1.137	72.573	104.107.878
1987	1.475	112.138	154.121.309
1988	1.959	190.623	265.624.150
1989	2.286	246.973	397.899.125
1990	2.665	325.981	567.211.080
1991	3.013	392.859	684.082.588
1992	3.215	435.949	832.315.178
1993	3.345	468.099	920.126.705
1994	3.488	521.237	1.055.420.642
1995	3.656	599.499	1.089.705.951
1996	4.082	814.221	1.190.123.769
1997	4.648	1.123.347	1.891.256.701
1998	5.132	1.438.482	2.762.848.701
1999	5.561	1.753.445	3.001.700.498
2000	6.235	2.390.015	4.216.028.540
2001	6.286	2.497.153	4.312.332.563
2002	5.430	2.894.531	4.857.840.557
2003	5.372	3.119.916	5.560.255.581
2004	5.380	3.123.712	6.579.879.402
2005	5.276	3.127.836	6.612.638.579
2006	5.258	3.135.696	6.105.519.082
2007	5.207	3.124.214	7.138.305.076
2008	5.095	3.162.870	6.975.204.677
2009	5.099	3.482.087	6.716.178.321
2010	5.015	3.801.829	7.856.347.169
2011	4.951	3.951.981	9.793.744.412
2012	5.002	4.161.930	10.251.068.440
2013	5.236	4.819.112	11.128.529.706
2014	5.285	4.886.592	13.076.522.912
2015	5.770	5.077.165	14.126.137.504
2016	6.111	5.245.772	12.771.094.449
2017	6.157	5.520.634	14.771.583.326

Onshore Wind		***Offshore Wind***	
Number of Turbines	Capacity (KW)	Number of Turbines	Capacity (KW)
2	52		
13	813		
23	1.090		
68	2.666		
165	6.252		
259	10.605		
334	14.270		
439	19.903		
828	47.076		
1.137	72.573		
1.475	112.138		
1.959	190.623		
2.286	246.973		
2.665	325.981		
3.002	387.909	11	4.950
3.204	430.999	11	4.950
3.334	463.149	11	4.950
3.477	516.287	11	4.950
3.635	589.549	21	9.950
4.061	804.271	21	9.950
4.627	1.113.397	21	9.950
5.111	1.428.532	21	9.950
5.540	1.743.495	21	9.950
6.194	2.340.065	41	49.950
6.245	2.447.203	41	49.950
5.307	2.680.581	123	213.950
5.158	2.696.566	214	423.350
5.166	2.700.362	214	423.350
5.062	2.704.486	214	423.350
5.044	2.712.346	214	423.350
4.993	2.700.864	214	423.350
4.881	2.739.520	214	423.350
4.785	2.821.237	314	660.850
4.611	2.933.979	404	867.850
4.546	3.080.531	405	871.450
4.583	3.240.080	419	921.850
4.720	3.548.062	516	1.271.050
4.769	3.615.542	516	1.271.050
5.254	3.806.115	516	1.271.050
5.595	3.974.722	516	1.271.050
5.649	4.228.834	508	1.291.800

A2: Energy Mix and historical development in Denmark

All of the key data in Appendix A6 are reproduced from The Danish Energy Agency Publication Dansk Energistatistik / Danish Energy Statistics 2016 (DEA, 2017b, p. 9,13,14).. The first graph below shows wind powers share of Danish electricity production (p. 9). The next table shows the installed capacity of electricity producing capacity (p. 14) The last table shows that fuels are used to generate electricity in Denmark (p. 13).



Elkapacitet, ultimo året

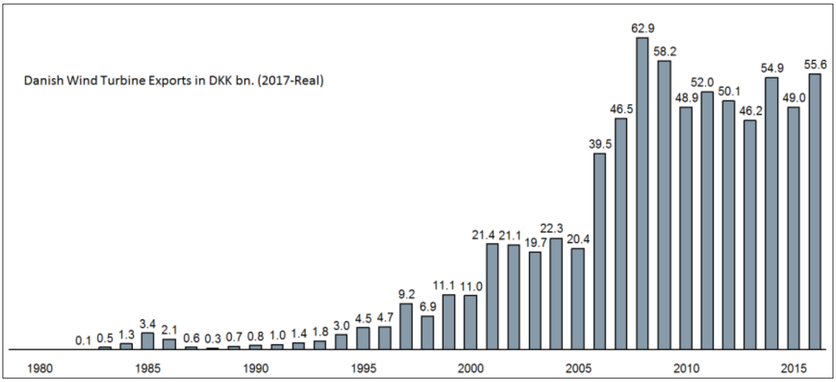
[MW]	1994	2000	2005	2010	2014	2015	2016	Ændring '94 - '16
Total	**10 767**	**12 598**	**13 088**	**13 450**	**13 626**	**14 006**	**14 247**	**32,3%**
Centrale anlæg	9 126	8 160	7 710	7 175	5 688	5 688	5 688	-37,7%
- Elproducerende	2 186	1 429	834	840	839	839	839	-61,6%
- El- og varmeproducerende	6 940	6 731	6 877	6 335	4 848	4 848	4 848	-30,1%
Decentrale anlæg	773	1 462	1 579	1 819	1 824	1 838	1 839	138%
Sekundære producenter	339	574	657	638	612	615	615	81,4%
Solenergi	0	1	3	7	607	782	851	•
Vindkraft	521	2 390	3 128	3 802	4 887	5 076	5 245	906%
Vandkraft	8	10	11	9	9	7	9	13,3%

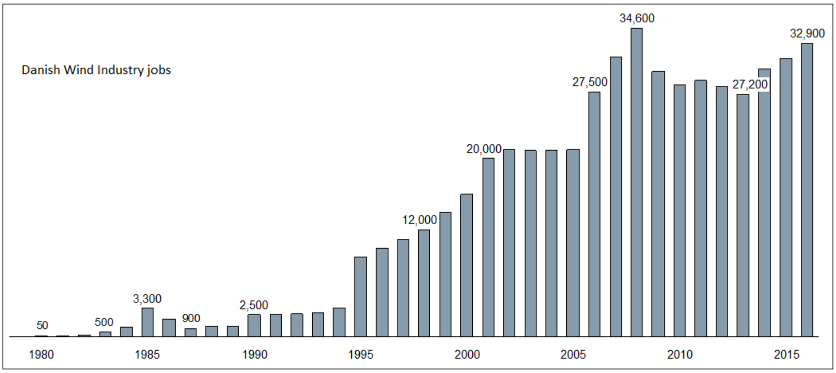
Brændselsforbrug til elproduktion

Direkte energiindhold [TJ]	1980	1990	2000	2005	2010	2014	2015	2016	Ændring '90 - '16
Brændselsforbrug i alt	**261 835**	**227 001**	**276 974**	**265 330**	**286 006**	**211 152**	**180 684**	**195 426**	**-13,9%**
Olie	47 533	9 215	40 356	11 867	8 087	3 245	3 110	3 033	-67,1%
- heraf orimulsion	-	-	33 503	-	-	-	-	-	•
Naturgas	-	6 181	68 868	65 912	57 229	15 898	14 303	16 103	161%
Kul	214 012	207 173	134 205	127 119	139 714	89 820	58 410	70 876	-65,8%
Affald, ikke-bionedbrydeligt	-	262	5 294	7 650	9 085	9 280	9 382	9 276	3 442%
Vedvarende energi	**290**	**4 170**	**28 252**	**52 784**	**71 891**	**92 910**	**95 479**	**96 138**	**2205%**
Solenergi	-	-	4	8	22	2 144	2 175	2 678	•
Vindkraft	38	2 197	15 268	23 810	28 114	47 083	50 879	46 014	1994%
Vandkraft	123	101	109	81	74	54	65	69	-31,2%
Biomasse	90	1 428	11 009	26 470	40 808	40 102	38 620	43 100	2918%
- Halm	-	363	2 021	7 715	10 213	5 983	5 806	5 841	1509%
- Træ	90	745	2 518	9 405	19 492	22 777	21 241	25 897	3376%
- Bioolie	-	-	0	0	-	-	107	25	•
- Affald, bionedbrydeligt	-	320	6 470	9 350	11 104	11 342	11 467	11 337	3442%
Biogas	39	444	1 861	2 415	2 872	3 527	3 739	4 276	863%

A3: Exports and Jobs

This appendix depicts key numbers on exports and jobs of the wind power industry. Below is a combined graph of exports and thereafter employees. The details of my estimate, which is gathered from multiple sources, can be found after the two tables.





Early Period	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Total
Exports (Bn. DKK - Real 2017)	0,0	0,0	0,0	0,1	0,5	1,3	3,4	2,1	0,6	0,3	0,7	0,8	1,0	10,9
													Per Year:	0,8

Middle Period	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Exports (Bn. DKK - Real 2017)	1,4	1,8	3,0	4,5	4,7	9,2	6,9	11,1	11,0	21,4	21,1	19,7	22,3	138,0
													Per Year:	10,6

Late Period	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Exports (Bn. DKK - Real 2017)	20,4	39,5	46,5	62,9	58,2	48,9	52,0	50,1	46,2	54,9	49,0	55,6	*55,6*	639,8
2017 is an estimate based on 2016													Per Year:	49,2

Early Period	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Employees	N/A	50	70	200	500	1100	3300	2000	900	1200	1200	2500	2500

Middle Period	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Employees	2600*	2700	3300	9000	9950*	10900	12000	14000	16000	20000	21000	20900	20900

Late Period	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Employees	21000	27500	31400	34600	29800	28300	28800	28100	27200	30100	31200	32900	*32900*

2017 is an estimate based on 2016

The years 1979-1989

The numbers from 1979 to 1989 are sourced from Peter Karnøe's dissertation on wind power from 1991 (Karnøe, 1991, p. 16). They are adjusted for inflation from Real-1990 to Real-2015.

The years from 1990-1996

Export and employment numbers are hard to come by in the early 1990's, so I have had to rely on estimates based on news-sources that reported on each years industry statistics. Below are the numbers in a table that have been converted (DST, 2016). The numbers with an asterisk are estimates based on the numbers from the neighboring years.

Numbers from available sources

1990: 2500 employees and 500 mn. in exports (Pol, 1991a)

1991: 2500 employees and 620 mn. in exports (Skaaning, 1993c)

1992: 915 mn. in exports (Nørgaard, 1993b)

1993: 2700 employees (Skaaning, 1993b) and 1.2 bn. In exports (Skaaning, 1993c)

1994: 3300 employees (Andreassen, 1994) and 2 bn. In exports (Skaaning, 1995)

1995: 9000 employees and 3 bn. *(article mentions 4 bn. sales of which "majority" is exports)* (AKT, 1996)

1996: 3.2 bn. (The majority of 4.3 bn. sales) (Panduro, 1997; Tornbjerg, 1997)

The wind turbine export numbers for 1997 and 1998 has been read from the export graph from the DWIA's 2007 industry report (DWIA, 2007). The Wind Turbine Export numbers from 1999-2006 are from the DWIA Industry's report from 2010 (DWIA, 2010, p. 16). The estimates for 2006 and 2007 have in the later 2016 publication been adjusted (Damvad, 2016, p. 11).

Full-time employees for 1997-2007 was found in the industry's 2007 report (DWIA, 2007). The numbers for 2006 and 2007 were later readjusted according to the industry's 2016 publication (Damvad, 2016). The most recent numbers on exports are sourced from the Danish Wind Industry Association (Damvad, 2016; DEA, 2011b; Soendergaard, 2016). The 2016 numbers are from the DWIA industry statistics (DWIA, 2017b).

A4: Subsidies and investments in wind power

The subsidies estimate is good as it provides an overview of proportions when it is combined with the exports calculated in Appendix A3. Below is a table of the estimates for each of the costs for the early, middle and late period of the 39 years. The table that follows has the estimate for each of the individual years. It is these years that provide the numbers for the totals for each 13-year period. Note that there may be small discrepancies in the totals, as the numbers are rounded off to the nearest whole number in the displayed years.

Investments (Mn. DKK, 2017-Real)	1979-1991	1992-2004	2005-2017	Total
Subsidies	995	15041	31155	**47190**
Research	570	764	910	**2243**
Grid Connection Onshore	132	563	1042	**1736**
Grid Connection Offshore	0	1350	4149	**5499**
Total Costs (Subsidies, Research, Grid Connection)	1696	17717	37255	**56668**
Average Costs per year	130	1363	2866	**1453**
Exports	10901	138005	639798	**788704**
Exports (Year)	839	10616	49215	**20223**
DKK exported per DKK spent on devices	6,4	7,8	17,2	**13,9**

Societal Wind Power Investments (mn. DKK, 2017-Real)	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Total
Subsidies	3	5	4	6	9	11	16	48	76	126	173	238	279	995
Research	96	20	28	55	50	39	44	42	35	39	39	40	45	570
Grid Connection Costs (Onshore)	10	10	10	10	10	10	10	10	10	10	10	10	12	132
Grid Connection Costs (Offshore)														0
													Total:	**1696**
													Per Year:	130

Societal Wind Power Investments (mn. DKK, 2017-Real)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Subsidies	335	374	403	406	411	662	863	804	1599	2394	2422	2000	2367	15041
Research	52	56	51	44	44	70	50	49	70	70	70	70	70	764
Grid Connection Costs (Onshore)	15	20	25	30	35	41	46	51	56	61	61	61	61	563
Grid Connection Costs (Offshore)								150			1200			1350
													Total:	**17717**
													Per Year:	1363

Societal Wind Power Investments (mn. DKK, 2017-Real)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Subsidies	2312	1490	1820	618	1189	1000	1361	2111	2975	3953	4538	3747	4043	31155
Research	70	70	70	70	70	70	70	70	70	70	70	70	70	910
Grid Connection Costs (Onshore)	61	71	79	87	48	87	87	87	87	87	87	87	87	1042
Grid Connection Costs (Offshore)					1297				1352				1500	4149
													Total:	**37255**
													Per Year:	2866

Exports do of course not equal direct revenue back to the state. But it does however equal jobs in a manufacturing sector that supplies other countries and therefore brings in tax revenues to the country both through company profit taxes and the taxes payed by employees. The DWIA recently calculated that the Danish wind turbine industry contributed with roughly 13 bn. in tax-revenues in 2016 (DWIA, 2017a, p. 16). Throughout the 39 years from 1979-2017, the wind turbine industry has on average spent less than 1.7 bn. DKK per year on wind power investments. What can also be seen over the split of the 39 years into an early, middle and late period is that the relationship to how much the industry exports compared to the incurred societal costs to the domestic fleet increased significantly since the mid-2000. If current trends continue, the state will annually spend in the proximity of 5-6 bn. DKK on costs of wind power, and receive tax revenues around 13 bn. Denmark thus receives 2 DKK in tax revenues from the wind industry per 1 DKK it invests. I acknowledge that some of the numbers are benchmark estimates and does not 100% accurately depict the costs. I have noted that there are some counterfactual costs to the grid that could have been added, but even if these would add 10-15% to the total costs, the conclusions about less than 1.7 bn. DKK as annual average investments would still hold, as well as the conclusion about 12 DKK exported per 1 DKK invested.

Sources and assumptions

Below is a walkthrough of where I have collected the various numbers used in my estimate. The subsidies are very well accounted for. The research grants after 1999 are not as easy to locate, but I have used I high estimate from the year in the 1990’s where there was spent a high degree of money on wind power research, 1997. Grid Connection costs for onshore are featured in some of the Energinet Annual report, but these were not published before 2005. I have therefore also taken a high estimate to account for the post-2005 years where I do not have data. This number is then slightly lowered in the early years, as it was a smaller installed fleet. On Offshore grid connections costs I have used the Horns Rev 3 costs as a benchmark for the other major wind farms built in Denmark. Horns Rev 3 is further from shore than the earlier farms, so these benchmarks will also likely overestimate the actual costs incurred. The final number covers balancing costs, Grid reinforcements and extra grid losses from the decentral production of wind power. This is a much more difficult entity to find actual numbers on but in 2013 the DWOA created an estimate based on the 2012 fleet. I have used this estimate to benchmark the other years. The number is lowered for the earlier years, as these costs correspond closely to the size of the installed fleet. It can be discussed whether or not some grid reinforcements and grid losses would have occurred anyway, if something else had been built instead of wind power. However, I have decided to take the full number to ensure that if I do make an error in this estimation exercise, it will likely be that I overestimate the costs. All numbers have been converted to 2017-Real using the official Statistics Denmark database (DST, 2018).

Subsidies

The numbers from 1979 to 1999 are from the DEC 2002 report on wind turbines subsidies. These numbers were sourced directly from the Danish Energy Agency by the DEC and are thus fairly straightforward (DEC, 2002a, p. 194).

Numbers from 2000-2004 are estimates based on available sources

Known Data Wind turbine subsidies in 2005 (2005 currency): 1952 mn. Wind power and other renewables' share of the total PSO costs was 54% in 2005 (3597 mn. DKK). I therefore attribute 55% of the total PSO-costs for 2001-2004 to wind power to gain my estimate.

The five years between 2000 and 2004 are the only ones where I do not have accurate data on wind turbine subsidies. I do however have a rough overview of the total PSO costs on "Environmental electricity" from 2001-2004 (P.-F. Bach, 2014, p. 2). I will therefore make an estimate of the costs based on the following assumptions. Since the publication I am reading the missing PSO numbers from is published in 2014, I have assumed that the numbers in the graph are 2013-Real.

Known data: Wind-turbine subsidies in 1999: 634 mn. DKK (2002-R): 804 mn. DKK (R-2017)

Unknown year 2000: Estimate is placed halfway between 1999 and 2001 number: 1599 mn. DKK (R-2017)

Total Environmental Subsidies 2001: 4250 mn. DKK hereof 55 % wind = 2338 mn. DKK (2013-R) = 2394 mn. DKK (R-2017)

Total Environmental Subsidies 2002 : 4300 mn. DKK hereof 55 % wind = 2365 mn. DKK (R-2013-R)

Total Environmental Subsidies 2003 : 3550 mn. DKK, hereof 55 % wind = 1953 mn. DKK (R-2013-R)

Total Environmental Subsidies 2004 : 4200 mn. DKK hereof 55% wind = 2310 mn. DKK (R-2013)

This is likely higher than the real share of wind power, but I want to be sure I do not underestimate the costs.

Research

There are accurate numbers on the research grants given to wind power research from 1979-1999. To estimate the amount of Research grants apart from subsidies that are given to wind power after 1999, I take the highest number for one year during the 1990-s This is 1997, where 55 mn. DKK was spent (70 mn. DKK in 2017-Real). I use this number for the remaining years in the analysis as the wind turbine research is spread over several different pots and it has not been possible within the scope of this thesis to more accurately track it. By placing the high 70 mn. DKK number for all years between 2000 and 2017 I am more likely to overestimate how much R&D funding has been given too wind power since several years in these periods so significant cuts to wind power funding. But as any analysis of the costs of wind power investments will likely be charged with not adequately attributing costs, I want to be on the safe side.

Onshore Grid Costs

These costs are not specified by the DEC. There is however estimates of grid connection costs for Wind-power and other renewables in two of the annual reports of Energinet (Energinet, 2006, p. 45, 2010, p. 42). Where the 2005 annual report has a number for 2005, the 2009 report has a number for 2008 and 2009. I use these estimates to set a general benchmark for the post-2000 years where there is no data available. In the years from 1979-1990, I keep a grid cost of 10 mn. DKK per year as there is a limited fleet. Thereafter the grid costs towards the next available number from the data, which is 61 mn. DKK, the one found in the 2005 annual report from Energinet converted to 2017-Real (51 mn. in R-2005). I decide to bring the estimate of 61 Mn. DKK on the table already from 2001. This is to ensure I do not underestimate the grid costs during the years were expenses allegedly was a problem. In the years after 2009, I use the highest estimate year-cost from the 2009 annual report (The 87 mn. DKK in R-2017 for the year 2008) as the mark for the other costs. It is worth noting that this cost includes connections costs to other decentral stations, so it might not only be wind power connection costs.

Offshore Grid Costs

When it comes to added costs for large offshore wind farms, I have used the Energinet annual reports as the key source and therefrom made estimates for earlier parks. The cost for Horns Rev 2 was reported as 867 mn. DKK, Roedsand 2 as 300 mn. DKK (Energinet, 2010, p. 18), Anholt at 1319 mn. DKK (Energinet, 2014, p. 38), while Horns Rev 3 is budgeted to 1500 mn. DKK (Energinet, 2016). I have estimated the earlier wind farms (Middelgrunden, Horns Rev 1 and Roedsand 1) based on the highest cost-total I have, the Horns Rev 3 costs. The added costs for offshore wind farms will therefore be as listed in the table below. Note that the year is just the year where I place the costs in the subsidies table, it is not necessarily the construction year of the farms.

Year	Wind Farm(s)	Size (MW)	Costs - Nominal	Costs (R-2017)
1999	Middelgrunden	40	Estimate 10% of HR3	150 mn. DKK
2002	Horns Rev 1 & Roedsand 1	325	Estimate 80% of HR3	1200 mn. DKK
2009	Horns Rev 2 and Roedsand 2	424	1167 mn. DKK	1297 mn. DKK
2013	Anholt	400	1319 mn. DKK	1352 mn. DKK
2017	Horns Rev 3	400	1500 mn. DKK	1500 mn. DKK

Note on possible additional costs (Balancing Services and grid losses)

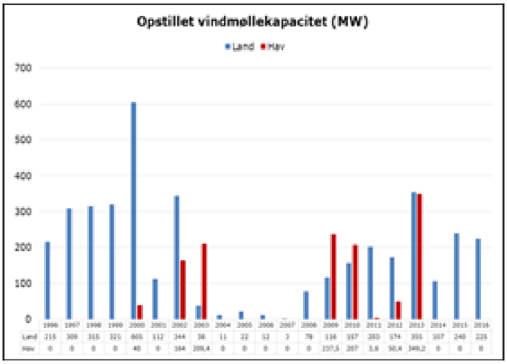
There are a number of services that are needed to balance the grid which is also incurred by the electricity consumers. In addition to grid losses that occur in the energy system. These numbers are significantly more difficult to calculate, and they are in a territory where it can be discussed whether or not similar costs would not also have occurred in the absence of wind power. I will therefore not include any such costs in this calculation, although I recognize that there may be some expenses with regards to this. The Danish Wind turbine Owners Association attempted to calculate such costs for the year 2012 (DWOA, 2013, p. 2)., but since it is only one estimate for one year (393 mn. DKK in 2012-Real, ed.), it is not solid enough to extrapolate to all other years. These costs are loose estimates and depend on the size of the installed fleet and other system-dependent factors. I asses that if these costs were to be estimated to the calculation, they would not change the total costs with more than 10%, but they would however add a large degree of counterfactual estimations to a calculation that otherwise is based on available official sources. I therefore leave these costs out for the purpose of having solidified investment numbers, but do however recognize the existence of such costs.

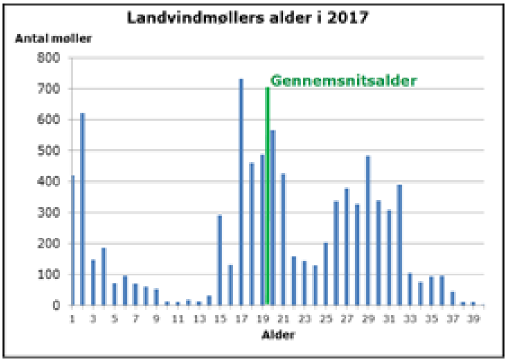
A5: Age and model type of the Danish wind power fleet

The below graph is from the Danish Wind Turbine Owners Association (DWOA) – The table has data up to the end of February 2017, so the final numbers will be slightly higher than the listed installed capacity of 5,2 GW by end of 2016 (DKvind, 2017). These numbers are found in detail in the DEA graph in Appendix A1. This table serves to show the age and size of the various installed turbines. The first graph next to it shows erected wind turbines for onshore and offshore in each year from 1996-2016. The second graph shows that the average age of the Danish onshore fleet of 3,9 GW, which in 2017 will be 19 years (DWOA, 2017). The table below and the two graphs are reproduced as depicted in the two publications.

Antal vindmøller og effekt

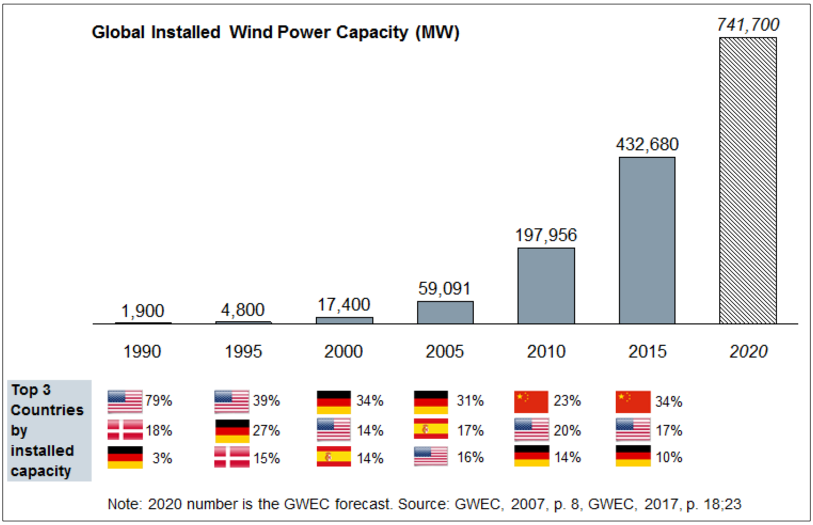
Størrelse,	Møller nu i Danmark		Gns.
	Antal	kW	alder
0-14	1.175	11.878	2,5
15-18	27	459	26,5
19-25	189	4.623	6,9
26-54	9	314	29,7
55	37	2.035	30,4
75	26	1.950	27,7
76-100	19	1.788	27,0
150	207	31.050	26,0
151-179	16	2.680	27,5
180-199	15	2.700	28,3
200-219	98	19.600	26,4
225	214	48.150	22,7
250	45	11.250	25,5
300	57	17.100	22,1
400	67	26.800	21,7
450	27	12.150	24,2
500	134	67.000	21,4
550	56	30.800	19,7
600	838	502.800	19,5
660	398	262.680	17,2
750	697	522.750	17,5
800	55	44.000	16,1
850	85	72.250	13,0
900	170	153.000	15,2
1000	186	186.000	17,0
1300	85	110.500	16,0
1500	43	64.500	14,1
1650	16	26.400	16,1
1750	32	56.200	11,5
2000	243	490.600	10,1
2300	357	821.300	8,7
3000	145	435.000	5,0
3075	191	619.475	2,6
3600	132	475.600	4,4
4201	13	88.900	2,6
Diverse	21	19.507	21,8
I alt	6.125	5.243.789	-





Appendix A6: Global Wind Power installations

The below table is a simple overview of the size of the global wind power markets sourced from the Global Wind Energy Council (GWEC). In addition to the total installed capacity, I have visualized the top three countries as they were placed at the end of each five year period. It is worth noting that in 2000, Denmark was the fourth largest market (13.4%) only slightly behind Spain (14.1%) in third place. In 2005, Denmark was the fifth largest market (5.3%), by 2010 it was the tenth largest market (1.9%) and by 2015 it was outside the top 10 (1.2%). As the 2020 number is a forecast I have not speculated as to what countries will form the top three markets. It is however commonly agreed that China will remain the largest market with around 30-34% of global capacity (GWEC, 2007, p. 8, 2017, p. 17,23).



Appendix A7: Ministers responsible for Energy legislation

Below is an overview of the Danish ministers, who had responsibility for energy after the ministry was first established in 1979. Note that there is one period, where the Ministry responsible for energy was not named after the area (2001-2005). The Ministry of Economy and Business is listed as it was therefrom the decision to cancel the planned offshore wind farms was taken in 2002. The rough length of the period is reflected in the height of the box (DEA, 2016b).

Period	Name	Name of Ministry
1979-1982	Poul Nielson (S)	Energy
1982-1986	Knud Enggaard (V)	Energy
1986-1988	Svend Erik Hovmand (V)	Energy
1988-1990	Jens Bilgrav-Nielsen (RV)	Energy
1990-1993	Anne Birgitte Lundholt (C)	Industry and Energy
1993-1994	Jann Sjursen (Christian Democrats)	Energy
1994-2001	Svend Auken (S)	Environment and Energy
2001-2005	Bendt Bendtsen (C)	Economy and Business
2005-2007	Flemming Hansen (V)	Transportation and Energy
2007-2009	Connie Hedegaard (C)	Climate and Energy
2009-2011	Lykke Friis (V)	Climate and Energy
2011-2014	Martin Lidegaard (RV)	Climate, Energy and Buildings
2014-2015	Rasmus Helveg Petersen (RV)	Climate, Energy and Buildings
2015-	Lars Christian Lilleholt (V)	Energy, Utilities and Climate

Appendix B. Interview Quotes

This Appendix contains the original quotes as I have transcribed them in Danish as well as the corresponding translated quotes that are featured in the text. Note that some of the Danish quotes in the tables below might be longer than the translated English quote, as I have trimmed the quotes in the text. The analysts from EA, DEA, Rockwool and Energinet are not listed by name, but their identities are known to the author. Below is a short description of the actors and which chapters their quotes are featured in.

#	Interviewee	Relevance	Chapters
1	Mogens Johansson	Lead Engineer on renewables for "Danske Elværkers Forenings udredningsenhed" DEFU. Central in first 1974 DEF report on wind power and part of the group writing the ATV 1975 report.	Unique Supplement
2	Niels I. Meyer	Head of ATV and founder of Wind Power Committee. Central in ATV-coalitions 1975 and 1976 reports and later alternative energy plans.	Unique Supplement
3	Henrik Stiesdal	Early wind power entrepreneur and responsible for early patented danish designs. Chief Technical officer for Bonus and later Siemens Wind Power from 1987-2014.	Unique Supplement, Climate Solution
4	Bent Christensen	Project and General Manager for ELSAMs renewable Units from 1986-2000. Senior VP in DONG Energy (2000-2013 and Siemens Wind Power 2014-ongoing.	Unique Supplement, Climate Solution, Global Advantage
5	Steen Gade	Head of Danish Parliament's Environmental committe 1994-1997, Director of Danish Environmental Agency 1999-2003. Energy spokesman for Socialistic Peoples Party SF throughout 19	Unique Supplement, Climate Solution
6	Jesper Tornbjerg	Journalist with focus on energy and environment for Ingenioeren and Politiken during the 1990's. Thereafter working as journalist with energy as focus for Danish Energy.	Market Distortion
7	EA Energy Analysis Consultants	The Two Energy Analysts who wrote the background report to the Danish Energy Agency note about Electricity Production Costs in 2014	Global Advantage
8	DEA Energy Analysts	The two energy analysts in the Danish Energy Agency, that were responsible for the note on Electricity Production Costs in 2014, and had hired the EA consultants to validate their findings.	Global Advantage
9	Rockwool report co-author	One of the two authors from the 2014 Rockwool report which featured the counterfactual analysis on wind power.	Global Advantage
10	Energinet Analysts	Two analysts in energy system development at the danish Transmission System Operator Energinet. They were interviewed about how much wind power could be integrated in the system.	Insights
11	Neil Fligstein	Co-Author of the Strategic Action Field theory. I had the chance to discuss the project with him at a visit in Berkely in the fall of 2016.	Discussion
12	Marion Fourcade	Author of several impotant papers concerning the task of setting a value on environmental matters. I also interviewed her about the project during my 2016 fall visit to Berkeley.	Discussion

1: Mogens Johansson		
#	Translation (English)	Original (Danish)
1	This was different people. You had Bent Sørensen who pulled very much in the direction that it should be doable, and Niels Meyer as well...Where we (DEF) probably used 4-5% (Discount rate), he (Bent Sørensen), was arguing that it should be down to almost zero. In that way he skewed it.	Der var andre folk ikk'. Man havde jo Bent Sørensen som trak meget i retning af at det skulle kunne lade sig gøre, og Nils Meyer sådan set også. Det er derfor jeg sagde det med real-renten, fordi Bent Sørensen eksellerede i det realrente. Hvor vi (DEFU) har vel brugt 4-5 %, men han var nede på at det nærmest skulle være 0. På den måde vred han jo på det
2	But then the ATV and Niels Meyer took initiative for windpower 1, which I was a part of… it lead to the wind power 2 committee, which was about the question 'what should we do, because there might be something in this'. And that turned into a program (proposed program in WindPower 2 report, ed.), which there was no money for	Men så var det at ATV og Nils Meyer tog initiativ til Vindkraft 1, hvor jeg så kom med. Og det første vindkraftudvalg var lidt af det samme. Der blev diskuteret meget realrente og al sådan noget. Men ellers var det nogenlunde det samme. Men så første det jo så til det andet vindkraft-udvalg, som gik på 'hvad skal vi gøre, fordi der er måske noget i det her'. Og det mundede jo så ud i et program, som der ikke var nogen penge til.
3	I proposed to the utilities, ELSAM and Power import, that we should set something up and make a plan, but they did not want to do this. ...But then sometime during the summer of 1976, the government sat aside money for energy research in connection with the employment-stimulating efforts, 42 mn. DKK i believe. Niels Gram had been secretary in Wind-power 1 (the first ATV report, ed.), and had studied together with me, so I knew him quite well. He was in the trade ministry, and then he called and asked us, if we had any suggestions about what could be done to improve employment. We had such a thing right there in the drawer. That suggestion did not become reality, it was actually a bit larger. They (the government) would give us 11 mn. DKK and the utilities would then also come with 3 mn. DKK, so we had 14 mn. DKK in total (61 mn. DKK in 2017-Real, ed.).	Så foreslog jeg elselskaberne, ELSAM og kraftimport, at man satte noget igang og lavede en plan, og det ville man så ikke. ...Men det var dog ikke så tosset, fordi så engang i 1976 omkring sommeren, afsatte regeringen så penge til energiforskning i forbindelse med beskæftigelsfremmende foranstaltninger., 42 mio. tror jeg. Niels Gram der havde været med i vindkraft 1, han havde været sekretær der., som jeg havde læst sammen med så jeg kendte ham nogenlunde godt. Han sad i handelsministeriet, og så ringede han og spurgte om vi havde noget forslag til hvad man kunne gøre for det (beskæftigelsen). Det havde vi lige i skuffen. Det blev så ikke det forslag der blev gennemført, det blev faktisk pustet lidt op. De (regeringen) kunne give os 11 mio. og kraftværkerne, ELSAM, Kraftimport og DEFU kom så med 3 mio., så vi havde 14.
4	I actually got in touch with a Dane who worked in a utility in one of the New England area states. He had read the report (DEFU 1974) and wrote me...Travelling to the U.S. At that time was expensive and troublesome, so there had to be something to travel for...It came to four visits for a combined 8-10 days I was over there. DEFU was always well-consolidated, so it was not an economic limitation. It was more a matter of how much it was considered reasonable to spend on it.	Så kom jeg faktisk i forbindelse med en dansker som var ansat i et elselskab i en af de der new england stater. Han læste rapporten (DEFU 1974) og skrev til mig...Dengang til USA det var både noget der kostede penge og var et hyr. Så der skulle ligesom være noget at hænge det op på....Det var vist de 4 besøg der, men der var en 8-10 dage jeg var derovre alt i alt. DEFU var altid velkonsolideret, der havde ikke været nogle problemer økonomisk. Det var mere hvad man mente der var rimeligt at bruge på det.
5	In 1976 it was unemployment which caused wind energy research to get funding. Then you started talking about wanting to become independent of the Arab states, the oil-nations. This was also something you wanted in 1985. Before CO2 became salient, it did not appear until in the 1990's....the whole supply security question was important.	I 1976 var det arbejdsløsheden, der gjorde at forskningen fik penge. Så begyndte man at sige at vi ville være uafhængige af arabiske lande, uafhængige af olie-nationerne. Det vil man også der i 1985. Inden CO2 kommer på banen, det gør den jo først der i 1990'erne..hele forsyningssikkerhedsspørgsmålet var vigtigt.

2: Niels I. Meyer		
#	Translation (English)	Original (Danish)
1	The official Denmark wanted to bet on coal and nuclear, and that was very broadly agreed, it was both industry, utilities and political parties, almost everyone. The idea of suggesting to bet on renewable energy was pretty original in the public debate. But because it was ATV that did it together with the grassroots, the grassroots could draw an advantage from our prestige.	Det officielle Danmark ville satse på kul og atomkraft, og det var meget bredt, det var både industri, elværker og politiske partier, næsten alle sammen. Det at foreslå at man skulle satse på vedvarende energi var ret originalt i debatten. Men fordi det var ATV som gjorde det sammen med græsrødderne, så kunne græsrødderne have fordel at vores prestige.
2	I did not have the entire ATV behind me, as they tried to have me removed as president of ATV. They did not believe you could have an ATV president who was "anti-technology". But I did however succeed in convincing them that there also was much technology in wind power	Jeg havde ikke hele ATV bag mig, for de prøvede på at få mig smidt ud som præsident for ATV. De mente at man kunne ikke have en præsident som var "anti-teknologisk" for ATV. Men det lykkedes dog for mig at overbevise dem om at der også var meget teknologi i vindkraft.
3	Already by January (1973), I had invited him (Dennis Meadows) to give a lecture at Copenhagen University. There was 500 people there to discuss....It was rather important because we got many of the younger politicians to join, Kristen Helveg Petersen, and some other older and experienced one....Lone (Dybkjær, ed.) and several other became very occupied with it. Radikale Venstre fully supported wind power and they were luckily the decisive vote in many situations. It was important that we had them.	Allerede i Januar (1973) havde jeg inviteret ham (Dennis Meadows) op til et foredrag på Københavns Universitet. Der var 500 mennesker til stede og diskuterede...det var ret vigtigt fordi der fik vi faktisk mange af de unge politikere med, Kristen Helveg, og nogle andre fornuftige gamle erfarne...Lone og flere af de andre blev meget optaget af det. ..De radikale støttede helhjertede vind, og de var heldigvis tungen på vægtskålen i mange sammenhænge. Det var vigtigt at vi havde dem.

3: Henrik Stiesdal		
#	Translation (English)	Original (Danish)
1	At one point (during the early 1980's), we came up to 0.1% of Denmark's electricity consumption, and we thought that was fantastic. It was a motivation to people that it could now be compared, and you could compete a little.	På et tidspunkt kom vi op på en promille af Danmarks elforbrug og det synes vi jo var fantastisk. det var jo en motivation for folk at man kunne sammenligne og man kunne konkurrere lidt.
2	The people I came to know in the environment, where for the most part driven by this opposition to nuclear power,..(some) objected to the first onshore wind farm Vestas was set to build in Ringkoebing. Wind power was supposed to be implemented through craftsmanship and not based on an industrial approach….From thereon I noticed that we differed too much on this topic.	De jeg kom til at kende i miljøet, For mange var det også den her atomkraft-modstand, der var driftkraft....(De) gjorde indsigelse mod den første vindmøllepark i Ringkøbing som Vestas skulle bygge...det skulle være et håndværk og ikke industrielt. Derfra bemærkede jeg at vi så for forskelligt på dette område.
3	I had long hair and wooden clogs, and met these older men, a bit set in their ways. At meetings, there would be this characteristic cigar-plate, wherefrom you could get cigars, cheroots, cigarettes, often accompanied by a shot of fine spirits. When I visited ELSAM during the 1980's, it would always start with a "Gammel Dansk" (A Danish Schnapps-like spirit, ed.). They often saw us as noise, and seem to think 'why should we take these people seriously, what is the logic of it'…It had been hinted at the utilities that they should engage…I do not think they cared much about the economics of it (wind turbines, ed.). It was a completely regulated system….They did not politicize on the employee-level, but they politicized a lot on the managerial level. They wanted nuclear power, it should be central, it should be big. We started as noise and then we became a threat.	Jeg havde jo langt hår og kom i træsko. Det var jo ældre mænd (Elværkerne) og gerne sådan lidt satte i det. Og det var et karaktertræk at der var cigarfad, så man kunne få cigarer, cerutter, cigaretter osv. , og der var også tit en dram. Når jeg kom i ELSAM i 1980'erne, så startede det altid med at man fik en gammel dansk. og De så jo på os som støj, 'hvorfor er det vi skal tage dem her alvorligt, hvad er logikken i det'....Elværkerne havde jo fået et vink med en vognstang om at de også skulle engagere sig...Jeg tror at økonomien var de fuldstændige ligeglade med. Det var et totalt reguleret system...De politiserede ikke på medarbejderniveau, de politiserede helt vildt på lederniveau. De ville have atomkraft, det skulle være centralt, det skulle være stort. Vi startede med at være støj, og så blev vi en reel trussel.
4	When we got to 2000 we were at 14%, which just happened. That thing about "what could the system take" was brought up from time to time, but anyone could see that it (the grid) could easily handle this level and that we were nowhere near any limit...From where I observed it that problem faded away.	Da vi kom til 2000 var vi på 14% , som jo bare var sket. Det der med 'hvad kunne systemet holde til' blev bragt op engang imellem, men enhver kunne se at det kunen sagtens holde til det her og vi var ikke nær nogen grænse. ...Fra min stol fadede det der problem.

4: Bent Christensen		
#	Translation (English)	Original (Danish)
1	There is a transition from when you are forced to do something, to when you have an organization in which it is a fun work-day which gives purpose. At that point, other forces start to push within the company.	Der er en transition fra at man bliver pålagt noget til at man så pludselig har en organisation for hvem det er en skæg hverdag, for hvem det gir mening. Så begyndte der at være nogle andre drivkræfter inde i virksomheden
2	At that time, a wind turbine was a bit "dumb" compared to today. Today a turbine can be expected to actively help in keeping grid-stability, which they could not do earlier. ...the toughest challenge was that all distribution-grids and local-grids were designed and dimensioned from the idea that the power only ran one way (From central power stations to users, ed.). Now the power started to run the other way, and it required a lot to upgrade the grid to handle that unpredictability.	På det tidspunkt der (start 1990'erne) var en mølle noget mere dum end den er idag. Forstået på den måde at idag kan en mølle jo tage aktiv del i at holde stabilitieten i nettet, det kunne de ikke tidligere....Der hvor man var hårdest ramt var reelt at alle distributionsnet og lokalnet var designet og dimensioneret ud fra at strømmen løb i én retning. Nu begyndte strømmen at løbe i den modsatte retning. Det krævede ret meget i nettet at få det opgraderet til at kunne håndtere den uforudsigelighed.
3	In a parallel track, you had all of these decentral heat-power plants that were emerging everywhere. In those you had the same challenges, with who would pay for grid-costs etc.	Parrallelt med det her havde du alle de decentrale kraftvarmeværker der skød op som paddehatte alle steder. Der havde du de samme problemstillinger med hvem der skulle betale de nettilsslutninger.
4	When you planned new build-out, wind power had traditionally been given a capacity factor of 0%. At some point (during the mid-1990, ed.) you raised it to 10%, and that was kind of a Eureka moment that you could now ascribe wind power a capacity factor of 10%.	Når man så dem der lavede planlægninger af ny udbygning, Der gav man til at starte med vind en kapacitetsfaktor på 0. På et tidspunkt løftede man det så til 10% og det var sådan en "aha" oplevelse at man kunne begynde at tilskrive vindkraft en kapacitetsfaktor på 10%
5	If the industry had not communicated as it did what would the situation then have been. Then you as a government authority would have observed an industry that was apathetic and did not act. You would quickly grow tired of that…. This was a vision that when we got to that point, we need to have found the right technical solutions...I don't know many other industries think 6-8 years ahead and set a target for their technology costs to remain sustainable as a business.	Hvis industrien ikke havde kommunikeret ud som den gjorde, hvad havde situationen så været. Så ville du som myndighed havde set på en industri der var apatisk og ikke gjorde noget, den ville du hurtigt blive træt af....Det her er jo en vision om at når vi kommer derud, så skal vi have fundet de rigtige teknologiske løsninger der gør at vi kan lave et nyt system....Jeg kender ikke så mange andre industrier der tænker 6-8 år frem og sætter et target på deres teknologi-cost derude for at det er sustainable.

5: Steen Gade		
#	Translation (English)	Original (Danish)
1	It was a tough discussion in Socialdemokratiet. They had a large party-gathering in Silkeborg…their position was 'we are against nuclear power, if you do not handle waste properly'. There was about 1000 people in that room, and they all knew what this was about…When Anker (Joergensen, ed.) then starts to say: 'The Socialdemocrats are against nuclear,…' he was interrupted. A minute long interruption (of cheers and applauds, ed.), …it was a symbolic description of the shift within the Socialdemocrats.	Det var en hård diskussion i socialdemokratiet. Så holdte de et stort møde i Silkeborg....deres position var "Vi er imod A-Kraft, hvis man ikke fik atomaffalds-håndtering etc. på plads". Der sad så 1000 mennesker i den her sal og de vidste godt hvad det handlede om. 28:00: Da Anker så siger "Socialdemokratiet er imod A-kraft...", så bliver han afbrudt. Et minutlangt afbrydelse, han kommer ikke tilbage på talerstolen.....det var en symbolsk beskrivelse af at så var det skiftet i socialdemokratiet....Når partiet ikke kunne komme igennem med at fuldføre sine tale.
2	The moment you became minister of something with as much money in it as oil, you became more important when you walked into the financial ministry, and could then negotiate more. It was also to be able to push the electricity sector (utilities, ed.) more	I det øjeblik du blev minister over noget der var så mange penge i som olie, så blev du vigtigere når du gik ind til finansministeren og du kunne forhandle mere. Det var også for at presse elsektoren.
	The aim was that the overall environmental concerns should direct more than the energy sectors own interests, that was the intent. The other thing was that Svend and the rest of us were concerned with jobs. It was a little bit down-prioritized (by others, ed.) in the general public discussions."	Her var sigtet at de overordnede miljøhensyn skulle styre mere end energisektorens egne interesser, det var meningen. Det andet der også var meningen. Det var at Svend og vi andre var optaget af jobs. Det var en lille smule underprioriteret i debatten.

6: Jesper Tornbjerg		
#	Translation (English)	Original (Danish)
1	From 2001 and some years onwards, the (Venstre-Conservative) government seriously questioned the question about climate change. There were some sceptical researchers that were a lot more active. There was the whole controversy around Lomborg and Svensmark. There was a different psychological climate in Denmark.	Fra 2001 og nogle år frem der blev der jo sat alvorlige spørgsmålstegn ved klimaet fra regeringens side. Der var nogle forskere der var noget mere aktive blandt de skeptiske forskere. Der var hele balladen med Lomborg og Svensmark. Der var et andet psykologisk klima i Danmark.

7: EA Energy Analysis Consultant		
#	Translation (English)	Original (Danish)
1	What they asked us for was a quality assurance of something they had already done…We do many products, which someone thereafter chooses to present, if it supports something that they want.	Det de bad om var vel egentlig kvalitetssikring af det de havde lavet...Sådan laver vi rigtig mange produkter hvor nogen vælger at gå ud med det hvis beregningerne peger på at det understøtter et eller andet de vil.

8: Danish Energy Agency Analysts (DEA)		
#	Translation (English)	Original (Danish)
1	Despite the fact that the calculations came out in a rather quiet news period (during the national summer holidays, ed.), there actually was a lot of reaction to it....It surprised us that it (back-up costs, ed.) ended up filling so much....There was a critique of the analysis only a few weeks ago (May 2015, ed.), that the CO2 price in the analysis was set much too high	På trods af at beregningerne kom ud i en pressemæssigt ret død periode, så er der faktisk rimelig meget reaction på det....Der har været alle mulige henvendelser og kommentarer...Det overraskede os at det kom til at fylde så meget....Der var en kritik af analysis for bare et par uger siden (May, 2015, ed.), om at CO2 prisen i analysen var sat alt for højt.
2	There is a caveat in the research note. If you look at combined scenarios and energy systems, then you cannot really use this analysis. But it can still say something about that under the simple conditions set up (the green field assumption, ed.), then the picture looks like this.	Der er også et forbehold i notatet. Hvis man kigger på samlede scenarier og samlede energisystemer, så kan man ikke rigtigt bruge den her analyse. Men den kan alligevel sige noget om at under de her simple forhold, så ser det sådan her ud.

9: Rockwool Report - Co-Author		
#	Translation (English)	Original (Danish)
1	When we started we imagined that it had become more expensive, as more wind energy was brought into the system. But we have simply not been able to see this over the period.	Da vi startede havde vi nok en forestilling om at det var blevet dyrere i takt med at man havde hevet vind ind i systemet, men det har vi simpelthen ikke kunne finde over denne periode.
2	What we have done (the counterfactual analysis, ed.) is almost banal in its approach and we are completely aware of that. But we wanted to show increasing returns to scale, this point that the more you produce the lower is your average cost....I don't know how much value it has apart from giving you an indication of what production costs are.	Det vi har gjort her det er næsten banalt i sin tilgang og det er vi helt bevidste om. Men det vi bare gerne vil have frem. Vi snakker jo increasing returns to scale, det her med at desto mere du producerer dets lavere er din gennemsnitsomkostning....Jeg ved ikke hvor meget værdi den analyse har andet end at den gir dig en fornemmelse for hvad er produktionsomkostningerne så.
3	I have no opinion towards the 14%, whether that is much or little. It was more to get that on the table and say "this is the cost, this is our best estimate'…The reactions have mainly been about whether one considered 14% to be expensive or not.	Jeg har ingen holdning til de 14% om det er meget eller lidt. Det var ligesom for at få den på bordet og sige "det har det så kostet, det er vores bedste bud"...Det som reaktionen egentlig mest har været det har været i forhold til de 14% er om man synes det er dyrt eller ikke er dyrt.

10: Energinet Analysts		
#	Translation (English)	Original (Danish)
1	Energinet is of the clear opinion that we do not need capacity markets…we expect that the demand side will be established to an extent where the few hours in the year [when there is not enough wind or interconnectors], something will be able to disconnect freely…technically, we have enough solutions.	Energinet mener sådan klart og tydeligt, at der er ikke behov for kapacitetsmarkeder...forventer vi, at forbrugssiden den er aktiveret, i en sådan grad, at de der få timer en gang om året, at der er der noget der kan koble af....Teknisk der har vi jo løsninger nok,
2	Whether the wind-share rises a bit more and such, that is not what really costs something on the supply security side….If one talks about dispatchable reserve capacity the last 10 to 15 years, this has actually not gone up if you look at the northern countries as a whole	Om vindandelen den stiger lige lidt mere, og sådan nogle ting, det er ikke det, der virkelig koster på forsyningssikkerheden...Altså, af regulerbar reservekapacitet, de sidste 10-15 år, eller sådan noget. Og det er faktisk ikke steget, hvis man ser på Norden samlet.

11: Neil Fligstein		
#	Translation (English)	Original (English)
1	That is a good question, It sounds to me like almost something that would have to be empirically established, at what point do the stop being a challenger and start being an incumbent. Certainly there was a moment where they were a challenger. They might maintain that challenger mentality, but who knows if it is real or not. I guess the way you tell is how the rules are written and who gets to say what.	Same

12: Marion Fourcade		
#	Translation (English)	Original (English)
1	You could not say that you have the policy and then you value; it is actually reverse. It is because you value in a certain way that you can imagine the policy, because then the policy makes economic sense….When it [i.e., nature] is priceless, it has no price and therefore you can't advocate for it in a way that is relevant. Basically, there are two possible ways to advocate for environmental policies. One is, you just do it because it is common sense to do it [e.g., precautionary banning of fracking in Europe]…the other way is to put a value on more and more stuff.	Same

Appendix C. Reports from the Danish Economic Councils 2008-2016

This appendix contain a more elaborate walkthrough of the Danish Economic Councils recommendations towards energy policy and the quota market from 2008-2016. It gives a short overview of how the DEC discuss the notion quota markets and additionally how they frame wind power.

2008 DEC Report: Market Exposure to prove affordability of wind power

In 2008, DEC would return to the question of socio-economic value of pursuing a wind power build-out. The cost-benefit analysis was again a central piece of the theoretical approach and was explained as such in their 2008 report: The analysis includes (in principle) a full quantification of both costs and benefits, meaning also valuation of changes in the supply of environmental goods. The analysis is based on welfare-economic calculation-prices. (DEC, 2008, p. 29)

In maintaining their 2002 calculation methods, the DEC noted that subsidies “obviously result in a redistribution which benefits the subsidized sector” (DEC, 2008, p. 34)**.** From this starting point, the DEC went on to explore the distortion effects of what would otherwise be an untouched market through the cost-benefit analysis. The conclusion reached was that wind power should not be supported as explained early on in the reports main findings.

> “As a starting point, renewable energy which can function on market terms should not be supported. This applies in example to wind power, and the support for this should therefore be dismantled”. (DEC, 2008, p. 19)

The DEC defined Energy Security as being primarily related to independence of foreign fossil fuel imports (DEC, 2008, p. 13,229), and argue that while energy security has been in focus throughout the energy policies of the 1970’s and 1980’s, it was now the case “in recent years”, that climate change has been the central factor of Denmark’s climate change policies (DEC, 2008, pp. 144, 229). This is a bit odd considering the Market Distortion period, but they likely refer to the 1990’s. The DEC further concludes that with regards to energy security, the problem is mainly with gas and oil, while there is an abundance of coal (DEC, 2008, p. 229). As a functioning CO2 market should theoretically solve both issues of climate change mitigation and Energy Independence, setting up goals for wind power build-out, was deemed “a risk” to achieving a “cost-effective way” of reducing CO2 and enabling energy security to set up specific goals for renewable energy. The weigh-off of measures (energy savings, renewables etc.) to achieve a reduction in the use of fossil fuels should “as a starting point not be made by politicians, but by the market” (DEC, 2008, p. 234). This statement is not directly related to the value of wind power, but it does become relevant in the fact that it places the responsibility for pricing energy independence and CC mitigation in the hands of the current market arrangement. What becomes even more interesting is to compare this with answer that the DEC authors gave in their follow up answers to critique of their report. Later in 2008, two of the economic wise-men would write the following in an Op-Ed discussing the results of the 2008 report.

> “The great question is, how large resources the current generation must use to fight off future climate changes…There cannot be given a final macro-economic answer, because it to a high degree relates to how great amounts of natural resources…our generation is willing to transfer to future generations. Such a problem of distribution is fundamentally political in its nature”. (Amundsen & Andersen, 2008)

It is intriguing that the economic wise men here argue that the problem of setting the value of mitigating climate change is ‘political in its nature’, yet according to their report, the method and pace of mitigating climate change should be determined by the market and not politicians (DEC, 2008, p. 19).

Reactions to the 2008 report

All the four major newspapers in Denmark covered the DEC’s conclusion regarding wind power, as the report was released, see the table hereafter (Dahlager, 2008; Gardel, 2008; J. S. Nielsen, 2008b; Stenvei, 2008).

Date	News-source	Headline
12.03.2008	Information	Wisemen: The market must save the climate
12.03.2008	Politiken	Wisemen: Expose of the support to wind turbines
12.03.2008	Jyllands-Posten	Dangerous Climate Course
12.03.2008	Berlingske	Wisemen: Stop supporting wind turbines

The EU ETS system had at the time just gone into its second phase, and expectations were that CO2 prices would stay high. The economic wise-men thus concluded that the EU ETS would come to constitute the well-functioning market, which would mean that subsidies could be removed. It was at this point reasonable to assume that the ETS market could have functioned. But it is worth noting that the DEC maintain this conclusion in the reports that follows although the prices of CO2 quotas dropped and stayed flat.

DEC 2010-2013: Wind power deemed less valuable than Carbon trading

From 2010-2013, the conclusion from 2008 regarding wind power subsidies and market interventions to build wind power was reinforced without significant changes. These reports will therefore not be covered in detail, but key assumptions and conclusions can be found in the table below. After the table, the author will hereafter go into detail with the three most recent DEC reports from 2014, 2015 and 2016 respectively, as these individually added to the original line of logic. Sources are as follows for 2010 (DEC, 2010, pp. 352, 355), 2011 (DEC, 2011, p. 201) 2012 (DEC, 2012, pp. 5, 45–46), 2013 (DEC, 2013, p. 66). As can be seen in the table below, the DEC recognize that the CO2 quota market is not functioning but still advices Denmark that there is “no longer any reason to subsidize renewables energy” as seen in 2010. Their 2002 point is re-emphasized in 2012, where they state that support for renewable energy in Denmark will not decrease CO2 emissions.

Year	Quote
2010	Renewable Energy can be a way to reduce GHG emissions, but if the primary target is such a reduction, the most targeted instrument is to increase the price through taxes and quotas… If there through quotas and taxes a high and fairly stable price of CO2 is secured. Going forward, there is no longer any reason to subsidize renewable energy (352). A disadvantage to using subsidies over taxes is…that subsidies in reality are technology specific. There is no evidence for a claim that politicians and government officials generally are better than the market at picking 'tomorrows winners' (355).
2011	A further taxation of CO2 in the quota-covered sector...will not lower the number of quotas and therefore not lower emissions of GHG's at an EU-level. The same applies for other measures…i.e. subsidies for wind power electricity (201).
2012	Increased support for renewable energy in the quota sector in Denmark, will not lead to lower CO2-emissions on a global level (5).
2013	From an economic viewpoint, the low quota price is therefore only a problem, if it does not reflect the political level of ambition, which can be caused by market uncertainty of whether the EU ETS (The quota system, ed.) will continue to exist…the effect of investments in green technology will therefore likely be very small. In addition, an intervention could provide further uncertainty in the market, as it can create an anticipation of other interventions in the future (66).

2014 DEC: what could be saved if all wind subsidies were removed

The DEC 2002 report started the DEC's research interest into the societal costs or benefits of wind power and the accompanying subsidies, by analyzing what the societal cost of the wind power build-out had been in the 1990's. The 2014 report would conduct a similar calculation, but looking at future years instead. The DEC thus decided to do a cost-benefit analysis of a 10-20 year future horizon to calculate how much money could be saved if all non-promised renewables subsidies were cancelled (DEC, 2014, pp. 38–39). By calculating the savings, the DEC could then conclude what the cost to consumers was by treating the difference between a "no subsidy" scenario with a "subsidies as planned" scenario. The conclusion of this Business as Usual type calculation was that the planned renewable subsidies constituted an added cost to end-users of 3.5 bn. DKK, which could be saved in 2020 (2014 currency) (DEC, 2014, pp. 38, 42). Additionally, the DEC calculated that the distorting effects of the renewable subsidies would lead to a drop in private consumption of 5 bn. DKK, and to an employment loss equivalent to 5000 jobs in a 2-3 year period (DEC, 2014, pp. 40–41). This led the DEC to recommend the Danish government to "cancel further support for renewable energy in electricity production" (DEC, 2014, p. 42). The 2014 report would thus reinforce the frame from 2002 of calculating subsidies enabling wind power, as being an added cost to society, which does not enable lower CO2 emissions at a European level.

DEC2015: A philosophical approach to economic calculations

In 2015, the DEC dedicated a full chapter to go into a more philosophical discussion of how to estimate the value of mitigating climate change and what a right CO2 emission price should be. They argue that traditional economic models are often underestimating future environmental damages (DEC, 2015, p. 304), and that a focus on BNP has a tendency to cause world policies to prioritize the need for material growth over environmental concerns (DEC, 2015, p. 309). They conclude that the world needs a significantly more ambitious climate policy and that this need makes it "correspondingly more important, that the climate policy is conducted cost-effectively" (DEC, 2015, p. 305). The DEC specify cost-effectively to mean a "global solution…based on economic instruments", wherein "concrete reductions should take place where it is cheapest…middle-income and developing countries" (DEC, 2015, p. 305,306). Wind power was only mentioned once in the report, as an example of how a renewable energy source could substitute an fossil fuel energy source such as coal (DEC, 2015, p. 234). Despite this mention, the overall DEC conclusion about how it was not recommended to subsidize wind power in Denmark, was not changed in this report.

DEC 2016: Cheap wind power, but expensive wind power scenarios

In 2016, the DEC would again calculate an added cost of Denmark's possible wind power build-out, this time in a larger context. They would set up the premise that it was assumed that the EU would not take any further climate mitigation actions than what had been agreed towards 2030, and Denmark would then proceed to become independent of fossil fuels by 2050 (DEC, 2016, p. 193). This analysis is by the DEC "connected with considerable uncertainties" as they include more factors than wind power build-out alone (DEC, 2016, p. 200). The electrification of the heating and transportation sector comes at considerable costs, and even with the calculated climate benefits, the DEC conclude that if Denmark was to go fossil independent by 2050 on its own, it would mean an additional cost of 16 bn. DKK (2015 Currency, compared to a base-case scenario (DEC, 2016, p. 10). The DEC specifically mention that although wind power is among the cheapest energy sources to build, a scenario in which Denmark deploys wind power on a large scale is more expensive than a base-case scenario (DEC, 2016, pp. 203–204).

The question of societal value of wind power is now recognized as being a different question whether one inquires whether wind power is cheap or whether wind power is cheap to build in the current system. The cost of the latter question is highly dependent on how much avoiding climate change impacts are assumed to be worth in the DEC's calculation. This assumption consist both of what the DEC estimate the social cost of carbon to be, but also what they expect the rest of the world to do, as this will determine fuel and CO2 quota cost. The estimate of the social cost of carbon and thereby the calculated benefits, is set to be 450 DKK/tCO2 (2015 prices), the average between two estimates of the period 2015-2050 (DEC, 2016, pp. 233–234). This number is sourced from a study conducted by an US interagency working group, using Integrated Assessment Models, such as the DICE model used in the 2002 DEC report (DEC, 2016, p. 234). To learn about the costs, one must analyze a background -note made by the consultancy firm EA energy analysis, which the DEC cites as their source for cost calculations (DEC, 2016, p. 201; EA, 2016a).

EA Energy Analysis (EA) has in the background-note "the societal added cost of a fossil free energy supply", set up the system assumptions that lay the ground for the conclusions in the DEC 2016 report. EA's analysis is only related to the societal costs, and has not been asked to calculate the benefits. As a result, they do not consider economic benefits on a global level, "as a result of lower temperature-rise and fewer climate changes" (EA, 2016a, p. 3).

EA use the IEA's 'New Policies scenario for calculating fuel costs and CO2 quotas in the future (EA, 2016a, p. 7,18). This is not the societal benefit of mitigating climate change, which the DEC themselves calculated, EA's analysis is in fact about what the expected quota prices to maintain the fossil fuel scenario would be. EA reach the conclusion that difference in energy system costs between the fossil fuel scenario and the wind scenario is 11 bn. DKK (EA, 2016a, p. 13), a lower number than the final 16 bn. DKK in the DEC report, due to the fact that the distortion effects of subsidies and taxes are left to DEC to calculate. But the CO2 and fuel price assumptions become of interest due to a paragraph on page 19 of the background-report, cited hereafter.

> "The 450 scenario leads in a direction, which meets the goal of maximum 2 degrees of global temperature-rise, while the new policies scenario lead to an approximate 4 degrees temperature rise. An assessment of the plans which have been submitted in connection to the global climate summit in Paris, indicates, for comparison, a global temperature rise of approximately 2.7 degrees. The Climate policy after Paris can thus be assessed to be somewhere between the New Policies scenario and the 450 scenario". (EA, 2016a, p. 19)

The EA calculation of how much it will cost to emit CO2 under the fossil scenario is thus based on an assumption that the world will steer towards a 4 degree temperature rise by 2100. This a significantly higher rise than what is expected after the COP21 meeting in Paris, wherein more than 190 countries delivered their internationally determined contributions (INDC's), as EA mentions. Assumptions about the cost of transitioning through the wind-scenario is based the notion that the rest of the world's countries will continue emitting consistent with a 4 degree scenario, equal to a future environmental state significantly ravaged by climate change. Secondly it is an inconsistency from the DEC's argumentation in the 2015 report, wherein there was a strong need for global action. It is understandable that DEC cannot guarantee that global action will happen, but it is nonetheless a contrary position to argue that emissions should happen where it is most efficient, and thereupon enact an assumption about the world where no such action is taken. It is in principle not a wrong calculation by the DEC, but it is a performative assumption of inaction, which is treated as a self-fulfilling prophecy.

Below is a summary table with some of the key quotes in relation to wind power and carbon markets for the years from 2014-2016. Sources are as follows for 2014 (DEC, 2014, pp. 38, 40–42), 2015 (DEC, 2015, pp. 234, 305) and 2016 (DEC, 2016, pp. 204–205) respectively.

Year	**Quote**
2014	A higher renewable energy share, achieved through more support to renewable energy in the quota sector, does not benefit the climate and is associated with costs to Danish households and companies (32). The model-calculations show that it costs welfare when cost-ineffective technologies are forced through, so costs are increased for companies and consumers….a direct added cost for end-users of approximately 3.5 bn. DKK (2013 currency) (38)…the

	calculations should primarily be perceived as illustrative of a medium-long 10-20 year perspective (39). The added costs inhibit Danish competitiveness, which triggers a fall in sale of Danish-produced goods. This leads to a fall in the Danish level of production and thereby also employment. In a 2-3 year perspective there is according to the model-calculations, a employment rate equivalent of 5000 people less…As competitiveness gradually improves, companies will improve employment, which over time will return to the original level. The salary level will however be permanently reduced (40)….As a result hereof (Lower salary level, ed.), private consumption falls in the same order of size, equivalent to about 5 bn. DKK (41). Recommendation: Cancel further support for renewable energy in electricity production and save approximately 3.5 bn. DKK in 2020. (42)
2015	One example of substitution between nature- and human-made capital is the construction of wind turbines as an alternative to coal-fired power plants. Here one type of human-made capital (coal-fired power plants), which are dependent on the consumption of particular non-renewable resource, is replaced by another type of human-made capital (wind turbines), which instead depend on a renewable natural resource (wind power) (234). The need for a considerably stronger effort in the climate policy at an international level makes it correspondingly more important that the climate policy is conducted cost-effectively. Otherwise, the disadvantages will be unnecessarily high. A cost-effective climate policy will among other elements constitute that reductions are made in those areas of the world, where it is cheapest. This requires a global solution, which as a starting point should be based on economic instruments (DEC, 2015, p. 305).
2016	The calculations show, that under the given assumptions there can be expected a rise in energy-costs of approximately 16 bn. DKK by transitioning to fossil free production (10). The combined emissions in the EU from the quota-covered sector, is controlled by the quota ceiling, and Danish initiatives within the quota-covered sector therefore have as a starting point no effect on the climate. Support for renewable energy and other initiatives within the quota-covered sector should therefore be argued for on

	other concerns than the direct effect on the climate (12). Wind power is among the cheapest energy sources on the market (203). The wind-scenario presupposes an extensive electrification, which requires larger costs to i.e. the electric grid and reserve capacity. In addition there are a number of derivative investments in the shape of heat-pumps and electric kettles. All of this contributes to making the wind-scenario more expensive, despite the relatively cheaper wind power (204).

This concludes the Appendix C walkthrough of the DEC's discussions of Climate change mitigation and wind power. As the dissertation is already quite long, I estimated that these additional DEC reports did not have to be part of the Global Advantage or Subsidy Burden period in high detail. But it was also a shame not to connect a few comments to these reports, if there would be a reader or two who shared my interest in the DEC as an actor. This appendix has hopefully served to show that the 2002 report was not a single isolated calculation from the DEC. They have continually argued for global market solutions to CC mitigation and this is why I still list them as an actor in the Market-coalition in the Global Advantage period.

Appendix D. Full quotes from three reports (AKF 1996, DEC 2002, EK 2017)

Below are the quotes that I cite from three of the reports in the analysis, namely the AKF 1996 report (D1), the DEC 2002 report (D2) and the Energy Commission (EK) 2017 report (D3). The number is in the left-most column, while the page where they can be found in the source report is in the second column from the left.

D1: AKF - The Societal value of wind Power (1996)

#	Page	Text
1	5	The foundation of the project has been the analysis, which the Danish Energy Agency performed in 1991 and 1994 respectively, to shed light on the private economic conditions of wind turbines. The analyses did not constitute a broader socioeconomic assessment of wind power. It has been the main purpose of our project to conduct such an assessment.
2	5	The build-out of 1000 MW corresponds to approximately 2000 larger wind-turbines. Our analysis only relates to wind turbines that are erected on land. We compare wind power build-out with two reference alternatives: a coal-fired and a natural gas fired power plant of 420 MW respectively. Despite lower electricity effect, the reference power plant can produce the same amount of electricity as the wind turbines. As the power plant can also produce electricity in periods of no wind, we have assumed, that the wind power build-out must be supplied by 220 MW back-up capacity from a gas-fired plant, to be equal.
3	6	A calculation of electricity production costs for wind turbines, measured per produced kWh, has been conducted. Additionally, a valuation of the wind turbines reduction of CO_2 (Carbon dioxide), SO_2 (Sulfur Dioxide) and NOX (Nitrogen-filter) from the electricity system and from noise and visual effects of wind turbines.
4	6	We have not conducted a valuation of the effects on employment and balance of payments of a build-out of wind turbines, but have calculated these effects in the natural key

		numbers: people pr. Year and million DKK respectively.
5	7	A build-out of the danish electricity system with another 1000 MW wind turbines is socioeconomically reasonable, when the assessment considers the CO2-savings of wind turbines - compared to traditional power plants based on coal or natural gas.
6	7	The costs per produced kWh electricity is today typically 7-8 oere higher for the most cost-effective wind turbines compared to traditional power plants, which among other things is due to the fact that wind turbines need supplementing electricity capacity for periods of no wind.
7	7	The total Danish employment and balance of payments is not affected significantly whether one or the other strategy is chosen.
8	7	Noise and visual annoyances for households, in the close vicinity of existing wind turbines have practically no influence on wind turbines combined environmental advantages as measured in oere/KWh.
9	8	The main result of our analysis is that the environmental advantages of wind power are so considerable, that it from a broad societal assessment is competitive with natural gas-based electricity production and more advantageous than electricity produced on coal power plants.
10	8	In figure 1.1 the broad socio-economic electricity production costs for wind, coal and natural gas are shown. The figure reflects our expectation towards costs around the turn of the millennium.
11	9	It must be strongly underlined that in the broad socio-economic assessment of wind power, the environmental effects have had a decisive effect, herein especially the CO2 aspect. We estimate that the value of the reduced CO2 emissions compared to a coal-fired power plant account for 18-26 oere pr kWh for the most cost-effective wind turbines. Compared to a natural gas fired plant, the value is somewhat smaller - 9-14 oere pr. kWh for the most cost-effective turbines.

12	9	The value of noise and visual annoyances for households, which live close to existing wind turbines, we have calculated to 0.04 oere pr. kWh, which diminishes in relation to the other valued effects.
13	9	We have valued wind turbines CO2-savings on the backdrop of newer Danish analyses, which asses the scope of the socio-economic costs, which are necessary to pay, in order to meet the CO2 target.
15	10	We estimate that wind turbines also in the coming years typically will be a more expensive build-out alternative than coal power or natural gas-powered plants...We have estimated, that the future - and likely larger wind turbines of up towards 1 MW - can be up to 25% cheaper pr. KW wind turbines effect than the cheapest wind turbines on the market today.
16	11	The main result of the analysis is that there is no decisive difference in the effects between wind and coal power built-out as seen over a 20 year period.
17	11	We have not found it reasonable to make a valuation of these macro-economic effects, meaning a calculation into oere pr. kWh. This is among other things due to the fact that in our view, it is problematic to let short-sighted economic cycle-political considerations have a decisive influence on long-term Infrastructure investments in the electricity sector.
18	11	The valuation of the CO2-advantage of wind power has a decisive influence on the assessment of whether wind power is socio-economically profitable. The CO2-advantage is valued on the basis of existing Danish analyses, which asses the socio-economic costs by having to fulfill the energy-policy CO2 target
19	11	It is assumed that the Danish CO2-target is fulfilled in the context of Danish mitigation measures. This means that international agreements about an optimal distribution of CO2 quotas, which incorporated which countries the largest CO2 reductions can be achieved per invested crown, is disregarded.

20	12	In the calculation of production-costs for wind power and for conventional power plant, some conditions which have an influence on the assessment of the electricity systems total costs, have been disregarded. This relates among other things to grid reinforcement costs, control and regulation costs and merit order effects, which all would position wind power worse compared to a conventional build-out.
21	17	We expect that wind turbines in the coming years will be cheaper pr. KW installed turbine-effect. This is among other things due to the technological development as well as economies of scale advantages. We estimate that in the coming years, wind turbines of up to 1 MW will enter the market and these can be from 0 to 25% cheaper per KW installed effect - compared to todays 600 KW wind turbines. On the contrary, we expect the coming power plants to be more expensive than today. The plants will however at the same time become more effective, which means a lower fuel-usage and thereby a lower fuel-costs - all other things being equal.
22	21	It is decisive for the calculations of the saved alternative production costs, that more wind power reasonably can be claimed to displace either coal-fired or gas-fired power plant capacity in the electricity system. If the wind power displaces central or decentral heat-power plants, the value of the wind power is lessened. We do not know how much less, as we have not conducted this complex calculation.

D2: DEC - Assessment of the 1990's Environmental policies (2002)

#	Page	Text
1	205	For CO2 there is used an estimate of pollution damages of CO2 emissions of 47 DKK and 270 DKK per ton.
2	206	In the calculations there is included a tax distortion loss. Taxes are distorting, among other things because they reduce labor-supply, which entails a loss of welfare

3	210	As there is already abundant electricity production capacity in Denmark, it is assumed that the build-out of wind turbines, decentral heating, etc., in real terms have resulted in the build-out of surplus capacity for electricity production and thereby have only saved fuel costs at the heat-power plants.
4	210	It is calculated that the amount of electricity, which is produced by privately owned wind turbines, have caused an added costs of approximately 19 bn. DKK (2002-Real), which corresponds to 37 oere/kWh....combined the privately owned and utility owned wind turbines are estimated to give a societal loss of 5 bn. DKK
5	208	It is a conscious choice to use a (real) discount-rate of six percent, as the main scenario, which is also used in the financial ministry et. Al. (2001). To illustrate the sensitivities of the results there is alternatively used a discount rate of three percent.
6	217	If Denmark is to keep its Kyoto-commitment as cheaply as possible, there are however other options than bringing down CO2-emissions in Denmark. The Kyoto protocol opens the option to use the so-called flexible mechanisms. They entail establishment of trade in CO2 quotas and potential implementation of reductions in other countries.
7	233	It is assumed that the growth in the wind turbines industry employment does not affect the total employment level...The potentially positive employment effects must also be held against the costs of supporting the industry, there among distortions by collecting a tax revenue.
8	234	If there did not exist wind turbines in Denmark, there could be imported environmentally friendly electricity from Norway or Sweden, which are lower than the prices of Danish wind turbine electricity. The same satisfaction of need as today, could thus be reached by lower costs.
9	252	From the available information about prices and sales of wind turbines, there is nothing which indicates that home-market sales should contribute with very much experience.
10	263	The wind power build-out of the 1990's is an example of a policy, which has been socio-economically unprofitable, even

		when the industrial benefits of the wind turbines industry's achievements are accounted for.
11	264	These policies should not have been enacted with the knowledge that exists today. To that extent, the enactment of these policies is due to a lack of a socio-economic analysis of the consequences of the policies.
12	265	The erected wind turbines in Denmark in the 1990's results in a societal loss of approximately 3 bn. DKK...the cause of the loss is first and foremost that there from the starting point was abundant electricity production capacity in Denmark. The wind-turbines build-out has thereby resulted in the build-out of a surplus capacity for electricity production and only saved fuel costs on the hear-power plants.
13	266	In addition to this, smoke-cleaning measure on the heat-power plants have meant, that the electricity production which wind turbines electricity replaces, is far from as environmentally damaging as in start of the 1990's.
14	266	The industrial benefit of roughly 2 bn. DKK of the electricity production subsidy comes from the fact that the subsidy increases sales of wind turbines and thereby stimulates experience-building in the wind turbines industry. This has entailed reduced costs and improved competitiveness in the industry.
15	266	Although the bet on wind turbines historically has been resulting in a deficit, wind turbines projects today could be profitable investments due to the technological developments. The best wind turbines on land are today likely societally profitable....Coming generations of wind turbines must as a result of the technological development be expected to become more profitable.
16	267	Many environmental industries received support in the 1990's, but as mentioned it is only the wind turbines industry, which has done especially well....Although a policy down the line turns out to have entailed economic advantages, this is not adequate to ensure a successful business-policy. The proven advantages could be caused by luck or the circumstance, at the business policy has been directed at many industries, but that

		the policy has only succeeded a few places.
17	268	There should however not be kept a narrow focus on developing environmental- and energy policies, which have economic advantages, as one can overlook alternatives, which have economic costs, but nonetheless give a higher net value of society due to environmental advantages.

D3: Energy Commission (EK): "Recommendations to future energy policy" (2017). The analysis of report is on pages 250-254

#	Page	Text
1	13	The falling costs of production of electricity from wind turbines and solar-cells, combined with expectations of increasing market-prices for electricity means that the transition to and build-out of a low-emission energy society in time – and maybe already by 2030 – can happen on market terms.
2	13	The production prices of onshore wind and solar-cells have over the recent years fallen, while there has occurred large drops in the costs of erecting new offshore wind farms. This means that the costs of producing power from onshore- and offshore wind turbines and solar cells, in many areas today are cheaper, than they would be if the power was to be produced on newly established fossil fuel power plants.
3	33	The cheapest sources of renewable energy, in example onshore wind, are in principle already today able to compete with new investments in conventional coal power plants.
4	33	It is very difficult to predict future costs of renewable energy….The Energy commission consider the (DEA Technology) catalogues costs to be too conservative.
5	34	The current electricity market prices are at a level, which cannot recoup any type of new renewable energy capacity, despite the fact that the costs of renewable energy capacity has fallen. Neither would it be possible to recoup fossil capacity with current electricity prices. The electricity price is expected to rise towards 2030, while costs of establishing and operating

		new renewable energy technologies are expected to fall considerably.
6	5	This support should…start from a principle of technology-neutrality, in order to support a build-out of renewable energy in the best and cheapest way from a consideration to the complete energy system. The market should be used to bring prices down, and the different technologies based on renewable energy should compete with each other.
7	5	There are in all areas considerable uncertainties around the price development of fuels, CO2-quota prices and not least technological development. Therefore, it does not today make sense to set a certain course towards 2030, let alone 2050.
8	17	As subsidies to some of the existing and expensive renewable energy capacity, herein several offshore wind farms, will disappear during the 2020's, it is estimated as likely that the total subsidy to renewable energy will be reduced in the period compared to today.
9	24	There is a risk of inefficiency, when investments in infrastructure capacity are decided administratively.
10	32	The current share of renewable energy is the result of a political prioritization and founded upon economic support through a longer period. In 2015, renewable energy was subsidized with 6.4 bn. DKK in direct support, additionally comes the indirect subsidies through tax exemption.
11	36	Support should be given under a principal of technology neutrality, which also accounts for other relevant parameters…this could in example be negative environmental consequences such as noise-annoyances from wind turbines…"
12	39	The fluctuating energy-production from wind and solar increase the need for flexibility to ensure a continued high supply security and stability in the grid.

SUMMARY

The renowned philosopher John Dewey understood that we can only replace our doubts and ideas about the world with settled beliefs through the tools we have available in our inquiry. Likewise, the characteristics that make technical objects like wind turbines visible are not pre-given. Instead, the value depends on the tools we use to make some characteristics visible. These characteristics are then framed to produce a given meaning about the value of wind power. It could be characterized as a supplement to an energy system locked in to past fossil fuel choices. It could be characterized as a subsidized distortion in a certain economic doctrine's conception of a free market. Or it could be seen as an indispensable solution to the existential climate crisis humankind has brought upon itself. Valuation of an object is never given nor objective, but produced through frames and networks that are contingent and disputable. This thesis uncovers how Danish wind power came to be thought of as a worthwhile societal investment through a long and ongoing struggle of valuation. When facts and opinions are increasingly mixed up, one must look beyond the numbers and to the valuation networks of humans, materials and calculative devices. As we are faced with the fierce urgency of the Anthropocene, we must make the social practices of valuation discussable to expose the limits and consequences of the metrics of the past.

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