# The Rise of Finance in the Wind Industry

## Financialization in Global Commodity Chains
## Analysis of the German Wind Energy Market

Philipp Jantz

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## List of Abbreviations

| | |
|---|---|
| ABS | Advances Business Service |
| AEP | Annual Energy Production |
| APS | Advanced Producer Service |
| BaFin | Bundesanstalt für Finanzdienstleistungsaufsicht (German for: Federal Financial Supervisory Authority) |
| BauGB | Baugesetzbuch (German for: Building Code) |
| BDCC | Buyer-Driven Commodity Chain |
| BImSchG | Bundes-Immissionsschutzgesetz (German for: Federal Immission Control Act) |
| BDEW | Bundesverband der Energie- und Wasserwirtschaft (German for: German Energy and Water Association) |
| CAPEX | Capital Expenditures |
| CDO | Collateralized Debt Obligation |
| DAX | Deutscher Aktienindex (German for: German Stock Index) |
| DD | Due Diligence |
| DIBt | Deutsches Institut für Bautechnik (German for: German Institute for Construction Technology) |
| DIW | Deutsches Institut für Wirtschaftsforschung (German for: German Institute for Economic Research) |
| DM | Deutsche Mark (German for: German mark) |
| DSCR | Debt Service Coverage Ratio |
| DSO | Distribution System Operator |
| EBITDA | Earnings Before Interest, Taxes, Depreciation and Amortization |
| EEG | Erneuerbare-Energien-Gesetz (German for: German Renewable Energy Act) |
| EEX | European Energy Exchange |
| EU | European Union |
| EUR | Euro |
| EYA | Energy Yield Assessment |
| FED | Federal Reserve System |
| FDI | Foreign Direct Investment |
| GCC | Global Commodity Chain |
| GDP | Gross Domestic Product |
| GPN | Global Production Networks |
| GVC | Global Value Chain |
| GW | Gigawatt |
| GWh | Gigawatt-Hour |
| ha | Hectare (1 ha = 10,000 $m^2$) |
| HGB | Handelsgesetzbuch (German for: Commercial Code) |
| IEC | International Electrotechnical Commission |
| IPE | International Political Economy |
| IPO | Initial Public Offering |

| | |
|---|---|
| IRR | Internal Rate of Return |
| ISP | Independent Service Provider |
| IWR | Internationales Wirtschaftsforum Regenerative Energien (German for: International Economic Forum for Regenerative Energies) |
| KAGB | Kapitalanlagegesetzbuch (German for: capital investment act) |
| KfW | The Kreditanstalt für Wiederaufbau (German for: Credit institute for reconstruction) |
| kW | Kilowatt |
| kWh | Kilowatt-Hour |
| MDAX | Mid Cap German Stock Index |
| MLA | Mandated lead arranger |
| MW | Megawatt |
| MWh | Megawatt-Hour |
| OECD | Organization for Economic Cooperation and Development |
| OEM | Original Equipment Manufacturer |
| OPEX | Operating Expenditures |
| OTC | Over the Counter |
| PDCC | Producer-Driven Commodity Chain |
| PSF | Producer Service Firm |
| REIT | Real-Estate-Investment Trusts |
| RENIXX | Renewable Energy Industrial Index |
| ROG | Raumordnungsgesetz (German for: Spatial Planning Law) |
| ROI | Return on Investment |
| R&D | Research and Development |
| SDAX | Small Cap German Stock Index |
| SPV | Special Purpose Vehicle |
| StrEG | Stromeinspeisungsgesetz (German for: Electricity Feeding Act) |
| TecDAX | German Stock Index for the Technology Sector |
| TOTEX | Total Expenditures |
| TSO | Transmission System Operator |
| TW | Terawatt |
| TWh | Terawatt-Hour |
| UK | United Kingdom |
| UNCTAD | United Nations Conference on Trade and Development |
| US | United States |
| USA | United States of America |
| USD | United States Dollar |
| USAID | United States Agency for International Development |
| WCA | World city archipelago |
| WpHG | Wertpapierhandelsgesetz (German for Securities Trading Act) |
| WTG | Wind Turbine Generator |
| WTO | World Trade Organization |
| YieldCo | Yield Company |

### Abstract

The energy revolution represents one of the greatest challenges of our times. Wind energy plays a special role within the implementation of sustainable energy supply. The increasing complexity of wind park planning, construction and operation, led by policy and economic developments, as well as the required targets for transferring renewable energies into a free market, is a difficult task for wind energy projects in Germany both today and in the future. Hereby the main challenge will be to operate an economically stable wind energy project despite fluctuating feed-in tariffs, changes to the political framework and occurring negative electricity prices. The wind industry and the financial sector are addressing these new challenges with new ideas.

In this context, an analysis from the perspective of the Global Commodity Chain approach will be presented, which will show the relations between the wind industry and the financial system and explain changes and shifts in this system of exchange relationship. The aim was to find out whether financialization processes influenced the structure, the actors and the functions of the wind industry, how financialization processes changed the governance of the wind energy commodity chain and whether changes in the institutional framework favored financialization processes. The term financialization process refers to the increasing role and importance of financial motives, financial markets and financial actors in a commodity chain.

Based on the research questions and the formulated hypotheses, indicators which made it possible to identify financialization processes in the wind energy commodity chain were defined. The scientific discourse on financialization has been integrated into the Global Commodity Chain approach, thus broadening the research discourse on Global Commodity Chains. The empirical results, which are also based on numerous discussions and interviews with industry experts and market players, show that the wind industry is being financialized and is gradually being penetrated by financial actors and financial markets. It appears that this development is only the beginning. The qualitative results of the interviews can be verified with quantitative data from statistics or self-created databases, which additionally confirmed the hypotheses.

The results show that the field of activity and the influence of the financial sector with its advanced producer services has changed considerably within the wind industry. In the early 2000s, the influence of banks and financial service providers within a wind energy project was mostly limited to the provision of loan capital and the structuring of financing. Today, financial service providers are faced with the challenges arising from the changing institutional frameworks with ever new forms of financing and financial products, as the analysis of financing structures in this work shows.

A key position will be given to service providers from the financial sector with advanced producer services. Through the extensive interviews, it could be proved that on the one hand, services, advice and consultancy with a focus on project and corporate financing are offered as well as optimization potentials of wind parks in operation. On the other hand, it has been found that new financial products and financial services create new circuits of value. New financial products and investment models for private investors and professionalized investors have been established on the market, and have now become an integral part of the wind industry. For example, an own survey shows that companies from the original manufacturing industry in the wind industry are now also playing a major role as financial services providers in the wind industry. These services are complemented by the ability to switch capital to other circuits of capital. Due to their interface position, financial actors are able to transfer capital from other investment sectors such as the real estate or insurance sector to the wind industry – and also to return capital from the wind industry to other sectors.

As a result of these services, financial services providers are able to prepare investment decisions by means of various advisory mandates, financial products and access to wind energy projects, and are able to point out investment opportunities, which has a considerable influence on the command and control of the commodity chain. Financialization processes have thus constantly changed and influenced the governance processes and structures in the wind industry. These processes have been strengthened in the wind energy commodity chain through changes in investment behavior and in the institutional framework. For example, a correlation analysis on a self-made database for fund products in the wind energy sector shows that the projected fund maturities have been steadily declining and investors have chosen an ever shorter investment horizon. Changes in the institutional framework are characterized by a sustained low-interest policy, lack of investment opportunities, liberalization of the renewable energy sector and over-accumulation of capital.

The overaccumulation of capital in the wind industry has led to a decline in return expectations and an increase of the readiness to assume risk, which could be proved by the numerous interviews. The low return expectations opened up new possibilities for financial service providers to financially restructure wind energy projects to improve returns. The increased readiness to assume risk enabled financial service providers to develop and sell new and more risk-bearing products. This development leads to crisis-like phenomena in the wind industry, which are already visible today. Nevertheless, a breakdown or collapse of the industry is not anticipated. However, financialization could play a major role in possible future collapses, particularly if there is a penetration of renewable energies in the mobility and heat sector and this penetration is accompanied by further financialization.

## Zusammenfassung

Die Energiewende stellt eine der größten Herausforderungen der heutigen Zeit dar. Eine besondere Rolle bei der Umsetzung einer nachhaltigen Energieversorgung spielt dabei die Windenergie. Die durch die Politik und den Markt vorgegebene Komplexität bei Planung, Bau und Betrieb von Windenergieanlagen sowie die geforderten Ziele zur Überführung von erneuerbaren Energien in einen freien Markt stellt ein Windenergieprojekt in Deutschland heute und auch in der Zukunft vor komplexe Aufgaben. Die größte Herausforderung dabei wird es sein, ein Windenergieprojekt trotz schwankender Einspeisevergütung, Veränderung politischer Rahmenbedingungen und auftretender negativer Strompreise wirtschaftlich stabil betreiben zu können. Diesen neuen Herausforderungen begegnen die Windindustrie und der Finanzsektor mit immer neuen Ideen.

In diesem Kontext erfolgt im Rahmen der Arbeit eine Analyse aus der Perspektive des Global Commodity Chain Ansatzes, welche die Austauschbeziehungen zwischen der Windindustrie und dem Finanzsystem aufzeigen und Veränderungen in diesem System erklären soll. Ziel dabei war es, herauszufinden, ob Finanzialisierungsprozesse die Struktur, die Akteure und die Funktionen der Windindustrie beeinflussen, wie Finanzialisierungsprozesse die Governance der Warenkette Windenergie verändern und ob Veränderungen des institutionellen Rahmens Finanzialisierungsprozesse begünstigen. Der Begriff Finanzialisierungsprozess bezeichnet dabei die zunehmende Rolle und Bedeutung von finanziellen Motiven, Finanzmärkten und Finanzakteuren in einer Warenkette.

Auf Grundlage der Forschungsfragen und aufgestellten Hypothesen wurden Indikatoren definiert, anhand derer eine Identifikation von Finanzialisierungsprozessen der Warenkette Windenergie möglich ist. Der wissenschaftliche Diskurs über Finanzialisierung wird dabei in den Global Commodity Chain Ansatz integriert und der Forschungsdiskurs um Global Commodity Chains somit erweitert. Die empirischen Ergebnisse, die sich auch auf zahlreiche Gespräche und Interviews mit Branchenexperten und Marktakteuren stützen, belegen, dass die Windindustrie finanzialisiert und von Finanzakteuren und Finanzmärkten Schritt für Schritt durchdrungen wird. Es zeichnet sich ab, dass diese Entwicklung jedoch

erst am Anfang steht. Die qualitativen Ergebnisse der Interviews konnten mit quantitativen Daten aus Statistiken oder selbst erstellten Datenbanken verifiziert werden, was die aufgestellten Hypothesen zusätzlich bestätigt.

Die Ergebnisse zeigen, dass sich durch Finanzialisierungsprozesse das Aufgabenfeld und der Einfluss des Finanzsektors mit seinen unternehmensbezogenen Dienstleistungen innerhalb der Windindustrie stark gewandelt haben. So war der Einfluss des Finanzsektors bei einem Windenergieprojekt Anfang der 2000er Jahre meist nur auf die Bereitstellung von Fremdkapital und die Strukturierung einer Finanzierung beschränkt. Heute begegnen Finanzdienstleister den aus sich verändernden institutionellen Rahmenbedingungen resultierenden Herausforderungen mit immer neuen Finanzierungsformen und Finanzprodukten, wie die Analyse von Finanzierungsstrukturen in dieser Arbeit zeigt.

Akteuren aus dem Finanzsektor und seinen unternehmensbezogenen Dienstleistungen wird hierbei eine Schlüsselposition zuteil. Durch die umfangreichen Interviews konnte belegt werden, dass zum einen Dienstleistungen, Empfehlungen und Beratung mit Fokus auf Projekt- und Unternehmensfinanzierungen angeboten sowie Optimierungspotenziale von sich in Betrieb befindenden Windparks aufgezeigt werden. Zum anderen wurde gezeigt, dass Finanzakteure durch neue Finanzprodukte und Finanzdienstleistungen neue Kreisläufe von Wertschöpfung erschaffen. So konnten neue Finanzprodukte und Beteiligungsmodelle für Privatanleger und professionalisierte Investoren am Markt etabliert werden, welche mittlerweile zu einem festen Bestandteil der Windindustrie geworden sind. So belegt eine eigene Erhebung, dass Firmen aus dem ursprünglich produzierenden Gewerbe der Windindustrie mittlerweile auch maßgeblich als Finanzdienstleister in der Windindustrie auftreten. Diese Leistungen werden durch die Fähigkeit vervollständigt, Kapital in andere Kreisläufe zu transferieren. Bedingt durch die Schnittstellenposition der Finanzakteure zwischen Windindustrie und Finanzwirtschaft schaffen sie die Möglichkeit, Kapital von anderen Investmentbereichen wie dem Immobilien- oder Versicherungssektor in die Windindustrie zu transferieren und auch wieder zurück.

Aufgrund dieser angebotenen Dienstleistungen können Finanzdienstleister durch verschiedene Beratungsmandate, Finanzprodukte und Zugang zu Windenergieprojekten gezielt Investmententscheidungen vorbereiten und Investitionsmöglichkeiten aufzeigen, was einen erheblichen Einfluss auf die Lenkung und Steuerung der Wertschöpfungskette mit sich bringt. Finanzialisierungsprozesse haben somit stetig die Governance-Prozesse und Strukturen in der Windindustrie verändert und beeinflusst. Verstärkt werden diese Prozesse in der Wertschöpfungskette Windenergie durch Veränderungen des Investitionsverhaltens und des institutionellen Rahmens. So zeigt eine Korrelationsanalyse auf Grundlage einer selbst erstellten Datenbank für Fondsprodukte im Windenergiebereich, dass die prognostizierten Fondslaufzeiten stetig gesunken sind und Investoren einen immer kürzeren Anlagenhorizont wählen. Die Veränderungen des institutionellen Rahmens zeichnen sich durch eine anhaltende Niedrigzinspolitik, fehlende Investitionsmöglichkeiten, eine Liberalisierung des Sektors der erneuerbaren Energien und eine Überakkumulation von Kapital aus.

Diese Überakkumulation von Kapital in der Windindustrie hat dazu geführt, dass Renditeerwartungen gesunken sind und gleichzeitig die Risikobereitschaft gestiegen ist, was durch die zahlreichen Interviews belegt werden konnte. Durch die niedrigen Renditeerwartungen eröffneten sich Finanzakteuren neue Möglichkeiten, um Windenergieprojekte finanziell neu zu strukturieren umso die Rendite zu verbessern. Die erhöhte Risikobereitschaft ermöglichte den Finanzdienstleistern neue und stärker risikobehaftete Produkte zu entwickeln und zu verkaufen. Diese Entwicklung führte zu krisenähnlichen Phänomenen in der Windindustrie, welche bereits heute aufgezeigt werden können. Dennoch ist noch nicht von einem Zusammenbruch oder Kollaps der Branche auszugehen. Eine mögliche Finanzialisierung bei der Durchdringung von erneuerbaren Energien im Mobilitäts- und Wärmesektor wird dabei eine entscheidende Rolle spielen.

# 1 Introduction

## 1.1 Research Interest

Perhaps the most ambitious task in this century is the complete phase-out of fossil fuels to achieve a sustainable energy supply for electricity, heat and mobility for a sustainable future. The success story of renewable energies has shown that reaching this goal is realistic and essential. This achievement would not have been so effective and fast without wind energy. It is indisputable that wind energy is a driving factor behind the energy revolution. Such an energy revolution can only be achieved with enormous investments, which must also somehow be financed. In addition to changes in the energy sector, there is also a further global change, the so-called financialization. This social change is a process in which credit and capital markets extend to areas outside the financial system. Therefore, there is a great interest in research as to whether financialization processes play a role in the energy sector, and thus also in the wind industry, especially given the background that electricity has become a tradable commodity.

The wind energy sector has experienced enormous growth in recent years. The worldwide installed capacity of wind energy amounted to 4,800 MW in 1995. Twenty years later, in 2015, the world's installed capacity of wind energy had grown to 433,000 MW (GWEC, 2015, p. 14; 2006, p. 8). This is more than 90 times the installed wind energy capacity of 1995. In addition to this rapid increase, wind energy industry has become competitive in Germany. It is also present in other European markets such as Spain, the United Kingdom, France, Italy, and also in countries such as China, India, Canada and Brazil.

On a global scale, according to a conservative calculation model, global wind energy potential could supply more than 40 times the electricity consumption worldwide (Lu et al., 2009, p. 10,933). These estimates indicate that the development of wind energy has to be an essential part of the energy revolution. Furthermore, it seems possible and realistic to supply 65 % of Germany's electricity consumption by wind energy onshore by using only 2 % of the country's land area (BWE, 2012, p. 4).

These opportunities to expand wind energy in Germany and beyond must be exploited.
This development was significantly influenced by two factors. On the one hand, the production of kWh from wind energy was supported by attractive state subsidies in many countries. On the other hand, wind turbine technology developed so rapidly and to an extent that the costs compared to fossil fuels fell sharply. Thus, wind became competitive. As a result, wind energy has now become a permanent status in the German energy mix. Thus wind energy with 79 TWh had a share of 12.3 % of the gross electricity generation in Germany in 2015 (AGEB, 2016).
These developments mean that the electricity generation costs of wind energy are now below those of new fossil power plants. Wind energy on land is now the most favorable source of energy available. In contrast to fossil and nuclear energy sources, there are also no social costs such as the final disposal of nuclear waste, climate impacts from $CO_2$ emissions or other environmental and health hazards.
One of the most important points directly related to this enormous growth is that this strong increase is only possible by investing in renewable energy and, in particular, investing in wind energy. This is also confirmed by the figures: as early as 2004, USD 19 billion were invested worldwide in wind energy, it was almost USD 110 billion by 2015. This corresponds to more than a five-fold increase in one decade.
But these rising figures do not mislead the fact that the wind industry is in a state of upheaval and the industry is changing. This upheaval is noticeable at different levels. On the one hand, there are some countries which are still at in the early stages of developing the wind industry and still have high potential for growth, but a clear market saturation can already be seen in several countries. On the other hand, in countries such as Germany a steady lowering of the feed-in tariffs for wind energy is recorded. Furthermore, some countries lack a special financial support such as feed-in tariffs, which means that wind energy is situated in a free liberal market and is must directly compete with other forms of energy production.
Because of these changes, and to reach the described goals for the energy revolution, it is essential to find new and innovative solutions and possi-

bilities to implement and finance renewables energies. The market for renewable energies in Germany, but also in Europe, has reached the point that there is no progress with conventional solutions. The wind energy market in Germany has matured in the last decades and has developed from a non-profit idealistic market to a very professional and specialized energy market. This can serve as an example for many other areas of the world. Due to this maturation project phases, such as planning, construction and operation have become standardized and globalized processes in the whole wind energy commodity chain.

With these standardization and globalization processes, electricity has become a tradable product[1]. This has also contributed to the deregulation of electricity generation, which is supported by some states. As a result of this liberalization, electricity and thus wind energy has become a tradable commodity. In Germany, this situation is reinforced by its geographic location. Germany is located in the middle of a networked electricity system in Europe. Electricity may be freely traded beyond national borders. The rules of the internal market apply. Added to this is the security of supply, which is essential for an industrial location like Germany – and which is increasingly important due to current geopolitical events.

All these changes have influenced the wind energy commodity chain. If these influences exceed a certain point, this can also change the structure and the actors of a commodity chain. In this context, it is essential to explore how the wind energy commodity chain is structured, how this chain is controlled and how the changes affect the chain. In this dissertation, it is assumed that the financial sector will play a central role in the context of the aforementioned changes in the general conditions. It is therefore important to explore whether and how the wind energy commodity chain is influenced by the investors responsible for the described increase in investment and the impact on geographic space.

[1] In this context, the product is understood as tradable commodity, which is produced, traded and sold in a free market.

## 1.2 Research Questions

In order to be able to derive meaningful answers and solutions, several research questions have to be developed. These research questions are the key questions, which are investigated by this dissertation and which are referred to repeatedly. In the following chapter 2 (p. 16), these key questions are embedded in a theoretical context which is anchored in the science of geography. In the later course of this dissertation, hypotheses are then assigned to the key questions. The hypotheses can be verified or falsified by means of suitable indicators, which are developed. The aim is to be able to answer the key questions in order to create added value for the wind industry, the research and the field of geography and to further expand and document this knowledge.

Against the background of the assumption of a changing actor structure in the wind industry, the question arises whether this changing structure also leads to a change in dominance from the real economy to the financial economy. At the same time, it seems that the financial sector, with its financial actors and financial markets, becomes increasingly important in the wind industry. Does this also mean that new products and services are implemented in the commodity chain? As can be seen in the financialization of the financial economy, and the financial crisis since 2007, an increase of speculation and an increased appearance of products is made possible by securitization.

From the research question of whether a financialization in the German wind industry takes place, the following arguments can be derived. Regardless of which indicators are used for financialization, there must be a change in the commodity chain. If there is no change, a commodity chain has either not been financialized or it has already been financialized before the analysis and it still is. Consequently, the focus lies on the changes in the chain. Therefore, from the research question, a total of three key questions based on the research framework of Global Commodity Chain (GCC) research can be derived. Thus, the first key question deals with the structure and the actors of the commodity chain:

**Key question 1:** Do financialization processes influence the German wind industry's commodity chain structure and do financialization processes change the actors and their functions?

The key question analyzes whether financialization processes change the structure as well as the actors of the commodity chain. Each commodity chain has its own structure. This means that there are a certain number of actors within this chain, which produce a finished product. Each of these actors has a different share of value added to this product. Similar to the analysis of the input-output structure in GCC research, each actor uses a certain input to generate an output. In the classical view, the analysis is done with the raw materials and resources that are needed to produce different products. In this dissertation, this analysis is transferred to a commercial level. This is a more monetary viewpoint, based on added value. This means that each actor provides some financial input to generate a financial output through the sale of the actor's performance. The difference between financial input and financial output is the margin which remains with the respective actor. If the structure changes, the margins can also change. Similarly, as commodity chains change, the actors and their functions can also change. The central question therefore deals with these changes and attempts to clarify whether the reasons for these changes arise through financialization processes.

The governance of this chain can also evolve with every change to the structure, actors and their functions. If there are financialization processes and more and more actors from the financial sector are involved in the chain, the question arises whether this also changes the governance of this industry. The direct question is therefore, who controls this chain? Who sets the rules? And who benefits from these changes? Regarding the input-output structure, the question can be asked whether there are actors who can change the margins of the actors through the existing governance. This can be caused by the following extreme situations. On the one hand, market players can be completely denied the access to the market, which would mean that they could no longer place their products on the market. On the other hand, certain actors can be treated preferentially, which could lead to monopolistic structures. These questions are linked to governance, which is a fixed research component of commodity chain research. Along with governance research, it is assumed that financial industry actors have a comprehensive command and control function in the chain and thus are able to create market barriers and control market entries. This suggests that this decision making power and influence is not limited to the financial sector, but has an impact on the entire chain and thus also on the real economy of the wind industry. Therefore, the following key question can be formulated as follows:

**Key question 2:** How is governance organized within the wind energy commodity chain and is governance changed by financialization processes?

To answer this question, it is first necessary to analyze how governance is organized within the chain. To assess whether financialization changes the governance of a chain, it is necessary to clarify how governance was organized before the processes of financialization compared to the present situation. The analysis of governance takes into account the approaches of producer-driven and buyer-driven chains as well as the discourse of lead firms. Do the big international wind turbine manufacturers control the chain or perhaps the project developers, who initiate each wind energy project? This question is possibly more complex than it seems. However, in addition, the focus regarding governance lies also on the advanced producer service (APS) firms. It is to be clarified which influence the APS companies have on the commodity chain. Do these companies have an advisory role or do they actively guide the business decisions of companies? It is also necessary to clarify the areas of the commodity chain in which these services are used.

However, what is the reason for the above-mentioned changes? The liberalization of the electricity market and thus the generation of electricity through wind energy is progressing steadily. Electricity has now become a commodity[2], a product that can be bought and sold in a liberalized market. The commodity can be traded and speculated. In theory, this deregulation results in higher economic efficiency and declining electricity prices. Whether this has happened in practice lies beyond the scope of this dissertation. This does not mean that a liberalization of the energy

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[2] Electricity can be defined as product or service. However, taking into account technological advances, it is already possible to sell electricity using blockchain technology without the need for utilities for billing. Electricity is therefore seen in this dissertation as a commodity that can be bought and sold at any time with traceable source of production.

market is the cause of financialization. However, without liberalization, financialization is not possible because liberalization creates the framework for possible financialization processes. The cause of financialization, however, arises when the power vacuum resulting from the state's further withdrawal is occupied by actors who, through their actions and business activities, encourage financialization processes. Nevertheless, certain questions should be critically discussed. If energy generation is ultimately freely accessible, this dissertation must clarify who owns production capacities and how ownership structures of energy generation change. It is therefore indispensable to analyze another GCC research level within this dissertation. By analyzing the institutional framework and the following guidance, the GCC analysis is also complete.

**Key question 3:** How does the institutional framework affect the German wind industry and do changes of the institutional framework favor financialization processes?

This leads to the question of how the wind industry is changing as a result of increasing globalization, the liberalization of the electricity market and the integration of the capital markets. These processes are accompanied by political influences such as the ever-changing Renewable Energy Act (EEG), as well as European harmonization efforts, which are reflected in a tendering model for wind energy. The aim of this key question is to find out whether these changes favor financialization, or even accelerate this process. It is of great importance with regard to a country's security of energy supply to recognize whether a production unit like a wind park is developing through the networking of capital markets into a speculative object and if so, how it changes over time.

## 1.3 Geographical Relevance

The relevance of this work and also the need to write a dissertation on the subject of financialization and the wind industry is bipartite. On a practical level, there is a great relevance for the wind industry to scientifically explain the developments taking place. At the second and theoretical level, a deep analysis is drawn up in this dissertation, which leads to a

link between the research of commodity chains and financialization debates. These two levels will be explained in more detail below.
Before the theoretical enlargement is discussed, an explanation of the relevance of this work for the wind industry follows. As presented, the wind industry is changing. This dissertation explores how it is changing, why it is changing and what the consequences of the changes will be. It will be used to draw conclusions on what the energy industry will look in the future in order to generate recommendations for action.
There is an interest in understanding how this industry works and how it is managed. How is the industry controlled and, above all, who controls and steers this commodity chain? This understanding is essential to predict how the industry will develop. The control processes and how these processes work are generally referred to as governance. A discussion board is to be developed which comprehensibly shows how decision making processes in the wind industry take place and how governance is built up in the commodity chain.
This dissertation is a continuation of a research series by the Hamburg Department of Geography. With focus on the German wind industry this research series also demands further research in the wind energy research sector. A comprehensive analysis has already been carried out to explain the industrial structures of the German wind industry. This analysis covers the entire development path of the German wind industry with all its key players. However, this research sees further research needs in exploring the business fields of service and financing systems (Kammer, 2011, p. 285). Furthermore, another research work stated that the question of industrialization processes within the wind industry and the related financialization has to be in the focus of further research (Sommer, 2015, p. 260). According to Adrian (2017) "it would be interesting to further analyze future developments in the industry and the changes in the shares of the different forms of value chain governance" (Adrian, 2017, p. 246).
Particularly regarding the privatization of the energy industry, it is indispensable that these governance processes can be understood and scientifically proven. In order for the energy revolution is successful, governance processes are decisive. Electricity generation units will be distributed throughout Germany. One of the most important questions which has

to be clarified is the question of the ownership structures of these electricity generation units. With respect to wind energy, the question is: Who owns this wind turbine? And with focus on the German wind industry one can ask: Who owns how many wind turbines? Can power relations arise through the ownership structures alone? For example, an actor or a certain group of actors, who operate many wind turbines, could play out their market power not only in the wind industry market, but also within the power supply of Germany. So, the question is, who is ultimately the owner and thus producer of the product wind energy, and whether these ownership conditions change.

Another change that can be seen in the wind industry is financialization processes. There are also initial research approaches in this area, which concern the importance of credit and capital markets and thus also financialization processes in the wind industry (Klagge and Anz, 2014). These research approaches are to be continued in this dissertation. The aim is to examine more deeply the impact of financialization on governance processes and the impact of financial actors in the wind industry.

In addition, it is necessary to clarify the reasons why certain ownership and governance structures have formed. It is particularly crucial to ascertain whether these structures are caused by internal or external factors, or by a mixture of both. Insights from this research broaden the knowledge of the functions and processes in the wind industry. With regard to Europe and the world in other countries where wind energy also has a similar course of growth, the results of the work can be used to fill the knowledge gap to explain past development and future trends in the wind industry.

Having discussed the relevance of this dissertation for the wind industry, the theoretical research gap this dissertation intends to narrow is explained.

The Global Commodity Chain approach tries to explain the global economy and specifically the implications for regional development resulting from linkages. In the foreground of the commodity chain framework[3] is

[3] Regarding commodity chains, there are different ways of viewing and researching such as the GCC, the GVC and the GPN approach. The supposed differences do not play any role in answering the research question of this dissertation.

the analysis of the sequence of processes from which a product is produced and brought to the market. But in summary, the GCC research approach contributes to better understand the complex changes in the capitalist world economy (Bair, 2005, p. 170). The GCC approach therefore inspired many researchers in geography, political economy, development studies and beyond. There is also a lot of literature and research on governance in GCC. It has identified lead firms, transnational corporations and strong Original Equipment Manufacturer (OEM) who can prescribe their supplier prices. The geographies of unequal development have thus been continually developed and advanced. In many commodity chains the governance structures were explained and analyzed by case studies. There were numerous discussions about upgrade potentials and development possibilities. Numerous examples of working conditions in manufacturing companies were examined.

Despite numerous studies and research discourses, there has been only limited discussion on the role of finance throughout the development of governance in commodity chains. "[…] [E]conomic geographers have treated firm finance as something of a black box, as a largely unproblematized input to production. Much of the research on the geographies of money and finance has focused on financial institutions and the supply of capital and not on firms and their demand for capital" (Pollard, 2003, p. 446). This black box is to be explored more deeply. The following questions play a role: what role do financial actors, financial markets and financial products play in the commodity chains and what influence do they have? The integration of the approaches of commodity chains and financialization has already been addressed in some pioneering research (Baud and Durand, 2012; Coe et al., 2014a; Milberg and Winkler, 2010; Palpacuer, 2008). However, the neglect of financialization in commodity chains or GPNs is often criticized. According to Coe (2012), "a persistent and certainly valid critique of GPN research has been that it has underplayed the role of financial capital and the financial sector in shaping the configuration of global production systems" (Coe, 2012, p. 392). While this lack of attention to financialization is known, Coe et al. (2014) still see a research gap in this area because "neoclassical economics tends to see finance as evenly distributed across space, while political economy prioritizes productive parts of the economy without exploring the connections to financial circuits. The same applies to the GPN literature and the cognate work on global commodity/value chains to which it is related; drawing on similar traditions (though leaning more towards political economy than economics), finance is a startling gap in this otherwise rich and multifaceted literature" (Coe et al., 2014, p. 766). As such, it "echoes and responds to more general calls for research bridging geographies of finance and geographies of production" (Coe et al., 2014, p. 772). This call is to be followed in this dissertation and the merger and integration of financialization into commodity chains will be further deepened in order to close a gap in research.

In the context of commodity chain research, a lot of research on governance was conducted as mentioned above. But as Yeung and Coe (2015) stated, "in particular, more theoretical work is needed to explain how and why the diverse actors and varied strategies profiled above shape developmental outcomes at different geographic scales" (Yeung and Coe, 2015, p. 53). This means that the assumptions and findings of this research need to be further developed. How do these governance structures arise? What are the benefits of certain governance structures? And how are decisions made by chains of these so-called lead firms? The range of research literature is also very large for governance structures. But is it possible that governance structures are more complex than they initially appear? An additional benefit arises from the combination and the fusion of different approaches. As Bassens and van Meeteren (2015) stated "this is as much a project of bringing into dialogue already existing insights from various research communities interested in service industries, global production networks, financial geographies, knowledge geographies, and many more, as it is a matter of opening new lines of inquiry. The challenges, but also the potential answers, lie in bringing such insights together in one analytical framework. In practice, we need a more thorough understanding of the geographies and power relations embedded in the knowledge value chain […]" (Bassens and van Meeteren, 2015, p. 17).

The geography of finance has also become an important part of economic geography since the economic crisis. David Harvey's research can be cited as an important starting point and an impetus for the further development of research into the geography of finance. According to Harvey (2005), capitalism, driven by the urge to accumulate capital, must constantly maintain the circulation of capital. This requires an appropriate social and physical infrastructure. This reproduction of capital therefore requires new geographies and is therefore the basis for capitalism (Harvey, 2005, p. 102; Zademach, 2014, p. 7).

This processes of a so-called financialization changes the geographies at different levels. The financial crisis has also shown that financial activities always have a spatial link and thus influence geography. Through the real estate crisis in the USA "[…] one can observe the ways the production of space is both a driver for and an object of financialization processes. Though the geography of the finance crisis is still in a juvenile state, the urban perspectives allow us to outline some heterodox building blocks which might be helpful to get a better understanding of recent events" (Oßenbrügge, 2011, p. 374).

The above-mentioned circulation of capital takes place through strategic nodes in the financial industry. These nodes are globally connected with each other through a financial network. Capital and information flow through this global network and at the junctions financial products are developed, assets managed and bonds traded. European financial centers play an important role in the global network and are an important part of the global city system (Dörry and Musil, 2015, p. 10). Financial institutions, such as banks and insurance companies, play an important role in the creation of financial products circulating in the networks. At the spatial level, stock and securities markets are central locations where financial products such as equities, bonds and derivatives can be traded (Klagge and Dörry, 2015, p. 5).

As this development continues to change and to affect spatial structures, the analysis of these changes and shifts remains a very interesting field of research for geography. Thus, this dissertation can contribute to the current research discourse of geography of finance by analyzing the financialization of the wind industry. The governance of the wind industry is analyzed using the commodity chain approach. It examines which actors control the chain and have command and control functions. The analysis is more strongly placed in the discourse around the debate of financialization.

In summary, bringing together the commodity chain research, financialization discourses and the analysis of the wind industry is valuable and yields new insights. Hereby the governance of the wind industry is analyzed using the commodity chain approach that examines which actors control the chain and have command and control functions. Nevertheless, the analysis is more strongly placed in the discourse around the debate of financialization.

## 1.4 Research Outline

This dissertation focuses on the wind industry and financialization processes. The above-described questions and the derived key questions lead to the development of different thematic complexes. These are taken up in this dissertation, which has been written as a monograph, and edited in a total of 5 chapters.

For a better overview, figure 1 (p. 14) shows a schematic overview and the structure of the dissertation. In chapter 1 the research interest is explained, clarifying that the reason for asking the question is to determine whether a financialization of the German wind industry is occurring and the impact on the industry and its players. This question was embedded in the GCC research, which is composed of different analytical methods. Therefore, the key questions presented in chapter 1 are also based on the GCC analysis criteria and questions of the input-output structure, the governance and the institutional framework. These three question complexes are then analyzed, discussed and evaluated in chapter 4.

In chapter 2, the research question and the guiding questions are embedded in a theoretical context. This chapter explains why the multifaceted GCC approach is very suitable for answering the questions. Starting from the historical research context, it is shown which research streams the GCC has contributed to and which different discourses and readings the approach has gone through. After explaining how governance in commodity chains is to be interpreted and analyzed, the influence of governance on upgrading possibilities is shown.

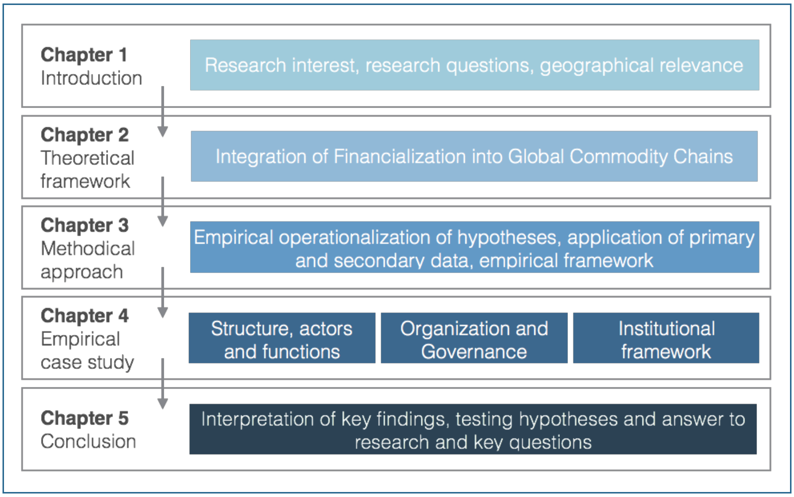


**Figure 1: Schematic overview of investigation (Own illustration)**

This is rounded off by the current status of commodity chain research and the identification of research gaps. The research gap focuses on financialization and the importance of financialization within commodity chain research. After the origins and perspectives of financialization have been explained, a connection between financialization and crises is established. Chapter 2 is rounded off by an evaluation of the theory and what added value the theory can contribute to answering the research questions and the key questions. Hypotheses are derived at the end of the chapter from the key questions, which are discussed in the following chapter 3.

Chapter 3, in which the methodology of the dissertation is explained and the empirical framework outlined, takes up the hypotheses and explains the methodological approach for testing the hypotheses. An operationalization is carried out. Each hypothesis is assigned certain indicators, which are explored and tested in chapter 4. The indicators are made up of certain data that must be regenerated for the most part. In this dissertation, primary data is generated by semi-structured interviews and expert surveys. Furthermore, chapter 3 explains how the interviewees are selected, how the guided interview questions are generated and how the interviews are transcribed and coded. In order to be able to verify the primary data, secondary data drawn from business reports, statistics, exchange data and fund databases is used. The chapter is rounded off by the explanation of the end product of the wind energy commodity chain and how exactly the German wind energy market can be demarcated as an empirical framework.

In chapter 4 the empirical investigation of financialization processes in the German wind industry takes place. Throughout the chapter, the questions of structure, governance and institutional frameworks are not analyzed separately, since they influence and depend on each other. In order to classify the events and processes, a historical embedding of the commodity chain and the development of the financial sector in the chain take place. This is followed by an explanation of how the chain is built up in the various processes and who are the actors of the wind industry. The product of wind energy is the result of the processes described up to this point. Furthermore, the chapter shows the value added by the various phases in the chain and how the different value added components affect the profitability of the produced wind energy. In order to better understand financialization in the context of the wind industry, it goes on to explain why the financial sector is involved in the GCC, how the development of the financial sector has been borne, and the role of the financial sector as a producer service firm in the commodity chain. This is used to analyze and assess the factors influencing the level of the investment, the time horizon investors are investing in, and how this can be affected by possible financial restructuring processes. At the end of chapter 4, the indicators for financialization derived from the hypotheses are reviewed and critically discussed.

The findings of the research are brought together in chapter 5. In the conclusion, the focus returns to the research questions and the hypotheses, clarifying whether the hypotheses can be verified or falsified. Finally, the answers to the key questions and thus to the research question can be derived. The dissertation closes with an outlook derived from the results and describes potential for further research.

# 2 Theory and State of Research

## 2.1 Global Commodity Chains

### 2.1.1 Definition of Different Commodity Chains

The world is in constant change. Globalization combines different shifts and processes in different areas e.g. economy, policy, culture, environment, and communication. These shifts are difficult to separate and influence each other. But globalization is "not merely the geographical extension of economic activity across national boundaries but also – and more importantly – the functional integration of such internationally dispersed activities. They reflect, therefore, essentially qualitative changes in the ways economic activities are organized" (Dicken, 2003, p. 12). To analyze this economic organization, one needs an analysis which reflects these changes in an international trading system, in which different actors are integrated in an increasing international and globalized economy.

The economic aspects of the globalizing processes are the primary focus of this research, but measuring and indicating economic globalization is difficult and depends highly on the various definitions. The geographer Dicken (2011) describes globalizing processes with an extensive geographical spread of economic activities and also a high degree of functional integration of economic activities (Dicken, 2011, p. 7).

Among the most important indicators to describe the globalizing processes are international trade and Foreign Direct Investments (FDI). As one can see in figure 2 (p. 17) international trade[4] and FDI have impressively increased in the last decades, which had and still have far-reaching consequences for policy and economy on a local and on a global scale. World trade, calculated as the sum of imports and exports, has increased and has more than doubled between 1960 and 2015 from almost 26 % to almost 58 % of the world Gross Domestic Product (GDP). The numbers in figure 2 show two important facts.

[4] The World Bank defines trade as "the sum of exports and imports of goods and services measured as a share of gross domestic product" (World Bank, 2016a).

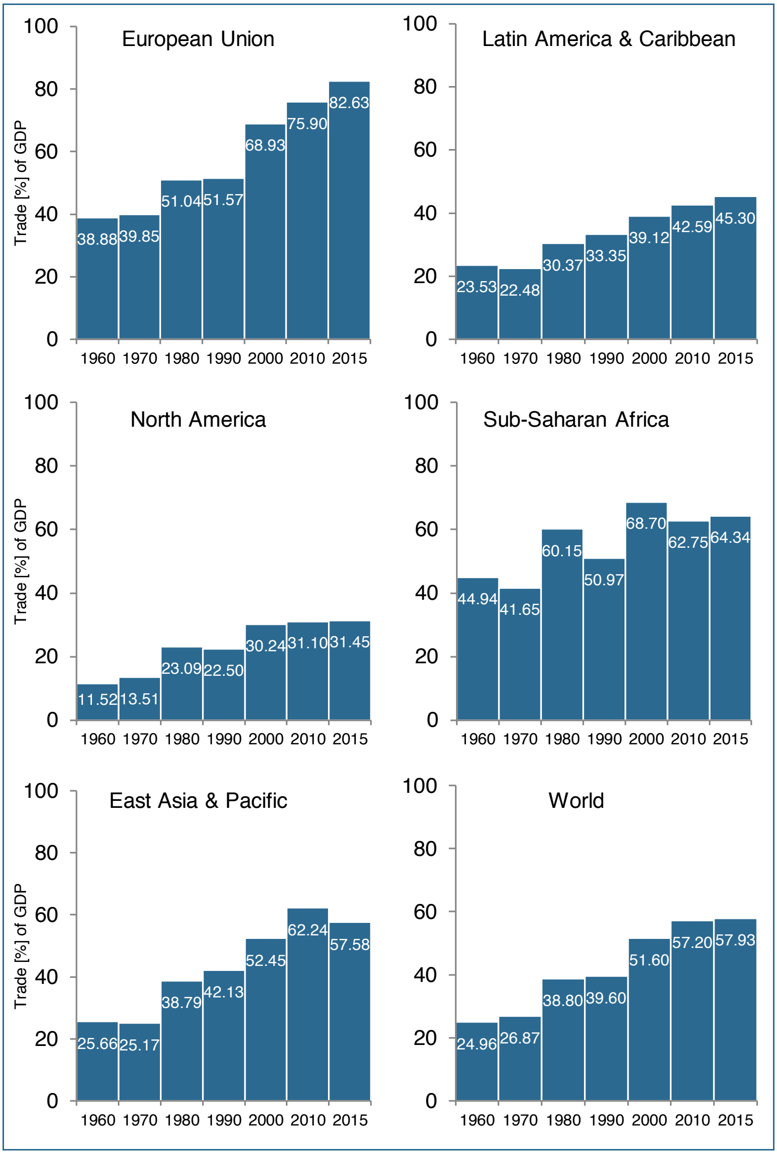


**Figure 2: Increasing global trade in selected regions, 1960 – 2015 (Own calculation based on World Bank, 2016a)**

First, the figure shows that international trade steadily increased worldwide since 1960. In all selected regions, an increase in the trade rate can be noticed. There are regions in fluctuation, such as Sub-Saharan Africa, but trade as a percentage of the GDP has increased in the period from 1960 to 2015. Second, the figure clearly demonstrates that the development of trade differs from region to region. There are some regions which participate more in trade in the global economy, measured by the trade share of the GDP, than other regions. With over 80 %, the European Union had a very high trade share in 2015. In contrast, North America has a relatively low trade rate of 31 % of its GDP. However, North America records the highest increase of the GDP's trade share with 173 %. With growth of only 43 % over the same period, the region of Sub-Saharan Africa has the lowest growth rate among the selected regions. Comparing the relatively high trading volume of the EU with the trading volume of in North America, it must be mentioned that there are 28 member states in the EU trading with each other, while in North America the only the USA and Canada are trading with each other.

This increase of trade and investment was possible through a new organization and production structure of goods and services. Within this new structure the different production steps are separated and globally divided. Products and services result from a so-called commodity chain (CC).

The origins of commodity chain research lead back to the world-systems theory, which examines the relationships between societies and the resulting changes. In 1977 Hopkins and Wallerstein, representatives of the world-systems theory, initially used the term commodity chain (Fischer and Reiner, 2010, p. 12). The concept of commodity chains was further elaborated and a clean definition was developed by Hopkins and Wallerstein (1986). They defined a commodity chain as "a network of labor and production processes whose end result is a finished commodity" (Hopkins and Wallerstein, 1986, p. 159). Thereby the commodity chain represents the stages of production as an ordered sequence of activities. These activities create value, consume resources and are connected with each other in processes.

This commodity chain approach has been further developed. In 1994 Gereffi and Korzeniewicz developed the Global Commodity Chain

(GCC) approach for analyzing the organization of the global economy in their publication "Commodity Chains and Global Capitalism". The commodity chain approach of the world-system theory has been transferred into an increasing economic integration of international production, international trading and international division of labor. The need to analyze new patterns of organization and change on a global scale leaded to a reformulation of the previous concept (Gereffi and Korzeniewicz, 1994, p. 1). According to Gereffi and Korzeniewicz "a GCC consists of sets of interorganizational networks clustered around one commodity or product, linking households, enterprises, and states to one another within world-economy. These networks are situationally specific, socially constructed, and locally integrated, underscoring the social embeddedness of economic organization“ (Gereffi and Korzeniewicz, 1994, p. 2). It has to be mentioned that in this course of development process a paradigm shift occurs: While "[…] world-system theorists are most fundamentally interested in how commodity chains structure and reproduce a stratified and hierarchical world-system […] GCC researchers understand commodity chains as sets of inter-firm networks which connect manufacturers, suppliers and subcontractors in global industries to each other, and ultimately to international markets, and they are principally concerned with the question of how participation in commodity chains can facilitate industrial upgrading for developing country exporters" (Bair, 2005, p. 156).

In 2000 a conceptual modification of the GCC approach emerged from a research workshop. Gereffi (2001) and other research colleagues established a another terminology to cover the variety of research approaches in a common research framework (Gereffi et al., 2001). The research workshop suggested the usage of the term Global Value Chain (GVC) and explained the need for new terminology with a more specific and application-oriented analyze of chain governance within the GVC approach. In contrast to GCC research, with its research focus on "inter-firm networks in global industries", GVC examines the "sectoral logics of global industries" (Bair, 2005, p. 160). GVC researchers argue that field analysis has shown that in reality there are a large variety of different organizational structures. Inspired by international business scholars,

the aim is to order these different forms of industrial networks to use the findings for strategies of firms and countries (Gereffi et al., 2005, p.79).
Finally, the framework of chain research a further branch of chain research has to be introduced. The reason for developing the so-called Global Production Network (GPN) approach was the negligence of the spatial dimension by the existing GCC and GVC approaches (Fischer and Reiner, 2010, p. 15).
The research approach of GPN is that the firms around a commodity are not organized in linear structures but are organized in an extensive network. The research focus shifted from the governance of inter-firm transactions in the GCC and GVC research to focusing on capturing all different actors of a commodity and their relationship to each other in the GPN research (Coe et al., 2008, p. 3).
The objective of GPN research is to outline "a conceptual framework for mapping and analyzing certain aspects of economic globalization – those related to production and consumption – and their developmental consequences. […] the global production network is an explicit attempt to break with state-centric conceptualizations on the one hand and significantly extend the analytic and policy utility of cognate formulations on the other" (Henderson et al., 2002, p. 458).
There are various reasons to research specific commodity chains. The aim of this research is compliant with Bair's (2005) understanding of GCC research, namely the aim is to "understand where, how and by whom is value created and distributed along a commodity chain" (Bair, 2005, p. 157). This breakdown of commodity chains allows commodity chain researchers to analyze the different production steps to define the winners and losers of the global division of labor. With this development from breaking down the chain to defining actors who benefit from the interconnection, chain research receives also an evaluating position which is linked to modernization and dependency theories. Hence commodity research is interdisciplinary and relevant for various sciences. Besides geography, economic sciences, sociology and development studies use this approach. International organizations such as the WTO, the OECD or the World Bank also use the commodity chain approach to

explain the effects of global economic shifts and to give policy recommendations and advice (OECD et al., 2014).
From a scientific point of view GCC research can be described by its three main characteristics: (1) identifying the chain's organization and structure with its driving factors also-called lead firms, (2) analyzing the chain's governance which has consequences for the profit distribution along the chain, which leads to the last main characteristic (3) determination of reasons for movements within the chain, from low to high but also from high to low value added activities (Lee, 2010, p. 2988).
The research view should be placed on the analysis of the wind energy commodity chain. A Global Commodity Chain consists of series of cross-organizational networks that are grouped around a commodity or product. They link households, companies and states within the global economy. These networks are situation-specific, social and in the respective local context anchored constructs (Gereffi and Korzeniewicz, 1994, p. 2). In general, the institutional context such as policy plays an important role. Specifically, fiscal policies such as the setting of interest rates or the compensation system for renewable energy, which was previously regulated by the Ministry of Environment and nowadays by the Ministry of Economics. These conditions and rules of play have certain influences on the chain. The chain must accept these basic conditions, adapt to the structure, and the actors position themselves within the framework of opportunities within the chain. Certain governance structures arise which have an impact on the vertical integration and disintegration of the production and distribution processes of the chain.
When analyzing this power structure within the chain, governance is paramount. This analysis of the governance of the wind energy commodity chain is the motivation to resolve the research questions; who controls this chain and who influences other actors within the chain?
The question is, how do certain governance structures arise? How does one particular governance structure emerge, and not a completely different governance structure? Who controls this process of governance development? And who can take advantage of the external influences to ensure that they are higher in the governance structure than others? And who controls the chain?

Could the financial sector be seen as a powerful actor in the governance structure, and so financialization processes may be seen as having power in the chain? The conceptual differences between the GCC, GVC and the GPN approaches are of less importance to address these questions, and thus are of less importance in this work. Thus, these approaches are understood as a common unified theoretical concept of commodity chain research[5].

### 2.1.2 Governance

In answering the research question, governance plays a central role. Governance is a key element and defines how a commodity chain is structured, how it works and how it will develop in the future. Commodity chain research can focus on four key dimensions: (1) Input-output structure, (2) Territoriality, (3) Governance and (4) Institutional context (Gereffi, 1994, p. 97; 1995, p. 113). In commodity chain research, the governance dimension is the center of attention. But why does governance play such an important role in chain commodity chain research? In order to understand how governance is defined in this dissertation, and what contribution the analysis of governance can make to the research question, an overview of the different analytical procedures and approaches to governance will be given. This is followed by an establishment of governance within the context of the presented research context and the research interest.

Since the beginning of commodity chain research, the question of development – and especially unequal development – determined the research focus and positioning. Derived from the world-systems theory, it exists an unequal spatial distribution of work processes. The different work processes have a different share of the product chain and therefore also benefit differently from participation. All these work processes are connected with each other through a commodity chain. The commodity chain approach analyzes how the commodity chain is structured and how, as a consequence, a hierarchical division of labor is produced. How

[5] In the following the terms of GCC, GVC and GPN are used synonymously. However usually the terms commodity chain or Global Commodity Chain are used.

these commodity chains are governed impacts the development and upgrading opportunities[6] for firms and also for whole regions. Particularly from a development perspective, governance analysis is important because the understanding of the governance structures of a commodity chain can show specific upgrading possibilities. Thus, governance research can provide answers to the following questions: Who is controlling the chain? What is the reason for this power? Who can define the chain rules and who can how enforce industrial standards? What are the consequences of these governance structures and who are the winners and losers of the commodity chain? These questions are direct related to the main research questions and the hypotheses[7] of this dissertation. To answer the research questions regarding whether financialization processes exist in the wind energy commodity chain and to verify or falsify the hypotheses, this chapter adapts the existing governance research of commodity chain research and selects the approaches which help to clarify the aforementioned research questions (see chapter 1.2, p. 4).

Already Wallerstein (1984) detected that commodity chains are centripetal. The chains tend to move from the periphery to the centers of the capitalist economy. During the development of the historical capitalism, Wallerstein (1984) describes both functional and geographical levels, which see an increase in chain hierarchism. This chain hierarchism has led to a different distribution of capital accumulation, which divides the world economy between centers and peripheries (Wallerstein, 1984, p. 30). This capital accumulation in the centers results from the division of labor and the geographical distribution of commodity chains, which are controlled by their governance.

But why it is important to deal with governance in commodity chains? Commodity chains are not just simple strings where simple economic relations exist between companies. Commodity chains form a complex network with different actors. There are different kinds of relationships between the different actors and companies. These interactions between the actors do not happen randomly and arbitrarily in the context of a

[6] In chapter 2.1.3 (p. 28) the upgrading possibilities within commodity chains will be further discussed and analyzed.
[7] All research questions and hypotheses are presented in chapter 2.4 (p. 60).

system. In this dissertation, it is assumed that the wind energy commodity chain is not a random array of companies but a system that works according to certain rules and which is controlled by a specific logic. "In short, governance refers to the inter-firm relationships and institutional mechanisms through which non-market coordination of activities in the chain is achieved" (Humphrey and Schmitz, 2001, p. 5).

The questions that play a central role in the commodity chain research, and especially in the analysis of their governance structures, are related to the different control functions within the chain. Who controls the chain, how and with what kind of resources? Who has what kind of power and why do some companies or sectors wield more power than others? Have certain players more power than others? Who can define the rules and thus determine certain standards that other actors have to enforce? What are the consequences for the less powerful companies in the commodity chain? And how does this control logic work in the chain?

To answer these questions, different analytical approaches of commodity chain researchers have been developed. Derived from the world-system theory, it is assumed that from the center lead firms dominate and control the production companies on the periphery, even without ownership of production facilities. Globalization has created two different types of commodity chains, which differ in their structural processes. The types are called producer-driven and byer-driven commodity chain[8] (Gereffi and Korzeniewicz, 1994, p. 97).

In a Producer-Driven Commodity Chain (PDCC) the whole chain is coordinated and controlled by large manufacturers, usually transnational orientated. Typically, economic sectors for PDCC are the automobile or aircraft industry and other industry sectors which are capital and technology intensive (Gereffi, 1999a, p. 9). In general, workers are skilled. Examples of such companies are General Motors or IBM (Ponte and Sturgeon, 2014, p. 201). These chains are characterized by strong and dominant producer firms, which have the ownership of a specific product and determine the production processes of the subsidiaries and the subcon-

[8] Since further research will focus on the differentiation of these types and the question of which type is present in the German wind industry, the different types are explained in more detail below.

tractors. These subsidiaries or subcontractors only provide components and no finished products. This influence occurs within the definition of the production parameters such as how the product looks, the process parameters, how the product is produced and which materials are used, and logistic parameters such as where the product is produced and how the components and products are transferred to the other stations in the chain. The last, and perhaps the most important influence factor is the influence of profit distribution. The controlling element of capital at PDCC is seen on an industrial level (Coe et al., 2013, p. 236).

In contrast to PDCC, Buyer-Driven Commodity Chains (BDCC) are those in which large retailers, marketers or branded manufacturers play the central roles in coordinating the whole commodity chain. BDCC are controlled from the other end of the chain. In a PDCC the controlling company sits at the beginning of the commodity chain. In contrast, in a BDCC the controlling company sits at the end of the chain, and thus closer to the end user. A typical example of such a chain is the textile industry, or the consumer electronics industry. Examples of such companies include Nike, Nestlé, Kraft and Wal-Mart (Ponte and Sturgeon, 2014, p. 201). These chains are characterized by low-skilled workers and are less technological and capital intensive. Large transnational retailers sell their products directly to end users and consumers. The research and development, design and marketing are executed by the lead firms, which are at the end of the chain. Thus, they can influence the suppliers regarding products, production, logistic and profit distribution in BDCC, just like in PDCC. Unlike in PDCC the suppliers provide finished products at BDCC. In BDCC the controlling element of capital can be seen at a commercial level (Coe et al., 2013, p. 236).

If this method is adopted to analyze the wind energy commodity chain in Germany, the result would show at first glance that the German wind industry is a PDCC. The wind turbine manufacturers in Germany are large and mostly transnational manufacturing companies. The largest share of the wind energy value is attributable to the production, construction and installation of the wind energy turbine with almost 80 % (Hau, 2014, p. 893). The cost of installing a 3 MW turbine amounts to more than EUR 4 million (Hau, 2014, p. 893). Thus, the wind industry is both very capital-intensive and technology-intensive, which is typical for PDCC. Whether the manufacturers, as with PDCC, also influence the suppliers and customers, such as investors and project developers, has to be clarified in the empirical analysis. However, it can be noted that the specific entry barriers in the wind industry lie in the necessary comprehensive and technology-intensive investments in the production sphere. For this reason, the manufacturers of Wind Turbine Generators (WTG) are major industrial companies and the core actors in the commodity chain. In summary, it can be said that if the governance approaches of Gereffi are applied to the German wind industry, this is a PDCC governance structure. However, this approach does not go far enough. Without a doubt, manufacturers of wind turbines are very distinctive for the German wind industry, and they determine the image one sees when examining this industry. However, governance processes are more complex and complicated than they seem at first glance. Therefore, this dissertation looks behind the scenes of this supposed PDCC structure and precisely analyzes which actors in reality prescribe the rules and control the chain or influence companies which are taking the decisions.

It should be noted that the definition of BDCC and PDCC is an older approach to analyze governance. “To sum up, the buyer- and producer-driven GCC typology was based on a static, empirically situated view of technology and barriers to entry, but both are dynamic because of technological change and firm- and industry-level learning (Gibbon and Ponte, 2005; Henderson et al., 2002). [...] [Thus] two things became clear: 1) there was a clear shift away from the vertically integrated, producer-driven variant in a range of industries, and 2) the buyer-driven type could not characterize all of the network types being observed in the field” (Sturgeon, 2009, p. 9).

In 2001 Humphrey and Schmitz defined which different forms the control of the commodity chains can assume. On the one hand, the so-called lead firms, which control the chain, can determine the commodity chain and what is produced within the chain. This is called a product definition. Furthermore, the lead firms have an immediate influence on how the product is produced. This can refer to the production processes, the technology used or certain requirements for standards for example. In addition, a means of control for the lead firms is the determination of when the product can be produced and in what amounts. The final factor, and perhaps the most dominant factor in the chain control is the definition of the price. A key question – which must be clarified – is whether the price can be determined by the open market, or whether the price is determined by actors of the chain, where companies can dictate the prices to other companies in the chain (Humphrey and Schmitz, 2001, p. 5). In the context of the research question, however, this definition of the so-called lead firms is too narrow. Thus, governance must be defined more precisely in this context.

Today's research discourse is using newer concepts for analyzing governance because in reality, governance structures are more complex than only two types of governance forms. Thus, in 2005 the researchers Gereffi, Humphrey and Sturgeon presented a broader concept of governance structures. They identified three variables to determine the governance structure and transactions costs. The variables are “(1) the complexity of transactions, (2) the ability to codify transactions, and (3) the capabilities in the supply-base” (Gereffi et al., 2005, p. 78). The combination of these variables results in different governance structures. The market determines the lowest level of explicit coordination and power asymmetry. The highest governance structure is the hierarchy. Between these two there are other governance forms as modular, relational and captive, ranging from a low to a high level of explicit coordination and power asymmetry.

This detailed classification is very suitable for analysis on a micro level, particularly when the commodity chain is analyzed focusing on governance and coordination structures of lead firms and their suppliers. This classification offers the opportunity to describe each relationship between two actors within chains with many actors, and to examine how the power is defined and how the price is determined of the transaction between the two actors. This approach allows researchers to analyze a chain and to define if the governance structure between these actors take place on base of on the so-called governance form of market, modular, relational, captive or hierarchy. A very good example of such analysis is that of Dolan and Humphrey (2004), who analyzed the governance struc-

tures of the fresh vegetable commodity chain from Kenya and Zimbabwe to Europe (Dolan and Humphrey, 2004).
Also important is corporate governance. In order to analyze the impact of corporate governance on the markets, and thus also on the chain, it is necessary to distinguish between two different types of corporate governance. “One is characterized by dispersed ownership and an arm’s-length relationship between managers and owners – an open system, such as that which prevails in the United Kingdom and Ireland. The main features of the other system, the closed one that prevails in continental Europe, are concentrated ownership and cross-shareholdings between related firms (Becht and Röell, 1999; La Porta et al., 1999)“ (Clark and Wójcik, 2003, p. 914).
Corporate governance has a significant impact on the markets, through shares in the stock exchange. For example, a correlation between corporate governance and stock price volatility is noticeable. The effects that result from this are dependent on the information flow. In an ideal system, all information would be freely accessible to everyone, but in a closed system the information is available only in the management of a company and the dominant holders of voting rights. Thus, outsiders do not have the opportunity to participate fully with the existing information (Clark and Wójcik, 2003, p. 914).
But these corporate governance forms are changing. They are also changing in Germany and thus also in the German wind industry. The impetus of these changes are financial institutions because “[…] financial institutions have sought to transform the regional-national-global scale of corporate governance and all that means for the distinctive manner in which German regional and national systems of governance have been sustained over the past fifty years” (Clark and Wójcik, 2003, p. 921).
But all the above presented approaches to the analysis of governance do not go far enough. They do not penetrate deeply enough into the decision making processes of companies, do not explain how strategic decisions are made or how recommendations for action arise. Therefore, a detailed way of looking at governance in commodity chains is required.
In this dissertation, it is not the aim to explore how the financial sector coordinates the wind industry on an industrial level. Instead, the aim is to

analyze if the financial sector influences the wind industry and if the financial sector influences the lead firms that decide who, how and where certain wind parks are planned, built and operated, regardless of the coordination of the relationship of the actors to each other. Thus, when analyzing governance, one must to distinguish between understanding governance as so-called driveness or as coordination.

“In the GCC framework, governance describes the power relations between actors that shape the flow of tasks and the distribution of costs and profits along the chain. Within any two chains of the same type the specific coordination of activities might be handled differently“ (Bair, 2008, p. 26). This is also reflected in the research question. But why is the question of the governance structure significant, and from where does this power structures derive? Perhaps the most important answers to the question of this work can be provided by the governance analysis in two areas. Firstly, governance is a relationship between different actors. Hereby, some actors have power over others. This power can have such an effect that some actors control which single actors or entire groups of actors get market access to the commodity chain and who does not. This means that there are lead firms in the commodity chain that decide whether other companies and stakeholders participate. On the other hand, governance of a chain defines the distribution of gains. This means that lead firms not only control the chain by their power, but also whether other companies participate in a chain and to what extent.

But where does this power come from and what is the origin of this power? The source of this power and the resulting power relations and structures can be summarized as follows: “As in all bargaining situations, the relative power of actors within a network depends, in large part, on the extent to which each possesses assets sought by the other party and the extent to which access to such assets can be controlled. The scarcer the asset the greater the bargaining power it conveys and vice versa“ (Coe et al., 2008, p. 276).

Thus, if certain governance structures exist in a chain and certain companies in this chain control this chain through governance, the question must be asked how decision making processes work in these companies and what influences them. The exclusion of the question of decision making is also the reason why financialization has played a subordinate role in the chain research. In GCC/GVC research the governance focus lay on "[…] the mechanisms involved in coordinating activities across the chain, and power relations influencing the distribution of income within the chain (Gereffi, 1994; Palpacuer, 2000; Gibbon and Ponte, 2005). The growing conceptual sophistication of GVC analysis in the early 2000s focused on technical and economic aspects of governance, overlooking changes of a more political nature in value allocation within the chain" (Palpacuer, 2008, p. 9). However, the literature on corporate governance is similarly interested in the system that "shape investment decisions in corporations, what type of investments they make, and how returns from investment are distributed (O'Sullivan, 2000, p. 1)" (Palpacuer, 2008, p. 14).

These leads to the conclusion that one has to shift the focus of governance to the decision making process. Here the focus regarding governance lies also on the advanced producer service (APS) firms. So, further research has to be clarify which influence the APS companies have on the commodity chain. Do APS firms have an advisory role or do they actively guide the business decisions of companies? At the forefront of this governance, therefore, are financial firms, which are linked to one another in the world cities network and which drive financialization forward and accelerate these processes. The power that unfolds in governance structures is defined as influence, which establishes itself on an economic, political and cultural level. "It is something made and remade rather than structural and independent from anyone's will, underpinned by the position of the APS at the center of the circuits of capital" (Wójcik, 2013, p. 339; Allen, 2009).

However, this influence of APS firms on companies is controlled by the institutional context. This means transactions and business are carried out according to certain rules and are subject to jurisdictions and laws, including tax laws. This has a special significance. Since it is always a question of businesses becoming more profitable, the focus is not only to optimize business processes in order to generate profits, but also to optimize profits. This leads, for example, to an optimization of tax issues. APS is particularly important in this respect. The APS firms are linked to each other and thus create a knowledge transfer between themselves. Through their accumulated knowledge, they can create new products in order to avoid taxes and thus optimize the profits of their clients. This knowledge allows the APS a significant power. This "[…] considerable power, which they exercise in a large measure by operating legal, accounting and financial vehicles designed partly to escape the control of governmental or intergovernmental organizations through the use of offshore jurisdictions" (Wójcik, 2013, p. 331).

These offshore jurisdictions are particularly important in times of globalization and ever-growing trade. While assets can be traded directly, products such as derivatives and securities take this to a new level. Derivatives and securities can be purchased and sold directly without a change in ownership. Shares may also be traded on the stock exchange without affecting the structure of the actual assets and the invested capital of that company (Wójcik, 2013, p. 332). The profits generated from these transactions can be settled without any problem by means of offshore jurisdictions. Since these cash flows flow through the offshore jurisdictions, there is no governance in this area, which affects the APS firms and the capital flows.

As a result of the rise in these financial services and financial products, companies are being increasingly financialized. This creates a governance which is predominantly driven by financial motives. The example of General Electric (GE), which among other business activities is one of the largest wind turbine manufacturers in the world, shows how strongly business of companies can change. While in the 1980s financial services played a negligible role in the GE group, financial services grew during the 2000s to such an extent that they accounted for almost half of GE's total turnover (Froud et al., 2006; Wójcik, 2013, p. 334).

However, APS firms are not the only actors playing governance function in these processes. The services are also supported and strengthened by "[…] banks, insurance companies, credit rating agencies, asset management companies, pension funds and other financial institutions" (Coe et al., 2014, p. 763). As a result, the network grows ever larger and extends into the real economy. It comes to financialization, which changes governance the governance structures. Financialization in this context can be understood as a process through which the financial sector and financial markets come to assume a dominant position within the wider economy and society. "[…] [F]inancialization speaks to the ways in which TNCs and wider GPNs are increasingly controlled, monitored and disciplined through financial markets via notions such as shareholder value, calculations of risk, and market perception of mergers and acquisitions" (Coe et al., 2014, p. 767).

But what role do service providers play, such as rating agencies in corporate governance? These service providers create certain standards to make different companies comparable. "Rating agencies do not put direct pressure on rated companies to change corporate governance practices, but their customers and particularly institutional investors do. Indeed, there is evidence of institutional investors exercising such power" (Wójcik, 2006, p. 655). But the creation of standards goes beyond rating agencies. For example, one "[…] can think of the role of law, accountancy and audit firms providing companies with services related to corporate governance. It is unlikely that these service providers apply entirely different standards to large as opposed to smaller firms. Audit requirements apply to tens of thousands of European firms, not only the publicly traded ones, and the Big Four companies increasingly dominate the market for audit services" (Wójcik, 2006, p. 655). This means that these service providers have an enormous potential to influence corporate governance of a company. If one takes this idea further, one comes to the conclusion that this influence also drives the decisions of companies, which in turn influence the commodity chain.

Finally, the question is which governance definition is the right one to answer the research question. Although Gereffi's definition of governance is already older, it covers and describes all the forms of governance mentioned above. The definition establishes a link between aforementioned governance, which takes place at a chain level, and the governance which takes place at a firm-level. This connection can be achieved by the following in so far as Gereffi defined GCC governance as "authority and power relationships that determine how financial, material, and human resources are allocated and flow within a chain" (Gereffi, 1994, p. 97). The dissertation wants to take up this governance definition and find out how it comes to the authority and power relations within the wind energy commodity chain.

### 2.1.3 Upgrading

A commodity chain can not to be seen as a fixed construct. Changes inside the chain can be caused by the actors, but also by external factors like market fluctuations or political changes to the basic conditions. Single actors can move upwards or downwards within the chain. This means if companies and actors profit more from the chain, this process is called upgrading in the GCC research. Conversely, if companies descend in the hierarchy and profit less from the chain, a so-called downgrading occurs. The origin of analyzing these changes comes from the research direction from development studies and the dependency theory. One assumes that certain dependencies occur between industrialized nations (the centers) and developing countries (the periphery). Dependency theory states that the dependencies do not result from endogenous factors such as lack of capital or missing modernization, but that it results from external factors which permanently assign the developing countries a subordinated position in the world economy. This is driven by a stronger and steadily growing integration of countries in worldwide operating markets. This growing integration also generates a growing pressure which oppresses the periphery countries with their lower work processes. "For producers to maintain or increase incomes in the face of this pressure, they must either increase the skill content of their activities and / or move into market niches which have entry barriers and are therefore insulated to some extent from these pressures. We refer to such shifts in activities as upgrading" (Humphrey and Schmitz, 2002, p. 3). In this case the centers control the chain and in the periphery, the demands of the centers are implemented. Development studies try in this context to indicate options and political action recommendations in a way that these countries can optimize their participation in the commodity chains in the peripheries. This would lead to an upgrading in their function and participation in the chain and the countries or companies can increase therefore their benefit. Taking these assumptions into account, the question arises whether the situation caused by this unequal integration in the world economy is

getting better or worse. An improvement would mean that the integration in the world trade from less developed countries would increase.
It has to be mentioned that the success of such an integration and are rather modest. Thus, an investigation was carried out by the UNCTAD from 2000 to 2005, focusing on 24 commodity chains which are an important source for foreign currency income by export for certain countries. The research investigated whether the enterprises in the least developed countries could succeed in upgrading during this period. The results of the study prove that upgrading was possible in just seven of the 24 examined commodity chains. In 12 chains a downgrading took place, meaning the situation worsened (Fischer and Reiner, 2012, p. 34; UNCTAD 2007, p. 26). This criticism of upgrading processes is independent of which approach of commodity chain research was chosen, especially the GCC and the GVC approach. "There is vigorous debate and substantial disagreement among academic researchers and policy-makers alike about the extent to which participation in GCCs can promote positive development outcomes" (Bair, 2014, p. 30).
But how is this downgrading and upgrading controlled, which factors of financialization processes cause chain positions to change? It is argued and believed that governance is crucial in these developments questions. This implies that if structures, actors, products, the risk relationship and the handling of speculation within a commodity chain are changing due to financialization processes, the governance structures are also changing. Hereby the so-called lead firms of a commodity chain can determine the upgrading opportunities of each participating actors of the chain. "This produces an emphasis on relationships between suppliers and buyers within a chain irrespective of where they are located, and a corresponding deemphasize on linkages within the locality" (Humphrey and Schmitz, 2002, p. 5).
Four different forms of upgrading can be identified. There is process upgrading, product upgrading, functional upgrading and chain or intersectoral upgrading (Humphrey and Schmitz, 2002, p. 6). With (1) process upgrading, a company improves the efficiency of a production system. For example, a manufacturer of a wind turbine generator (WTG) can be mentioned. This WTG manufacturer can produce in his manufac-

turing halls five turbines per day. Due to higher demands, the WTG manufacturer would like to raise the output of five turbines per day. The manufacturer changes his production rails and uses new automated production engineering that the manufacturer can produce now six turbines per day. This upgrading process leads to a higher output of 20 %.

The second form of upgrading in commodity chains is (2) product upgrading. This means that firms move into sectors where they can produce more advanced products or services. Thereby the product's quality will be improved, and thus the value to the consumer also increases. For example, a blade manufacturer supplies the wind turbine manufacturer. Due to research and development the blade manufacturer can now produce the blade in the same shape and with the same stability, but with less material. Thereby, the blade is much lighter and has many advantages for the wind turbine manufacturer, which then assembles the components. With a lighter blade, a higher production of electricity is possible and the tower can be designed for lower loads, which generates a value added for the WTG manufacturer who sells the turbines to its customers. The blade manufacturer wants to charge the WTG for these advantages and the value added. In order to remain competitive in the market, it is constantly necessary to conduct product upgrades which helps to withstand the development trends and keep up with the ever-increasing standards.

A third option for upgrading and to ascend in the commodity chain is (3) functional upgrading. Hereby a company takes a new role and thus exercises a new function in the chain at a higher level than the previous position. This has the consequence that in this process more value can be added. As an example, the following situation can serve for the explanation. Generally, project developers plan and build wind parks. This is the core business of the project developer. If the decision is taken by the project developer to also operate the park and take over the commercial and technical management the wind park after the planning and building is complete, this would be a functional upgrading of its original activity. The developer thus expands his offer range of services. Thus, the project developer can create value and generate benefit for himself also in other parts of the commodity chain.

The last form of upgrading form is referred to as (4) chain or inter-sectoral upgrading. Here, the knowledge and experience that has been generated in a special chain can be used and applied in another completely new commodity chain. The acquired knowledge in the old chain can be applied to the production processes of new products in the new chain or to another specialized service. For example, planning companies in the wind industry have built knowledge and experience in this field through years of planning wind parks. This planning experience could be used for planning in another sector, such as the solar industry or the grid and network industry. Thus, the planning companies from the wind industry could use their knowledge in the wind industry in the other chain through a chain or inter-sectoral upgrading by applying the knowledge in the solar industry or the grid and network industry.

It should be noted that only companies and enterprises are upgrading. This can also have positive effects for regions or countries where these firms are based, and on the people who work at these companies. However, this is not necessarily a causal relationship. Upgrading of companies does not forcibly lead to social upgrading or automatically improve working conditions.

The importance of upgrade potential arises from the assumption that the upgrade potentials are controlled by the lead firms. So, if companies from the financial sector are identified as service providers who influence the lead firms' strategic decisions in the German wind industry, this would mean that the financial sector possibly controls the commodity chain and also could possibly decide which players of the chain can upgrade or which players have to downgrade. Financial services providers for example could establish certain standards and define the rules what and how the other actors in the chain have to produce. These regulations have an enormous impact on the development and upgrading possibilities of these actors. Thus, financial service providers would not only define which actors receive upgrading potentials but also determine how these upgrading processes have to take place. Thus, the empirical analysis of this dissertation has to clarify whether the above assumption can be affirmed. Furthermore, it is important to analyze whether the control function of the lead firms is uniformly distributed on all upgrade options or whether certain upgrade options are more affected by lead firms than others.

### 2.1.4 Current Status of Commodity Chain Research

Commodity chains are linked to complex processes of globalization. Assuming that labor-intensive production processes are outsourced by industrial countries and taken over from developing or emerging countries, it is the aim of commodity chain research to analyze the organization and relationships within the chain. With a growing division of labor and higher outsourcing of work processes and steps, further coordination of the chain is necessary. This results in another objective of chain research, namely the analysis of this coordination. How are the relations between the actors organized and who controls these processes, who sets which standards and establishes different quality requirements?

Research regarding commodity chains is bountiful. The commodity chains and the resulting trade relations between countries and companies have already been analyzed based on different products and goods, with analysis carried out according to the theoretical concepts of GCC, GVC and GPN.

Commodity chain research often visualizes the production of goods, the production organization, the various forms of work and resulting living conditions of people in different places, where this chain is situated, and to identify problems. This visualization is a great benefit of this chain research. Chain research makes the changing geography of global value visible and adds a spatial dimension to the inequality, but also to the development opportunities (Fischer and Reiner, 2012, p. 43).

The analysis and results of the chain research have already been continuously extended by many empirical studies. In the following an excerpt[9] from these studies is shown. For example the production and trade of agricultural products has been analyzed in the context of the commodi-

[9] To present an all-encompassing excerpt from the commodity chain research would go beyond the scope of this work and could never guarantee completeness since the research field is interdisciplinary and widespread. The following examples are intended to give an idea of which products have already been analyzed and which product areas they originate from.

ties of coffee (Fitter and Kaplinksy, 2001), cocoa and tea (Talbot, 2002), fresh vegetables (Dolan and Humphrey, 2000, 2004), wine (Gwynne, 2006), cut flowers (Hughes, 2001) and salmon (Phyne and Mansilla, 2003).

Industries for industrial or commercial products have also been analyzed by commodity chain researchers. The focus industries include the electronic industry (Kenney and Florida, 1994), the automotive industry (Sturgeon et al., 2008), the clothing industry (Palpacuer et al., 2005), the footwear industry (Schmitz and Knorringa, 2000), the apparel industry (Bair and Gereffi, 2003; Gereffi, 1999b; Gereffi and Frederick, 2010; Gereffi and Memedovic, 2003), the Peruvian industry for mining equipment (Bamber et al., 2016), the industry for carbon-reducing technologies as for example LED lighting, auxiliary power units and solar power (Gereffi et al., 2008) or the wind energy industry (Ayee et al., 2009).

Recent studies have focused not only on products but also on services. Examples for these services are software engineering (Dossani and Kenney, 2007), financial services (Milberg, 2008), tourism (Dörry, 2008), recycling (Crang et al., 2013) and producer services as consultancy, legal services, accountancy, finance and insurance (Parnreiter, 2015).

Referring to the subject of this dissertation, the focus should be put on the research analysis of the wind energy as a commodity. According to present knowledge the research work "Manufacturing Climate Solutions", which was prepared on behalf of the Environmental Defense Fund and published in 2008 (Gereffi et al., 2008) is, along with the chapter extension "Wind Power: Generating Electricity and Employment" (Ayee et al., 2009), one of the few published commodity chain research that focuses on the wind industry. The geographical research focus of this work is the US American wind industry. The theoretical framework is based on the GVC approach and defines the manufactured wind turbine as the final product of the chain. This implies that the chain is divided into five main processes of materials, components, manufacture, logistic and operations and as the final process end use. All these processes are accompanied through the whole chain by a sixth process of research and development. As a wind turbine consists of an estimated 8,000 parts, the researchers make excellent work by breaking down all different materials, and following how materials are transformed into components. The components are manufactured by the turbine manufactures. The geographic distribution of the representative wind turbine manufacturers in the US is also shown. The wind turbine and their components and materials are paramount. But important services such as project developing, technical and commercial management, financing are currently no significant driver in this chain analysis.

Leaving these players out of consideration and attaching no importance to them, a different result is obtained. One aim of this study is to explain the influence of the wind industry on the labor market. The analysis can also show how many jobs are created in which areas and which manufacturers and where in US produce the turbines, which has an impact on local employment.

However, the study does not go far enough. If the impact on the labor market shall be represented, it is of great importance to question, who, for example, decides in a project, which wind turbine shall be planned. The decision-maker can also choose a turbine that is not manufactured in the US. Therefore, no local jobs would depend on this turbine. It is therefore important to go one step further and to better investigate the question of control of the chain. Hereby, it is not enough to limit it only to the manufacturing of the turbine. Rather, all active players and related service providers which are involved from the initial idea of a wind park to decommissioning after 20 years of operation must be included in the investigation.

As discussed in chapter 2.1.1 (p. 16), this approach has been modified and adapted several times[10] and thus a great deal of excellent academic work has been generated through the last decades by different scholars[11]. The receptiveness of international policy and international organization such as the World Trade Organization (WTO) or the Organization for

[10] The development of the commodity chain approach with all its various forms is explained in chapter 2.1.1 (p. 14).

[11] The online database of global value chain publications (see: www. globalvaluechains.org/publications) listed as of March 13, 2015, over 922 entries of papers, reports, journals and books regarding global value chains between 1982 and beginning of 2015. Of course, not all value or commodity chain publications are listed in this database but it gives an indication.

Economic Cooperation and Development (OECD) towards using GVC concepts to explain the world economic with its shift and changes have contributed to the increasing number of commodity chain publications. But in contrast to the huge amount of publications regarding commodity chains only a relatively very small percentage have thoroughly investigated the impact and influence of financialization on commodity chains.

At this moment, the thoughts regarding governance from chapter 2.1.2 (p. 22) are to be taken up. The concept of the described producer-driven and buyer-driven chains is not wrong. It describes the way in which certain chains are constructed and differentiates the two. But it does not go far enough regarding the question who controls the commodity chain and how. Governance types such as market, modular, relational, captive and hierarchy as described in chapter 2.1.2 (p. 22) also depict how governance is organized at first glance. With regard to the wind industry, therefore it can be assumed that wind turbine manufacturers could be identified as lead firms in this chain, because they develop with R&D departments new technologies, produce profound knowledge and manufacture the core product of the wind industry. These manufacturers have grown in to big international companies, possess huge production facilities around the world, have sales in the billions and thousands of employees. With regard to governance as understood in commodity chain research, the following may be asked. Do the manufacturers have capabilities over other actors of the chain? While this question is answered in the course of this research, this question does not fully explain the question of governance. Do these manufacturers really control the wind energy commodity chain? Do the manufacturers shape the direction in which the industry is developing? Do the manufacturers actually have command and control functions, or are they given power by other actors? The dissertation will be based on these questions of commodity chain research.

Subsequently these questions should be analyzed in a deeper way. In addition, it appears to be useful to add the discourse of financialization to answer the questions. Already Palpacuer (2008) pointed out that "[p]aradoxically, while the notion of governance has been acknowledged as central to Global Commodity Chain analysis (Bair, 2005; Henderson et al., 2002) the financialization of lead firms and its consequences for

supplier relations have gone fairly unnoticed in this literature" (Palpacuer, 2008, p. 6). But what are these consequences? And how does the financialization of these lead firms work? These questions are to be examined and further deepened in this dissertation.
Among other research agenda, the focus will also be directed to the producer service firms, which offer advanced producer services (APS). Like Parnreiter (2010) it is also the aim of this dissertation "[…] to highlight whether and to what extent producer service firms […] exercise control over the production chains for which they supply services" (Parnreiter, 2010, p. 36). When applied to the wind industry and the above-mentioned manufacturers as lead firms, this means that the producers are influenced by the producer service firms. This would mean that international tax advisory firms, law firms and financial consultants have an influence on the wind turbine manufacturers and thus indirectly control the chain through the manufacturers.
These APS firms are interconnected via a network. According to Coe et al. (2014), the financial industry, which also offers APS, is intra-connected through a so-called global financial network (GFN). This creates certain interactions between the GFN and the manufacturing economy within the GPN. Similar to Coe et al. (2014), finance is of great importance in this dissertation. Finance is increasingly placed at the center of the way of looking at global commodity chains. Sticking to Coe et al. (2014) "[…] no GPN can function without financing and financial logics permeate the entire operations of GPNs. Moreover, understanding finance is indispensable to empirical studies of GPNs, especially with regards to developing measures of value creation, capture and transfer" (Coe et al., 2014, p. 763). The same applies in this context to GCC.
But what exactly does the financial sector characterize, which APS the financial sector provides, and what influence do the services have on a commodity chain? According to Bassens and van Meeteren (2015) there are three main elements, which are offered by APS firms. (1) services, advice and consultancy, (2) creation of new circuits of value and (3) capital switching. These three elements not only shape the world city

archipelago, but also significantly shape commodity chains[12]. The over-accumulation of capital here is seen as a trigger. This creates a formation of an APS class monopoly (Bassens and van Meeteren, 2015, p. 10). These three elements will be given great attention in this dissertation.
This approach is, however, to be analyzed in more detail with aspects of financialization. In this context, the research focus is directed more towards financial management itself. What happens if not only producer services firms are established in the commodity chain through financialization processes? What happens when whole groups of actors change through financialization? How does the structure of a chain change when whole groups of actors are displaced by financial actors? This is followed by the circle of governance. How does governance change when financialization changes the whole structure of a chain?
Therefore, an analysis of governance in commodity chains without a consideration of financialization is no longer appropriate. It can therefore be stated that a "limitation of the GVC approach reintroduces the role of power understood as the capability of certain actors over others. The limitation has to do with the remarkable absence of finance and financialization issues in the GVC (Williams, 2000) and its conceptual apparatus" (Fernández, 2014, p. 11).

### 2.1.5 Existing Limits of Commodity Chain Research

During the research process, it has to be decided how far and how deep the research has to proceed in the commodity chain. Thus, it has to be clarified to what extent the research will delve into vertical integration and real net output ratio. For example, it has to be decided what degree of vertical analysis is sufficient for the analysis of the product of a wind turbine. One can define the boundaries for example on the basis of individual components such as rotor blades, gearboxes or towers. But of course, different items, materials and raw materials are needed to assemble these components. Naturally, different companies and actors are involved this process, which manufacture the small components, such as

[12] The three elements, which are offered by APS firms are explained in detail in chapter 2.2.2 (p. 41).

ladders, elevators, and various plant engineering. Since it is assumed that the control function of the entire chain takes place on a macro level, the analysis is carried out on a larger level. This assumption and determination has natural uncertainties but it is not assumed that the control function of the entire chain – which includes planning, financing, construction, and operation of a wind park – takes place at a lower level of vertical integration and real net output ratio, such as for example the component manufacturers or the concrete supplier for foundations. While it is indisputable that governance structures prevail also at these levels, for example between foundation companies and their concrete suppliers, these can be neglected in the research context of this dissertation.

Another limitation of chain research lies in the limitation of the chain as an object of investigation itself. As in research analysis focus is only on the commodity chain, other actors who have no direct inter-firm relationship through production or services are excluded from the chain and there are also excluded from the consideration. This neglect of other actors means within the chain research, these other actors have little or no influence on the chain. Examples of such actors are NGOs, international organizations or unions (Levy, 2008, p. 13). Nevertheless, these actors can influence or even control the chain, however, they are largely overlooked in chain research. This criticism may play a role for other chain researches, but it is assumed that these other actors as mentioned above play a subordinate role in the wind industry in Germany. In development studies, in which the inequality of regions and entire countries is the focus, that may be different.

A further restriction that has to be made in order to reduce the chain's complexity is the research approach of production. Production is simply accepted as a rule in the chain research as a manufacture processing step. Production is considered as the black box in the chain. A more detailed analysis of production is necessary because related factors such as necessary labor and social relations are typically not considered and not documented (Raworth and Kidder, 2009, p. 189).

In most research, there is the understanding that the chain is integrated by an institutional context. Thus, the commodity chain is regulated by specific rules which are defined by policy, and these rules have an impact on the chain and its actors (Coe et al., 2008, p. 279). For the wind industry chain, it can be noted that the institutional context has a significant impact on the wind energy commodity chain in Germany. Thus, the focus has to be enlarged in this dissertation and has to analyze the interactions between chain and policy, as the changing political environment has a significant impact on the chain, their governance structures and actors.

Another limitation of the theory approach arises from the complex structure of a commodity chain. A major criticism of the chain theory focuses on the linearity which a chain implies (Henderson et al., 2002, p. 442). The criticism is that one has to assume that in reality a product is not completed linearly in the chain piece by piece, and each actor add its value into that product piece by piece. Rather one must assume that chains are organized in a more complex way, which is also considered in the theory of GPN where manufacturing and producing is organized in production networks. This presentation of complexity should come closer to reality and is not included within chain research. There is no doubt that commodity chains, including the wind energy commodity chain in Germany, are complex. Whether the process steps and chain is linear or not has no effect on the research question or on the control function of the chain. Here, only the governance structures between the different actors are important, not the question of the complex structure in which they are arranged.

When considering the control of the chain, other dilemmas in chain research arise. According to the theory of commodity chain research, there are so-called lead firms which control the chain, set standards and have a higher power position than other companies in the chain, which are located on lower positions in the governance structure. This means that these lead firms make certain decisions that have an impact on the chain. But here the question arises of how these lead firms come to their decisions and how the decision making process. For the theoretical approach, this means that one has to expand the research view to figure out how the decision making of the lead firms works. It is therefore necessary to work out whether so-called producer service firms who offer legal services or accountancy affect the lead firms, and how these companies influence the final decisions. There is already research that confirm that the decision making process is influenced by producer service firms (Parnreiter, 2015, p. 12). This leads to a process, where governance gets embedded in so-called command functions, which “[…] refer to the series of activities that need to be done for global firms to execute their operations without losing sight of the corporation’s aims. It is a kind of embedded governance – embedded in the lawyering, the accounting and the investment choices of the firm, often via the advanced producer services (APS) to which it outsources some of its management functions“ (Sassen, 2010, p. 158).

One last limitation of commodity chain research which has been already mentioned but should be taken up again because it has a central role in this dissertation, is the frequent absence of finance in the commodity chain research. All actors of the commodity chain have to be financed. Every company needs capital to invest. Without investment, a company cannot produce and therefore participate in the trading process. Therefore, the question arises how the company finances and how the rules are defined for this financing. In a company that finances itself from its own resources without participation of shareholders, the decisions and the long-term strategies lie with decision makers of the company. If a company is leveraged with loan capital and if perhaps shareholders are involved, the question may be asked whether the decision and the resulting impact on the chain would have the same consequences when the financing and participation would be designed differently. Based on this assumption, it is an objective of this research to expand this existing limits of chain research and to focus on financial flows which affect decision making and governance, and thus the whole commodity chain (Dörry, 2016, p. 11).

In summary, this dissertation is intended to extend two existing limits of commodity chain research. On the one hand, this dissertation wants to make a contribution to the wind energy commodity chain. On the other hand, this research wants to contribute to develop the research discourse of financialization processes within commodity chains.

## 2.2 Financialization of Commodity Chains

### 2.2.1 Origins and Perspective of Financialization

Since the late 1990s, scientific studies dealing with economic changes have intended to show and explain these changes under the term financialization. In this dissertation, the definition of financialization is merged by Epstein (2005) and Krippner (2005): Financialization is defined as "[…] the increasing role of financial motives, financial markets, financial actors and financial institutions in the operation of the domestic and international economies" (Epstein, 2005, p. 3), which leads to "[…] a pattern of accumulation in which profits accrue primarily through financial channels rather than through trade and commodity production" (Krippner, 2005, p. 174).

As written above, financialization is seen in an interdisciplinary context. Therefore, financialization research also has different foci and emphasis depending on the research discipline at both the theoretical and the analytical levels. Heires and Nölke (2014b) summarize these different contributions of financialization research (Heires and Nölke, 2014b, p. 20), for example, sociological research deals with rationality and asks for the reasoning contexts of economic action, which are characterized by a growing capital market orientation of corporate management and by the growing shareholder value principle (Faust et al., 2011; Froud et al., 2000; Kädtler and Sperling, 2002).

The research focus of financialization in heterodox economics is the analysis of the macroeconomic impact of financialization with respect to the impact on aggregate demand, the economic efficiency and the distribution of income and wealth (Epstein and Jayadev, 2005; Stockhammer, 2004; Van Treeck, 2009).

According to political scientists Heires and Nölke (2014b), political science research on financialization is still in its infancy (Heires and Nölke, 2014b, p. 20). Recent political science analysis focuses on the decisions and institutions which allow and support financialization processes. Here processes such as the liberalization of capital movements and deregulation of the financial sector have to mentioned (Abdelal, 2009; Helleiner, 1996). In human geography one of the research focuses of financialization lies on of the spatial dimension, such as the globalized financial markets and local real estate markets (Aalbers, 2008; Dörry, 2010; French et al., 2011; Leyshon and Thrift, 2007; Pike and Pollard, 2010).

All research approaches on the subject of financialization have one thing in common. They all want to better understand the economic changes and want to see in these changes a structure which is defined as financialization. Research into this topic would like to show that there are ongoing financial processes in various fields and they want to understand the reasons why it ever comes to these changes. The studies of financialization are, as described above, very versatile and therefore also rely on very different research fields. Due to this fact, the evidences of financialization processes also differ. Nevertheless, the focus should be directed to one aspect, which is shown in figure 3 (p. 48) and which reduces the processes of financialization to a common worldwide denominator.

Figure 3 shows the worldwide annual Gross Domestic Product (GDP)[13] provided by the World Bank. The GDP is the total value of goods and services produced within a year of a national economy, after the deduction of any inputs. In the period from 1998 to the end of 2015 the global GDP steadily increased from USD 31 trillion to over USD 73 trillion. The circulation of derivative contracts is shown for the same period and compared to the GDP. The Bank for International Settlements estimated the global Over-The-Counter (OTC) derivatives in 1998 to be USD 80 trillion. A derivative is understood as an agreement between two parties whose value depends on fluctuations in the value asset. Here assets are for example, bonds, equities, commodities, and currencies. OTC derivatives refer to financial transactions between two market participants that are not handled by the stock exchange and thus run without the supervision of a stock exchange. This has the consequence that the details of

[13] The World Bank defines GDP as ”the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used“ (World Bank, 2016b).

prices, the risk assessment and the given securities of these transactions will not be displayed to the public. By 1998, the value of derivatives was more than 2.5 times as high as the global GDP at the same time. As seen in figure 3 a steep increase of OTC derivatives occurred and reached its climax in 2013 at just over USD 710 trillion. This was at that time about 9 times more than the GDP. In the following years, the derivatives slightly decreased. At the end of 2015, the number of derivatives was still at nearly USD 493 trillion that is 6.7 times as much as the GDP for the same period.

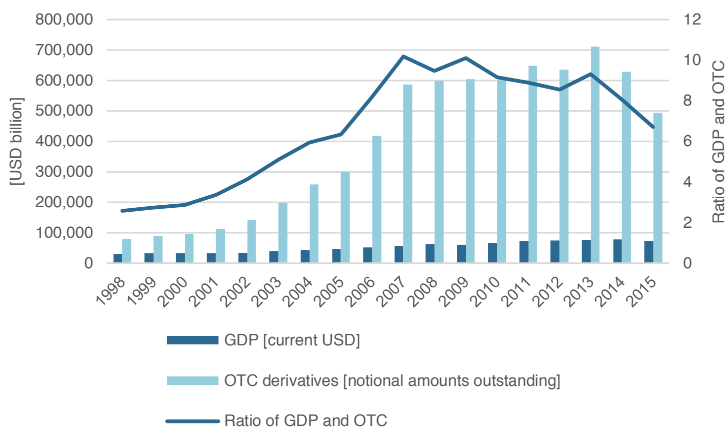


**Figure 3: World GDP and OTC derivatives (BIS, 2016; World Bank, 2016b)**

Because derivatives have basically no own value, they are essentially a bet. Normally derivatives are closed to hedge against increasing interest rates for example. However, with derivatives one can also bet on falling interest rates. Thus, financial markets are creating capital in an artificial manner. This artificial creation of capital is not connected to real economic production processes. Therefore, financialization denotes a new type of capitalism, in which the creation of capital is decoupled from work and production.

Perhaps surprisingly, figure 3 shows that derivatives continue rising despite the financial crisis from 2007 to 2013. Despite the financial crisis, the financial sector is still growing in this area. It can be assumed that the widespread trading of derivatives reflects the high-risk appetite of market participants. In the discourse of financialization it is doubted that the high amounts of derivatives are used for hedging risk mitigations. Rather, it is assumed that they are securitized bets on future developments in financial markets, which represents only a shift of risks.

It remains to be seen how the relationship between GDP and derivatives will behave and develop in the coming years after the sinking of the derivatives volume. As described, financialization shows itself at different levels in different forms. It should thus be clarified in this dissertation if there are tendencies of financialization in the German wind industry and what impacts these financialization processes have on the real economy of the wind industry and its players.

### 2.2.2 Financialization of the Financial and Production Space

In addition to the concepts of globalization and neoliberalism, the term financialization and the associated research is relatively young. Since the global financial crisis in 2007, the concept of financialization has regained international importance and attracted more attention. The term financialization was taken up in different disciplines, who have critically studied the financial sector and its impact on the environment from different perspectives.

As described in chapter 2.2.1 (p. 46) research into financialization originates from fields including economic sociology, human geography, heterodox economics, and international political economy (IPE) (Heires and Nölke, 2014a, p. 28). Through the diversity of disciplines and approaches, there is no uniform definition of financialization. Some researchers use the term financialization in the analysis of corporate governance to explain the growing influence of shareholder value. Other researchers use the term financialization "[…] to refer to the growing dominance of capital market financial systems over bank-based financial systems […], for some financialization represents the explosion of financial trading with a myriad of new financial instruments" (Epstein, 2005, p. 3).

But the term financialization is also used in other contexts. The United Nations Conference on Trade and Development (UNCTAD) has dealt with the questions of how prices are formed in financialized commodities and which role information plays in this process. The UNCTAD defines that "[…] financialization of commodity trading indicates the increasing role of financial motives, financial markets and financial actors in the operation of commodity markets" (UNCTAD, 2011, p. 13).

But as already mentioned, in this dissertation, the definition of financialization is adopted from Epstein (2005), which defines financialization as "[…] the increasing role of financial motives, financial markets, financial actors and financial institutions in the operation of the domestic and international economies" (Epstein, 2005, p. 3).

However, it is necessary to bring these forms in a context. The origins of financialization can be already found in Marx's Capital. In part II, the transformation of money into capital, Marx describes the generation process of capital.

First, money as money and money as capital differ only in their various forms of circulation. A form of circulation is the transformation of commodities (C) into money (M). This process of exchange takes place from commodities into money, and again back from money into commodities (C – M – C), which Marx defines as general formula of capital. This means that an exchange of equal value is performed but with a different value of use. The money assumes only a switching function in this transformation process. Something is sold to buy something different. The situation is different in the circulation process when the starting point of the process is not a commodity, but money. Here, the circulation of money will change qualitatively and the transformation of money into a commodity and the re-transformation into money (M – C – M') takes place. In this transformation, a commodity is not sold to buy another commodity, but a commodity is purchased to sell this commodity. In order to make this exchange economically viable, it depends on the money that the trader gets at the end. If the money (M') which the investor receives is equal to the amount of money (M) he spent, there would be no point of investing. There must be more money than the initial value, otherwise the exchange in a commodity would not make sense. Thus, the money, which is part of this circulation, is transformed from money to capital. However, it is already capital by its provision (Marx and Engels, 1867, p. 155).

Arrighi (1994) applies Marx's general formula of capital to the world-system theory and interprets the formula as a recurrent pattern of historical capitalism. In an analogy to the transformation of money into a commodity and back (M – C – M') Arrighi (1994) describes the shift of epochs of material expansions to financial expansion. "In phases of material expansion money capital sets in motion an increasing mass of commodities, including commoditized labor power and gifts of nature; and in phases of financial expansion an increasing mass of money capital sets itself free from its commodity form, and accumulation proceeds through financial deals. Together, the two epochs or phases constitute a full systemic cycle of accumulation (M – C –M')" (Arrighi, 1994, p. 6). If the commodity only takes the intermediary function to make more money out of money, the money becomes a commodity through this transformation, which can be traded. Therefore, this commodity is traded to increase it and to make profit.

This model (M – C – M ') is located in the production space. As shown in figure 4 (p. 52), this represents an ideal typical space. The production space is driven by the cycle of capital. The driver of this cycle is the search for an optimal commodity to maximize capital. Capital is invested in a commodity to generate a value by selling this commodity again. The original value itself is converted to a surplus value, which eventually leads to a capital accumulation. The production space is confronted with the financial space. In the financial space, the value is generated without a circuitous route via a commodity. This abridged circuit (M – M') creates added value through lending business. The added value arises before a commodity exists at all. In contrast to the production space, in the financial space, "[…] commodities confront each other as claims to future value, thereby bringing value into existence before it is produced in the labor process and realized in exchange. Profit appears as interest, dividends, and settlement prices for futures, options and swaps; the expansion of capital appears to derive from the incessant flow of money in various forms, pure moneymaking independent of the production process" (Labban, 2010, p. 550).

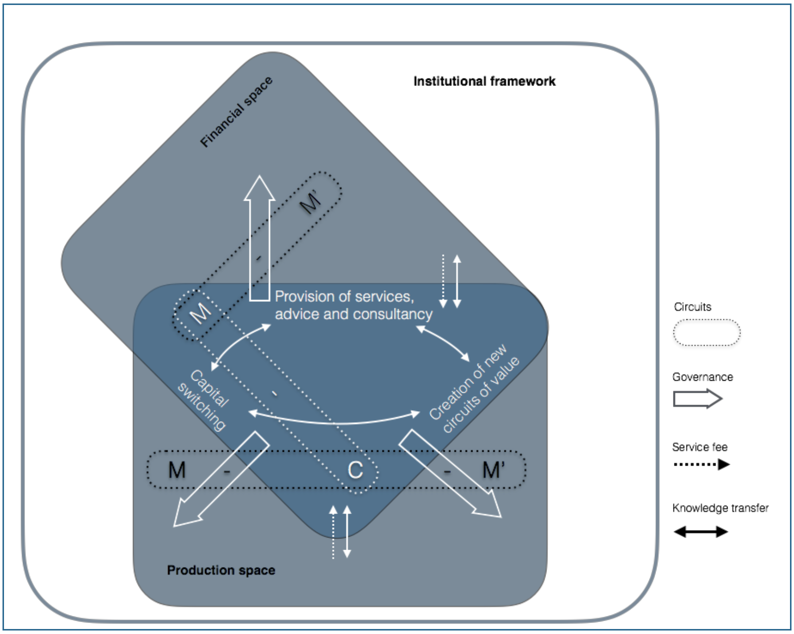


**Figure 4: Conceptual overview of financialization in production and financial space (Own illustration based on Bassens and van Meeteren, 2015)**

As figure 4 shows, however, the two spaces do not exist independently. On the one hand, they are mutually interdependent and on the other hand, the spaces also differ. There is an overlap of the production space and the financial space. In this overlap, the world city archipelago (WCA) exists, which is "[…] a material yet non-contiguous space of world city islands, which is (re)produced through the socio-spatial practices of advanced producer services (APS) firms as they assist in constructing (financial) accumulation strategies for their clients" (Van Meeteren and Bassens, 2016, p. 62). These APS firms are linked by the WCA, offer different services for the production space as well as for the financial space and play a decisive role in the connection of the world city network and global commodity chains. The APSs play on a so-called dual role in their function. "Firstly, they provide an essential input [...] necessary for creating and sustaining global commodity chains. Secondly, producer service firms are concentrated in the respective capitals and form links between the cities through their transactions, generating a network of global cities. This double function of advanced producer services connects these networks so that they overlap in the global city“ (Parnreiter et al., 2005, p. 38). By integrating the research lines of global commodity chains and global city research, the role of these APS firms can be better explained in the context of globalization and financialization. “By playing a crucial role in both networks, ‘glocalized’ financial institutions provide the indispensable connection between the World City Network and Global Commodity Chains: all Global Commodity Chains ‘run’ through world cities, and all cities are integrated into commodity chains” (Brown et al., 2010, p. 27).

In the WCA there are three activities. The first activity is the (1) provision of services, advice and consultancy. These services optimize the production and financial space in the areas accountancy, advertising, banking, finance, and law. The specific actors of these services can be divided into the following groups; advertising firms, law firms, accountancy firms, management consultancy and financial service firms, which “[…] have been some of the most creative within economic globalization through inventing new financial instruments to move, change and expand capital as never before” (Taylor et al., 2012, p. 4).

The aim here is to make the companies more economical and to generate even more added value (M ') in the cycle. Regarding governance, the APS firms have a particular role to play “yet, since efforts to create and implement global standards are undertaken in many areas (for example, legal practices, financial markets, real estate markets), it is reasonable to assume that producer service firms have in fact become important influencers in corporate decision making. A producer service firm’s capacity to influence the governance of commodity chains depends, however, on (a) which tasks are decentralized within corporate networks, and (b) which tasks are outsourced, either at the global or at the local level” (Parnreiter, 2010, p. 45).

Through these services, the APS benefits not only from a mutual knowledge transfer between the production space and the financial space but also from a service or transaction fee. This flow also leads to an accumulation in the WCA.

In addition, APS firms establish (2) new circuits of value. “Such new circuits of value can be produced via the ‘innovation’ of new financial products and legal contracts […], often in tandem with the construction of new markets for investment altogether. […] [T]he resulting financial products that provide entry-points to newly constructed circuits of value often promise a reliable rate of return and are in large demand, especially under conditions of overaccumulation when profitable investment opportunities increasingly grow scarce” (Bassens and van Meeteren, 2015, p. 12-13).
The third and final activity is (3) capital switching. This activity is not attributed to a specific participant, but comprises different compilations of actors from the entire APS complex (Bassens and van Meeteren, 2015, p. 11). This task is equivalent to a switchman. This is possible through the knowledge gathered throughout the WCA complex and through the exchange of knowledge with other APS actors, the production and financial space. In this context capital switching means that “[…] overaccumulated circulating capital can be switched into a form of fixed capital circulation which helps to increase the rate of profit” (Harvey, 2006, p. 271). By knowing where and in which way money can be best spent in commodities, which is relevant for improving and optimizing returns, at the so-called switchman position it can be decided which money flows into which channel and which commodity is fed.
Through these activities, new governance structures are created which have an impact on the production space and the financial space. Thus, it can be argued, “[…] that the pressures and opportunities associated with financialization impinge on lead firms and compel their strategic shift toward developing and expanding their global production networks. [...] Lead firms that succeed in meeting the demands of financial discipline through globalizing production tend to perform well in the financial markets in terms of stock prices and executive rewards, prompting a further shift in their strategic emphasis toward a finance-driven approach to corporate growth and governance” (Yeung and Coe, 2015, p. 39). Regarding the circuits of money and commodities, the money and the commodity itself are directly influenced by the APS. The APS firms therefore have extensive command and control functions directly on the

commodity in the production space, rather than on the money of the financial space. As a result of the aforementioned services as consultants, switchmen and developers of new products, governance structures are directly related to the transformation processes. This means that APS firms influence how, when and where investments are made, and how commodities are returned to a value of money. Through this decision making power, APS firms are able to combine two separate cycles of capital, namely the production space cycles and financial space cycle. As a result, the cycles can not only be controlled, but also it can be controlled when and where accumulation and overaccumulation occur.

With respect to wind energy this means the following. At the beginning, there is the same cycle of C – M – C. A wind park operator holds a wind park and produces electricity with this wind park. He can sell this electricity and gets money by selling the produced kWh. The wind park operator can use this money to acquire other commodities. The money is thus converted into another commodity. In the case of financialization, the cycle is different. An investor has money to invest. In order to make more money from this money, the investor buys a wind park, which can be considered as a commodity. As an investor has certain return on investment requirements, the investor sells the produced electricity or the entire wind park and converts the commodity back into money. Since the value of the wind park has increased over time, the investor has in the end more money than before. The circuit is closed.

Here there is a breakdown because this action is no longer relevant to the real economy, and also has repercussions outside of the real economy, for example on social and cultural activities. Thus, in finance a shift has taken place. Financing has changed from assisting the operation of the real economy to dominating the real economy. The purpose of finance is therefore only to increase money. This means, that the wind park has become an object of speculation to make more money out of money. Hereby the wind park is interchangeable with any other commodity. These processes exist not only in areas of the economy of goods and services, but also in the public sector and health services and social services, which has enormous influence on public life and private households (Christopherson et al., 2013, p. 352).

It is therefore clear that financialization may have different effects in different regions. On the one hand the broad approach would be an advantage because it can cover many areas and thus also offers plenty of room for different analysis options. But on the other hand, with a broad approach one risks losing the selectivity of the approach. Therefore, it is important for the conceptual work to differentiate exactly this approach and define well considered indicators for the concept verification. But how does one define this approach without curtailing too much, so that the approach still stands as an independent theoretical concept in the foreground? For this purpose, different definitions of financialization can be found in the literature. An early definition of "[…] financialization refers to the increasing importance of financial markets, financial motives, financial institutions, and financial elites in the operation of the economy and its governing institutions, both at the national and international level" (Epstein, 2001, p. 2). If one combines this aforementioned definition of the increasing importance of the financial sector with the approach of cycles taken from the world-system theory, one can extend the definition of financialization by the following processes.

But according to the mentioned processes of capitalist production and the circulation and accumulation of capital, financialization can defined "[…] as a pattern of accumulation in which profits accrue primarily through financial channels rather than through trade and commodity production (Arrighi, 1994). 'Financial' here refers to activities relating to the provision or transfer of liquid capital in expectation of future interest, dividends or capital gains" (Krippner, 2005, p. 174).

To answer the question of this dissertation, these processes must be precisely defined to be able to separate cause and effect from each other. From the definitions, above therefore three conclusions can be drawn that define this financialization processes accurately and precisely and distinguish between cause and effect. (1) The importance of the financial sector increases relative to the real economy sector. (2) There is an income transfer from the real economy to the financial sector. Consequences that may arise from these processes and shifts can also be operationalized. As a consequence of these two processes, the following process can be mentioned. (3) There is an increase of income inequality and contribute to stagnation of wages (Palley, 2007, p. 3). These three processes can, if they are operationalized and appropriate indicators are found, be accurately measured and thus financialization processes can be proved or disproved.

It is therefore important to emphasize that in this dissertation financialization and its associated processes are understood as a conceptual approach that deals critically with the role of financial markets and its actors. Financialization is intended to add value to the discussion of the question in this dissertation in the context of an interdisciplinary approach. Here the growth of the economic importance of financial markets through a quantitative and qualitative analysis is critically examined.

### 2.2.3 Relationship Between Financialization and Economic Crisis

Since the research questions and the hypotheses deal with the question of whether the wind industry is susceptible and vulnerable to crises, and to what extent the vulnerability is based on financialization, first the relationship between financialization and economic must be clarified.

The effects a strong financialized economy can have, are shown by the financial crisis[14] from 2007 onwards. This crisis has gone through different stages of development with different names. Thus, a real estate crisis or subprime crisis in the US in 2007 became a global banking and financial crisis. This banking crisis peaked in 2008 as the US bank Lehman Brothers collapsed. More and more banks and financial institutions encountered serious difficulties. Due to this development, many banks had to be rescued by grants or nationalization. Thus, it becomes clear that this global economic crisis carries different names. Below it will be analyzed what caused this crisis and how the concept of financialization may help to explain the crisis.

As already indicated, this global financial crisis developed from the subprime crisis in the United States. At the beginning of the last decade, the Federal Reserve System (FED), the US Federal Reserve kept low interest rates to boost the economy. Due to the low interest rates, more people

[14] The following description of the events that contributed to the financial crisis cannot be seen as a summary of the financial crisis. Rather, the importance of financialization in the financial crisis has to be carved out.

could acquire a loan to finance a real estate purchase. The number of sales of existing and newly built houses can explain the upward movement of the prices. The numbers had risen steadily for about ten years, and then after a brief pause in 2000 and 2001 the numbers reached its maximum in 2005 and 2006 (Czaykowski et al., 2009, p. 37).

The mortgage market in the United States is divided into the areas of prime, Alt-A and subprime. Each area represents a different risk category. Debtors who cannot meet the required bank criteria, receive so-called subprime loans. This is the riskiest category and due to the higher risk, they are provided with a higher interest rate. The newly issued credit volume in the subprime sector was USD 216 billion in 2001. By 2006, the volume had risen to USD 600 billion (Jäger-Ambrożewicz and Voigtländer, 2008, p. 7). With these loans, the real estate serves as security for the bank, which can securitize credit claims. The credit claims are bundled by the bank into packages with a large amount of different individual claims. The packages are so-called Collateralized Debt Obligations (CDO).

The creditworthiness of these packages is rated by the rating agencies. The rating agencies work closely with the lender banks and provide as many packages with a positive rating as possible. Traditional loans are converted into complex and speculative financial products. The packages are then sold to different investors and thus the risk of a credit default is also transferred to the investors. The installments now flow to the buyer of the package. If some debtors fail, this is initially unproblematic because in this case the real estate can generate the profit. The demand for these packages is high due to the earnings outlook which continues to rise. The CDOs spread throughout the banking system. But it comes to the point where the demand for real estate loans is saturated. However, the demand for CDOs still persists. The banks begin to grant real estate loans to persons with low creditworthiness and no securities. This results in a further increase in real estate prices and thus sufficient safety may be expected. But by securitizing the individual loans the real risk is obscured.

Despite the inclusion of lower income groups in the cycle of real estate loans the demand for bonds cannot be satisfied by the global investors.

Due to this situation, the financial service providers create new financial products to satisfy the demand. The bonds, which are based on mortgages to finance real estate loans by debtors with low credit ratings include different parts with different ratings. As shown in figure 5 this subprime mortgage bonds range from AAA ratings with very good credit rating to BB and unrated parts with poor credit and high probability of default. Figure 5 shows that the bond has 80 % shares with best (AAA) and 15 % with better credit ratings (AA - A).
Bonds with the best (AAA and AA) ratings are combined into a new CDO, a so-called high grade structured-finance CDO. This is a CDO with a good creditworthiness. The slightly less good tranches of the original CDO (A and BBB) are combined into new mezzanine CDOs with a median creditworthiness. This construct could be securitized again in a so-called CDO-squared. Thus, a re-securitization is possible by the multiple division into tranches. This multiple division into tranches could be continued arbitrarily (Krassin et al., 2009, p. 78).

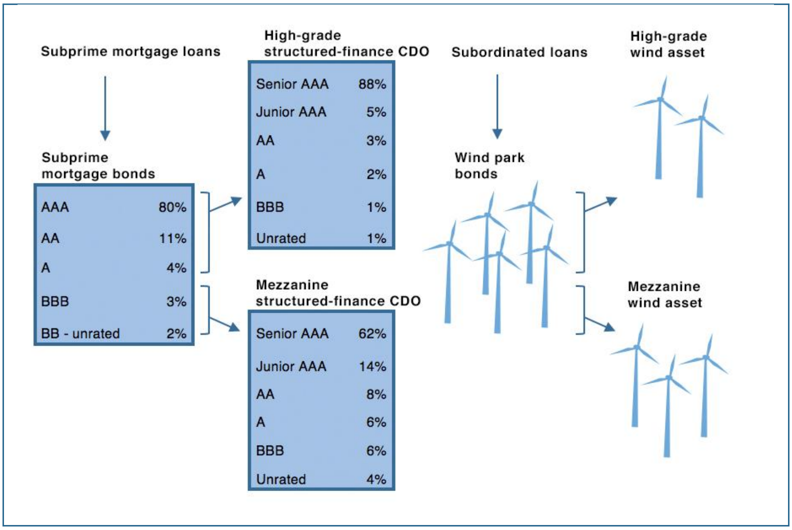


**Figure 5: Multi-Layered structured credit products (Own illustration based on International Monetary Fund, 2008, p. 60)**

The methodology of securitization and bundling of individual assets is transferable to the wind industry. Here as well, subordinated loans can be converted into a financial product and combined into a wind park bond. Individual wind power turbines or entire wind parks can also be divided by their rating into different financial products. This can lead to high-grade wind assets or mezzanine wind assets. As figure 5 (p. 59) illustrates, the approach of financial product creation in the wind industry is the same as the creation of financial products that ultimately supported and sped up the financial crises.

Credit rating agencies play a key role in the financial crisis because they classified these high-risk packets as safe. The rating, along with the expected high yields, were the main investment criteria of investors. The high returns combined with low risks were the main driver for worldwide demand for derivatives. As to why the rating agencies classified the CDOs with a high creditworthiness, which is opposed to economic reason, this could possibly be explained by an incorrect application of external ratings, conflicts of interest, lack of competition and the liability of credit rating agencies (Bloss et al., 2009, p. 232).

With each new sale of mortgages or derivatives, bankers and mortgage brokers received a commission. This quick success with high commission outweighs the potential consequences as debt defaults and the resulting foreclosures caused by changes in interest rates or decline in real estate prices. It is believed that the methods applied in the distribution of subprime mortgage loans, were often not morally acceptable and also possibly illegal within the distribution practices (Huth, 2009, p. 61).

However, the situation changed. The number of debtors who could not pay their rates raised. More and more debtors had to pass their real estates to the bank. This, combined with a lack of demand meant that the real estate prices fell. With the collapse of prices and the resulting debt defaults by the debtors, the owner of the CDO packages are in the possession of real estates with falling real estate prices. The securitized loan packages begin to become worthless. The institutions that have these packages in their possession are trying to sell the toxic assets quickly as possible. But there is no demand and therefore no buyers. The first companies, the most risk-tolerant hedge funds, are collapsing under the weight of the toxic assets. Financial companies such as banks and financial institutions fall into mutual distrust. They provide less credit to one another, although they depend on the credits, especially after the incurred losses. The banks have held too little capital for the risky CDOs and cannot compensate their losses. The US financial sector collapses step by step.

This course of the crisis makes it clear that the interaction of certain factors was the cause of the financial crisis. On the one hand, there was a decline in inflation before the crisis, which also influenced the lowering of the interest policy rates. At the same time, the market was extraordinary overaccumulated. By shifting large amounts of capital into the US market, there was a decline in long-term interest rates in the United States. As described, this led to a price reduction of loans on the supply side. On the demand side, the borrower tried to offset a loss in relative income, which resulted in an increase of mortgages. At the same time, there was an increased incidence of institutional investors, which brought a demand for bonds. This high demand created a basis for financial service providers to develop securitized bonds and CDOs and to bring them to market. After the market was undermined with these bonds, the trust in these bonds began to decline and investors were skeptical. It came to a crash (Ramskogler, 2015, p. 58).

This means that although on the one hand external factors laid the foundations of the financial crisis, the financialization of the market led to a collapse of the market and the financialization was intensified. Transferring this causality on the assumption that financialization processes are also present in the German wind industry, this would have certain consequences. However, to suggest a parallel with the financial crisis, the external factors which lead to a crisis would also have to be similar. On the one hand, long-term interest rates have to run at a constant low level and on the other hand an environment would have to be created where the German wind energy market gets very high inflows of capital and is therefore highly liquid. If, in addition to these external factors, a financialization of the wind sector by the financial sector can also be identified[15] and the financial sector offers within the wind energy industry financial products and financial services where risks are securitized and can be traded, this would come very close to the initial situation of the financial crisis. It is therefore necessary to analyze whether financialization processes are present in the wind energy industry, and if that is the case, it is necessary to analyze which potential crisis indicators, such as the creation of securitized risk products, emerge.

## 2.3 Theoretical Framework

### 2.3.1 Integration of Financialization into Commodity Chains

In chapter 2.1.4 (p. 37) the current state of commodity chain research has been presented and which questions can be solved with the GCC research. Based on these findings the limitations of this theory were discussed in chapter 2.1.5 (p. 42). These limitations of the GCC theory, however, can be extended by integrating further research discourses into the GCC theory. This chapter has the aim to explain the value added by such an integration and is not an overview of the current state of research.

To analyze financialization in the German wind industry, in this analysis the theoretical approach of financialization will be connected with commodity research and before examining the approaches through an empirical analysis of the German wind energy market. A high financialization of the wind industry would mean that the financial sector is deeply involved in the wind industry. However, this alone does not prove financialization unless, through this process, the financial sector rises and takes a leading position in the industry. From this position, control functions are performed and the commodity chain is managed. In the commodity chain research, the analysis focus lies on these positions of power and control. The research which deals with financialization processes and the commodity chain research therefore do not exclude each other, but would complement and enrich each other. Financialization also means

[15] The operationalization of how financialization in the wind industry can be determined is explained in detail in chapter 3.1.2 (p. 71).

that capital markets are globalized and deregulated at the same time. New financial instruments and products will be promoted and distributed. By doing so, the financial sector reaches higher sales and thus the financial sector receives more shares in the commodity chain. The investigation on the relationships in the commodity chain is also part of the GCC research.

By integrating the concept of financialization into the approach of the commodity chain analysis a synthesis is created. It is important to emphasize that it is the focus of this dissertation to analyze the financialization of the wind industry and it is not the goal to develop and establish a new theory approach or structure. This synthesis between financialization and the commodity chain research is only used as a means to an end for the analysis. The aim is to explore the financialization of the wind industry, and the research of the GCC is used as an analytical tool. This means that the basic idea and the concept behind this dissertation is financialization, and the theoretical background of GCC forms empirical approach by which the investigation takes place.

When analyzing financialization in commodity chains, the financial sector and finance itself plays a crucial role. This insight is not new. Finance has a particular importance that Dicken (2015) explained: “Most important have been the transformations in the where and the how of the material production, distribution and consumption of goods and services, including, in particular, finance” (Dicken, 2015, p. 6). Therefore, it is assumed that this synthesis of these two theoretical concepts is not new. Already Williams (2000) described the development from shareholder value to present-day capitalism, showing the influence of financial structures on corporate strategies and management is constantly increasing and thus could permanently change all economic sectors. Thus, the power position of finance and related services rises in a commodity chain.

Furthermore, it was discovered that financialization can change the power positions within the chain. “[...] [T]he financialization process as well as the financial system tends to deepen the asymmetric control of power, and establishes entry barriers for mainly small actors. In order to improve their functions and positions in the GVC through new financial investments, these latter actors rest on the assistance offered by either leader firms or by national and international coordinated programs from international institutions of development and financial assistance“ (Fernández, 2014, p.12).

Financing becomes increasingly important for companies. Considerable appreciation potential can be only achieved by optimizing the financing. But a thorough analysis regarding supply chain management is still missing (Gomm, 2008, p. 2).

The whole area of the financial sector thus receives a lot of attention. The rise of finance into an independent advanced business service (ABS) underlines the financialization processes in a commodity chain. This ABS or advanced producer service firms become independent members of a commodity chain that influence and control the production processes, the input output currents and thus also control the distribution of profit, participation and power. This implies that “[…] of all the advanced business services, financial systems play the central role. The decisions of financiers exert an extraordinarily powerful influence, not only in lubricating production circuits but also in shaping them through their evaluative decisions on what (and where) to invest in order to gain the highest (and sometimes the quickest) return“ (Dicken, 2015, p. 56).

There are already many case studies showing the integration of financialization in commodity chains based on an analysis of a particular commodity. For example, a field study by Palpacuer (2008) examined the financialization processes in the commodity chain of clothing. Palpacuer (2008) shows how the financialization of lead firms leads to a degradation of the working conditions in the commodity chain of clothing. Reasons for these changes include institutional investors and executives of large corporations, which stand at the top of the GCC. This leads to an unequal distribution of power within the chain. This change leads to a shift in value added processes that leads forcibly to a shift in the distribution of income. In the context of the governance discourse and debate, three different approaches are identified: shareholder, stakeholder and institutional. The course of study was carried out under the theoretical frame of GCC. Furthermore, it also can be noted that “paradoxically, while the notion of governance has been acknowledged as central to GCC analysis, the financialization of lead firms and its consequences for supplier relations have gone fairly unnoticed in this literature“ (Palpacuer, 2008, p. 6).

Newman (2009) also applied the concept of financialization in a case study on the commodity chain of coffee in 2009. The focus of the analysis was the distributional implications of the international coffee markets, which have undergone a restructuring. The research discovered that the financial investments on international commodity exchanges have increased. Furthermore, it is argued that due to financialization the inequality in the commodity chain of coffee continues to grow and benefits and drawbacks are not distributed equally among the chain stakeholders. Inequalities are emerging in the structure of production and marketing of coffee. It is argued that “[…] there is a need to constrain the process of financialization in coffee markets that may be achieved by separating the process of price determination of the physical commodity from the price of the futures contract that is formed on international exchanges“ (Newman, 2009, p. 19). It should be noted that although this analysis empirically examined the commodity chain of coffee, it did not use the analytical background of the commodity chain which was developed by Gereffi and Korzieniewicz in 1994.

Coe et al. (2014) emphasize that the role of the financial sector has been largely overlooked in the approach of global production networks. They assume that the financial sector is even more globalized and interconnected than the production economy. They develop the scientific concept of the global financial network that finds its origin in financial geography. It should be noted that world cities, offshore jurisdictions and especially business services play a significant role in this global financial network. Coe et al. (2014) note that an integration of the financial system and thus also of financialization in the research of GPN leads to an extension of the approach and the concept. It is done by integrating a conceptual development and improves the approach on a methodological and empirical level (Coe et al., 2014, p. 761).

However, critically it can be said that “[…] the concept of commodity chain, as popularized by Gereffi and Korzieniewicz (Gereffi and Korzeniewicz, 1994), was widely accepted as unproblematic even though this was a completely inadequate way to represent the financially motivated matrix choices of a firm like Ford which variably combines component production, car assembly, finance, car rental and after-market services" (Williams, 2000, p. 6).

In summary, it can be stated that good preparatory work to bring together the concepts of financialization and the commodity chain research had already taken place. It was noted that the financial sector in these chains playing an increasingly important key position and also performs a function as APS. Nevertheless, there is still a demand that the focus of financialization and its impact in the GCC research must be extended further.

Hereby it should be noted that especially within the analysis of APS further research is needed. "[…] [I]t is important to classify firms as well as services as regards the potential of PSFs for influencing chain governance. […] As regards a specification of services, the most promising way is not to group them into sub-branches (e.g. legal services have more impact than accountancy), but rather to classify them by (relative) scarcity" (Parnreiter, 2015, p. 13).

### 2.3.2 Evaluation of the Applied Theoretical Concept

After the current state of research has been presented in chapter 2.1.4 (p. 37), it is the purpose of this chapter to find out whether the chosen theory approach is well suited to answer the research question. In order to evaluate the applied theoretical concept, it has to be analyzed whether the theoretical concept is well suited answer the research question. Starting from the world-system approach, different process steps are connected in a commodity chain. These processes are unequal in their division of labor and can also take place at different times before ultimately being connected and merged to a final product. This connection through the chain may transcend national borders and can have transnational and globalized characteristics. The chain is usually driven in a capitalist value added way. The added value is moved from the periphery to the center through the chain links of the commodity chain. These chains are all embedded within an institutional framework. Driven by institutional boundary conditions and competition, companies located the center become increasingly specialized, which also forces the companies in the periphery to carry out a greater specialization. If these processes progress, a vertical integration of companies can arise, which undertake upstream or downstream process steps within the chain. Thus, after some time, monopolies can form, with the result that the added value increases and is skimmed off by the companies in the center. These operations sustainably change the chain and provide a geographical hierarchy of the space (Hopkins and Wallerstein, 1977, p. 128; 1986, p. 25).

This approach for analyzing commodity chains, derived from the world-systems theory, with its theoretical and empirical approach of commodity chain research, is well suited for the research questions of this dissertation. Starting with the question of whether financialization takes place in the German wind industry it must first be clarified whether the financial sector is actively involved in the commodity chain and to what extent that happens. If an active participation of the financial sector emerges, it is important to analyze whether processes similar to those described above emerge. Here it is assumed that the flows of value are run as described in the world-system theory. The values flow from companies in the periphery of the wind industry, which are settled in the lower segments of the chain, to the centers from which the chains are controlled. It is assumed that financialization companies are also located in the centers and control the chains.

In the world-systems theory it is noted that whenever a vertical integration of two links in the chain occurred, it was possible to shift an even larger portion of the total value to the center. Here it is very important to notice that in order to shift value, links are necessary and indispensable. In this dissertation, these links between the production sector and the financial sector must therefore be discovered and proven to exist. Then the shift results in a concentration of capital in the center. This accumulation of capital in the center can then be used to gain further competitive advantages for the companies in the center, which allows them to continue setting the rules and to strengthen and further expand the power position. This strengthening of the power position can result from the fact that new products, which are scarce in the diversity are created in the center (Hopkins and Wallerstein, 1986, p. 27).

This principle of world-systems theory can be applied to the German wind industry if it appears that certain companies leave their original areas and intrude into other areas of the commodity chain. The theoretical concept of world-systems theory and the research approach of commodity chains can also be applied to the wind industry. If one analyses the value flows in the wind industry and identifies that value flows from companies which sit in the so-called periphery towards companies in the center, an accumulation of capital could also exist in the centers of the wind industry. "[...] [T]he dominant direction of flows along GCCs is from the periphery to the core, [...], they do so at the expense of two forms of circularity. Firstly, high-profit sections of a chain are core-like, implying either high-technology or organizational barriers to entry. Secondly, profits are explained by power, which itself is defined in terms of high profits" (Raikes et al., 2000, p. 401). Through this analysis, the winners and losers of the commodity chain can be identified. But this approach is well suited for further research questions in this dissertation. On the one hand, it has to be investigated whether it comes to financialization processes due the accumulation of capital in the centers where the companies control the chain. And on the other hand, it has to be analyzed to what extent this accumulated capital is reinvested and how the capital is returned back to the circuit. If the recovered capital is not returned by the companies in the financial sector to the real economy, financialization processes can be assumed, which have their theoretical roots in the worlds-system theory.

In order to answer the research questions of this dissertation empirically the macro level of the world-system approach must be combined. To identify the flows of goods and services, as well as the winners and losers of the chain, the approach of the GCC is excellent as an empirical analysis instrument. The relatively free approach allows adapting the research focus to that level, which was defined as an empirical framework. This means, that the "[…] GCC approach […] can operate simultaneously at the level of the single commodity chain and at the level of the national economy within which these chains are embedded" (Selwyn, 2015, p. 269). In the case of this dissertation, the empirical framework lies not at a macro level, such as the analysis of globalized and international economic contexts, neither on a micro level, where chain research deals with a very specific product such as the power structure of a supplier to its subcontractors. This research focuses rather on a meso level. In this dissertation, the entire commodity chain of the wind industry will be analyzed, with all its different products, different facets and power relations. This system is embedded in the institutional framework of financial and economic policy. Specifically, policy is an influential factor in this industry, because the chain occurs in a regulated environment. In Germany, there is no free market as policy defines the compensation for the entire commodity chain.

Since the focus in the GCC analysis lies on the inter-firm networks in global industries the GCC approach is very suitable for analysis in this dissertation for several reasons. Firstly, to understand all the processes within the whole commodity chain, the analysis must include all levels with all processes in the entire system. External factors such as the political or financial interest rates have an impact on the chain and must be considered in a governance analysis. Another factor is that the chain of the wind industry is, like most other commodity chains, much too varied and complex to analyze governance structures with the sectoral logic approach by Gereffi, Humphrey and Sturgeon (Gereffi et al., 2005, p. 78). Thus Bair (2008) already concluded that "[…] given their interest in demonstrating the macro-level consequences of these networks, the GCC framework provides a better analytical lens than that of the GVC governance theory" (Bair, 2008, p. 14).

One focus of this dissertation is to analyze and to point out the impact of the financial sector in the German wind industry. In order to make meaningful statements it is not sufficient to concentrate on a single product, such as a special wind turbine with a special tower, and it does not go far enough to define this special turbine as a final product for the whole commodity chain. Instead, the whole industry with all its different products and projects has to be included in the analysis. Also from a historical point of view, the analysis has to occur within a larger theoretical perspective as such of the GCC analysis. In Germany wind energy projects are designed to operate for 20 years. This means, for example, it is possible that wind parks, which run and are operated for 10 years have been created under very different governance processes within the chain. However, it is important to note, that these parks can be today renewed

and restructured on the commercial and financial side by the financial sector. This means that an old product is available again in the current wind energy market and participates in the current changes in the institutional framework. Through the restructuring the same wind park differs as a product from its previous status. The approach of GCC research gives more flexibility to react to these changes than the GVC[16] approach.
Since the entire chain of wind energy will be analyzed, the commodity chain starts with the first idea of a wind park project, involves all stakeholders such as project developers, manufacturers, consultants and financing banks. The end of the chain and the final product represents a generated kWh from wind energy.
The research focus of commodity chain research is ideal for answering the research questions. The main focus of commodity chain research deals with the question of how the chain is organized. “As for who does the organizing, a group of ‘lead firms’ play a critical role by defining the terms of supply-chain membership, incorporating or excluding other actors, and allocating where, when and by whom value is added (Gereffi, 1994; Gibbon and Ponte, 2005; Kaplinsky, 2005)“ (Ponte and Sturgeon, 2014, p. 201). This means that governance plays a special role in commodity chains. This governance issue are also reflected in the research question of this dissertation. If financialization processes can be identified in the German wind energy industry, one can address the question of how the financial sector is organized and what role it plays in the governance structure of the chain.
Besides the pure control function of governance, in GCC research, as well as in development studies, governance deals with the development of the various actors in the temporal context within the chain. This analysis of downgrading and upgrading actors is an excellent basis for analyzing a possible rise of the financial sector in the chain of wind energy in Germany. So, in addition to these upgrading opportunities and the associated consequences, the command and control of the chain can be analyzed. As a result of this analysis, certain companies will be identified, which are defined in commodity chain research as lead firms. These lead

[16] It has to be noted that the two research approaches of GCC and GVC should not be regarded as different theories, but the research focus in both analysis methods is different.

firms, which are mainly located in the centers of the world economy, control the production and the entire chain. In the chain research, it is argued that in such a context the lead firms, which are transnational companies, have no own production capacities. Referring to the commodity chain of the wind industry, it must now be determined who the lead firms of wind energy commodity chain are.
Furthermore, GCC research falls back on four different areas of investigation: (1) the input-output structure of the chain, (2) the spatial distribution and dimensions of the chain, (3) the governance structure and (4) the institutional framework in which the chain is integrated (Gereffi and Korzeniewicz, 1994, p. 97; Gereffi, 1995, p. 113). This approach is also very suitable to accompany the empirical work on this issue in order to answer the research questions. All these areas of investigation can be used to analyze whether financialization of the wind industry takes place, and whether the position of the financial sector in the chain is being strengthened. It is assumed that if financialization processes take place the input-output structure of the actors would change significantly.
These changes result from the fact that the structure of the chain is changed by the financial sector. This is done on two different levels. On the one hand, it is argued that the decisions of lead firms, influenced by the financial sector, have an impact on the structure of the actors and thus on the input-output structure. On the other hand, it is assumed that certain actors are displaced in the chain, and these positions are re-staffed filled with companies from the financial sector at the same position in the chain. There is the possibility that companies from the financial sector make different decisions as other companies would have done in the same position.
Furthermore, if activities shift from the production economy to the financial economy, a change in this input-output structure would be noticeable, which was already analyzed for example in the commodity chain of coffee (Newman, 2009). If the theory is confirmed, the lead firms would be concentrated spatially where the production is controlled. The analysis of governance structure is getting a special focus in this analysis because of its importance in this dissertation. The governance structure and a possible shift in the governance structures lies at the core of this disserta-

tion. When analyzing possible shifts in the lead firms in the commodity chain, leading wind firms should be identified. It should be determined whether companies from the financial sector are involved, and whether the structure is shifting in favor to the financial sector. The institutional framework that shapes the wind industry is primarily influenced by the EEG. This law regulates the remuneration of wind parks and every single wind turbine in Germany that is connected to the public electricity grid. Through various calculation models which are integrated in this law, politics determines of the profitability of a wind park. This has enormous impact on the commodity chain and thus this law holds some control functions.

In summary, it can be said that the world-systems theory as a framework combined with the addition of the theoretical approach of the GCC research are excellently qualified to answer the research questions of this dissertation. The aim of this dissertation is to empirically examine whether financialization takes place within the commodity chain and what impact that has on the whole chain. Through the empirical work and analysis of the results, however, it is possible to draw conclusions about the theory, which can expand the research area of the GCC, where appropriate. This extension is done by the inclusion of the research approach of financialization. This connection is necessary to answer the research questions. The approach of financialization provides the thematic framework and the theory of GCC brings here the empirical bases for answering the research question adequately.

## 2.4 Hypotheses

### 2.4.1 Derivation of Hypotheses from Research Questions

In the introduction, the research question has already been defined and the research interest behind it has been justified. The aim of this work is to analyze whether financialization processes can be identified in the German wind industry. This is to be determined using the GCC approach. Based on the research question and the theoretical background of the GCC and financialization approach, key questions can be derived which run through the entire work. These key questions are necessary to break down such a complex topic into different sub-questions and then work on these in different sections. Thus, the complexity of the research objective can be dissolved and be applied to the empirical approach on a lower level for the analysis. Then the results from these different sections are brought together again at the end of the dissertation. Based on the merged results the superordinate research question of whether financialization takes place in the German wind industry can be answered.

The key questions are derived from the research question. Therefore, for each key question various hypotheses are formulated. The hypotheses are formulated statements, which have a possible validity in relation to the financialization of the wind industry. The validity of the hypotheses is possible, but can only be empirically proved and verified or refuted and thus falsified.

Enhanced by the theoretical background the research question can be subdivided into several key questions and supplemented by the hypotheses. The division of the key questions is based on the methodical approach of the GCC research with its analysis dimensions, which every commodity chain has. The input-output structure, the geographical coverage, the governance structure and the institutional framework (Gereffi and Korzeniewicz, 1994, p. 97; Gereffi, 1995, p. 113). Thus, key questions and hypotheses can be stated as follows. Key question 1 references the input output structure of GCC. Key question 2 is concerned with the dimension of the governance structures of a chain and key question 3 examines for the institutional context in which the commodity chain of wind energy is embedded.

**Key question 1:** Do financialization processes influence the German wind industry's commodity chain structure and do financialization processes change the actors and their functions?

Hypothesis 1a: The structures of owners and investors of wind parks and the business activities of firms are shifting from the real economy towards the financial economy[17].

[17] A precise definition of real and financial economy can be found in chapter 3.1.2 (p. 71).

Hypothesis 1b: To hedge risks and optimize returns, new financial products are created that extend the financial sector's field of activity, which leads to a change of actors and their functions.
Hypothesis 1c: Wind energy projects and electricity from wind energy are increasingly being traded and becoming an object of speculation, which changes the commodity chain's structure.

**Key question 2:** How is governance organized within the wind energy commodity chain and is governance changed by financialization processes?
Hypothesis 2a: The influence of the financial sector in the wind industry is increasing, which leads to a rising command and control position of financial actors in the commodity chain.
Hypothesis 2b: Due to the rising power position, the financial sector receives extensive command and control functions within the chain, creates market barriers, controls market entries and thus has decision making power not only in the financial economy but also in the real economy.
Hypothesis 2c: Decisions of corporate management are increasingly taken in a way that the business strategy is focused on shareholder value and thus the decision making is based on the return on investment.

**Key question 3:** How does the institutional framework effect the German wind industry and do changes of the institutional framework favor financialization processes?
Hypothesis 3a: Changes in the institutional framework strengthen the position of the financial sector in the wind energy commodity chain.
Hypothesis 3b: Through changes in the institutional framework, wind energy plays a larger role in the capital market and thus attracts investment from other investment sectors.
Hypothesis 3c: Due to changes and a financialization of the industry, the readiness to assume risks increases, so that wind energy projects and the whole commodity chain are more susceptible to crises.

### 2.4.2 Presentation of Hypotheses

All hypotheses are related to the key questions, however, they also have a direct relation to the research question of this study whether there are financialization processes in the German wind industry. Below these relationships and causal connection are further analyzed and explained. The following hypotheses are related to the dimension of the GCC research, which deals with the input-output relations within a commodity chain.

**Hypothesis 1a:** The structures of owners and investors of wind parks and the business activities of firms are shifting from the real economy towards the financial economy.

It is assumed that the commodity chain of wind energy consists of certain actors that have shaped the chain since the first boom of the wind industry in the early 1990s until today. Furthermore, it is assumed that the defining actors of this industry were initially the project developers and the WTG manufacturers. The term developer includes individuals or small groups as well as professional project developers. These individuals or small groups of developers who shaped the image in the early days of the wind industry were then steadily replaced by professionalized project developers who already operate partly on an international level. The WTG manufacturers are regarded as the second important actor in this chain. The technique and type of a turbine is not only crucial for a wind energy project, but also comprises a very large part of the commodity chain. Finally, the wind turbine manufacturer not only produces the turbine with all its components, but the manufacturer constructs and erects the wind parks and maintains them if required. With respect to the question of whether there are financialization processes, it is assumed that in addition to these two major actors more players appear, who increasingly come from the financial sector, which leads to a change of the chain structure. Furthermore, it is assumed along with the mentioned changes of the participants in the chain, the operator groups and therefore the ownership structures will change. It is assumed that the owners and operators of wind parks were initially individuals or individual energy cooperatives. With a change in this ownership structure it is supposed the initial owners are gradually replaced by representatives of the financial sector. This not only changes the participation in energy and infrastructure projects, but also changes the ownership structures in rural areas and entails a shift away from the real economy towards the financial economy.

**Hypothesis 1b:** To hedge risks and optimize returns, new financial products are created that extend the financial sector's field of activity, which leads to a change of actors and their functions.

Within a commodity chain, different processes and steps exist to produce a final product. At the end of the commodity chain is the final product that can be bought and consumed by a consumer. In wind energy, the final product is the kWh produced from wind energy. The hypothesis assumes that by consuming these produced kWh, new products and areas of activity can be created which are primarily performed by the financial sector. As a kWh cannot be changed due to its nature, characteristics and applicability, this means that new businesses are created within the chain, with more value added by the financial sector. If the price of a kWh remains the same in spite of these changes, this means that other divisions such as the real economy has to hand over value added activities. It is assumed that the primarily function of these products is to hedge risks of wind energy projects or to optimize the return which is generated by the wind parks.

**Hypothesis 1c:** Wind energy projects and electricity from wind energy are increasingly being traded and becoming an object of speculation, which changes the commodity chain's structure.

This hypothesis relates to the research question regarding the structure of the commodity chain and the impact of financialization processes that affect the chain. This hypothesis focuses on the meaning and purpose of the chain's product. The hypothesis assumes that the product, a wind park or a produced kWh, will evolve away from its actual purpose and become an object of speculation. It is thus assumed that in the early days of the wind industry, wind parks were built and used for electricity generation. The kWh was produced and sold and thus made usable for the end user. The commodity chain was aligned for this process and purpose. Then the chain changes through conversion into a speculative object. Thus, project rights are not bought to be implemented, but to be traded and to speculated. The same is true for wind parks. The hypothesis assumes that wind parks are purchased and are not operated for more than

20 years, but change owners during this time. The electricity produced is also traded several times before it reaches the final consumer.

The hypotheses (1c), as well as the other two (1a, 1b), are all related to the input output dimension of commodity chain research. If these hypotheses can be verified, the research question can be answered. A financialization of the structure of the commodity chain would thus confirm that financialization processes influence the commodity chain's structure of the German wind industry and change the actors and their functions.

The following hypotheses deal with the key question of governance which prevails within the commodity chain and which companies and actors control and influence the chain.

**Hypothesis 2a:** The influence of the financial sector in the wind industry is increasing, which leads to a rising command and control position of financial actors in the commodity chain.

It is of great interest to analyze which actors have what kind of power positions in the commodity chain. The hypothesis implies that in the past, the financial sector has not had much impact on value-adding processes in the chain but now the influence of the financial sector in the chain is growing steadily. It is alleged that this influence of financial actors increases in such a way that the financial actors receive an elevated position of power within the chain. Due to such a power position, various command and control functions may be performed, which may fundamentally change the commodity chain.

**Hypothesis 2b:** Due to the rising power position, the financial sector receives extensive command and control functions within the chain, creates market barriers, controls market entries and thus has decision making power not only in the financial economy but also in the real economy.

Control and management functions have an incredible influence on the actors, their processes, the participation on the commodity chain and the resulting profits. Especially in the control of market barriers and market entry, companies may be favored that are already under the control and the influence of financial actors. For other actors, which may possibly bring no financial advantage for financial actors, the entry to the market can be hampered by this power position. They can even be forced out of the market. Thus, the lead firms can decide who are the winners in a chain who are the losers in a commodity chain. This circumstances also influence the upgrading[18] possibilities.

**Hypothesis 2c:** Decisions of corporate management are increasingly taken in a way that the business strategy is focused on shareholder value and thus the decision making is based on the return on investment.

Hereby it is assumed that within wind industry companies the strategic orientations and decisions are no longer focused on reinvestment and corporate growth. Instead, there is a shift towards a strategy in which the dividend payments are of the priority when making decisions. In this context, shareholder value is understood as the company's strategy in the sense of the shareholder. The aim is to maximize the company's value and thus to increase the return on equity. As a result, the equity interest rate dominates other company decisions. However, one must distinguish between different scenarios. Firstly, there are listed companies in the wind industry, which are under the influence of shareholder value. Secondly, there are companies that are under the influence of other lenders. Here, the dependence on these lenders is particularly interesting, as well as the rating of the borrower. While the sale or purchase of shares affects a company only indirectly, changes in the conditions of access to credit have a direct impact on the business operations. From a lender's point of view, the increase in value is of less importance, but the reliable solvency of companies plays a central role, connected with hedging risks. The focus here lies on the enforcement of ratings from private rating agencies which become globally accepted as an independent orientation system. This acceptance is encouraged by the international banking supervision which gives the rating agencies a public status.

The hypothesis (2c) mentioned above and the other hypotheses (2a, 2b) are settled in the commodity chain dimension of governance in the German wind industry. The hypotheses analyze how governance is structured, how it works and identify who are the companies with command

[18] In the GCC research upgrading is described as a process in which companies ascend in the commodity chain. This may occur (1) if products which are higher quality and higher price per unit are produced, (2) if improved technologies or production systems are used, (3) when changing from one industry to higher value added industry or (4) if a manufacturer is responsible for additional process steps in addition to its base production (Bair, 2005, p. 166).

and control functions and which companies have to follow them. If the hypotheses can together be verified, the governance in the German wind industry is changed by financialization processes.

The last three hypotheses relate to the central question for the institutional framework, which is also a dimension of the GCC research. It is argued that each commodity chain is embedded in such a framework, and that the chain is exposed to certain influences, emanating from the institutional framework. The intention is to analyze whether the institutional framework is changing and what impact this possible change has on the commodity chain of wind energy in Germany.

**Hypothesis 3a:** Changes in the institutional framework strengthen the position of the financial sector in the wind energy commodity chain.

This hypothesis argues that the institutional framework, especially the EEG, changes. These changes, which are noticeable especially in the last EEG changes in the EEG 2014 and EEG 2017, have an impact on the commodity chain's framework to such an extent that a strengthening of the financial sector is created within the chain. The idea behind these changes is to convert the remuneration of wind energy long-term in a free market. This process has already been initiated and proceeds gradually and continuously. While a review of this law process is not a priority in the analysis, it is assumed that due to the progressive liberalization and implementation into a free market new space is created which can for example used for new financial products. In a free market, specific risks need to be covered in order to generate a stable cash flow, to guarantee secure finance. To hedge these risks, it is argued that new financial products are created, which enlarge financial sector's sphere of influence and increase the share of value added. In addition, an enormous cost and competitive pressures occurs throughout the whole chain resulting from the integration into a free market. This means that all chain actors work on their profitability, they have to perform their services more cost effectively, they need to optimize their expenses and possibly they have to lower their margin expectations. If all cost items in a wind energy project are already optimized, ultimately the structure of finance and withdrawable financing terms decide whether a project is still economically viable or not. This circumstance allows the financial sector in the wind energy sector completely new business areas and new possibilities for action, which strengthens their power position in the chain significantly.

**Hypothesis 3b:** Through changes in the institutional framework, wind energy plays a larger role in the capital market and thus attracts investment from other investment sectors.

This hypothesis assumes that the institutional framework changes to such an extent that the wind energy commodity chain – with all its products and actors – attracts more interest in the capital market. Furthermore, as a consequence of these changes the wind industry needs the capital market for capital procurement. Here, the capital market serves the wind industry for the short-term, medium-term and long-term capital procurement for financing companies which are working in the wind industry or to finance and invest in wind energy projects. Thus, for example project planners can raise capital from the stock market or can finance their operational business with so-called profit participation rights. This can also be done via the gray market. The gray market is part of the financial markets. It is not illegal, but is not governed under state financial or similar regulations. The need to address the capital market and the capital market's interest towards investing in wind energy is caused by different factors. Firstly, it is expected that wind park planners and operators continue to grow in the future and this growth must be financed. It is assumed that they increasingly finance their operational expenses with bonds. The interest to invest in wind power is caused by both long-term and stable rates of return. This interest rate is generally above the interest rate of bank deposits and government bonds, which makes wind energy very attractive for the capital market. A growing importance of wind energy in the capital market would support the idea that financialization exists in the wind energy commodity chain.

**Hypothesis 3c:** Due to changes and a financialization of the industry, the readiness to assume risks increases, so that wind energy projects and the whole commodity chain are more susceptible to crises.

In this hypothesis, it is argued that due to the various changes in the framework and the possible financialization, wind energy projects become riskier, which has impact on the entire industry. Similar to the financial crisis, which has shown that it became increasingly difficult for the stock exchanges to evaluate the risks, the vulnerability to risk caused by financialization can also increase in the wind industry. The opaquer and complicated the financial products become, the easier it is to overlook the errors in the system. In this case, it is claimed that a causal relationship exists between financialization and crises. New financial products and new forms of bonds for wind parks include for example derivatives, which hedge certain risks. Due to a restructuring, the risk is made tradable, which is not completely assessable, transparent or manageable for an investor or operator. It remains to be seen whether this hypothesis can be sufficiently proven or disproven. First, the aforementioned hypotheses must be proved in order to determine financialization processes in the German wind industry. The hypothesis of the risk exposure is based on the previous hypotheses. Furthermore, it has to be analyzed if vulnerability to risk can be ever proven or disproven, if no crisis has yet occurred. This will be processed, identified and assessed in the following.

All three previous hypotheses are embedded in the commodity chain research dimension of the institutional framework. If the hypotheses (3a, 3b, 3c) are verified during the empirical research, it will be explained how the institutional framework affects the German wind industry and if changes to the institutional framework favor financialization processes.

# 3 Research Design

## 3.1 Methodical Approach and Research Strategy

### 3.1.1 Research Process and Structure of Investigation

The methodology of this research work derives from the logic of the research question and depends on the chosen research context. An important decision for the choice of the applied methods is the availability of data and information. Since financialization processes can express themselves very differently and can also appear at different analysis levels, it has been decided to carry out the analysis at different levels. Due to these different levels, it was also necessary to use different methods, since not every method could be applied to every level of investigation. Thus, a combination of different methods and research approaches was considered as useful.

In order to generate new data and gain new findings, both qualitative and quantitative methods of investigation were used in this empirical research. Qualitative examination methods are non-standardized interviews in which the respondents were asked open questions. In this dissertation, both informal expert surveys[19] and semi-structured interviews were conducted. The reason for the choice of these methods was the proximity to the process that these methods have and the speed at which these processes can be captured. In both qualitative methods, the respondents were able to talk freely. Since the data and findings of the expert surveys and semi-structured interviews were obtained directly from the data collection for this research purpose, these are primary data. Primary data have the advantage that they often have very high significance, since the primary data is collected directly for the purpose of the investigation and the related research question of the financialization in the wind energy market. This does not mean that secondary data is not highly significant, but the high significance of primary data for this dissertation arises from the fact that the research questions explores a recent phenomenon which is still developing.

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[19] For further information regarding expert surveys see chapter 3.2.6 (p. 94).

Furthermore, the semi-structured interviews have to be used to differentiate the applied methods more precisely. In this analysis, a distinction must be made between the methods of collection, processing and evaluation of the data. For example, semi-structured interviews are a qualitative survey method that does not yet provide information about the processing and the evaluation of the data obtained. For this reason, the following detailed explanations are given as to which technical aids were used for the evaluation and which aspects and with which research focus the interviews were evaluated and which procedures were applied.
Due to the research question, the examination process in this dissertation is designed to be very open and explorative. This seemed to be useful in view of the subject area, which was still under investigation and has barely been researched. Therefore, the focus was placed on a qualitative method with the semi-structured interviews. For the validity and the possibility to generalize these statements, it is particularly important in qualitative research to document the procedure in detail and to make the research process comprehensible (Mayring, 1999, p. 115).
In order to strengthen the significance of the qualitative statements and findings, quantitative data was added to the qualitative data. The quantitative investigations are about generating an analysis of the largest possible quantity. For the dissertation, mainly secondary data was used for quantitative data. The aim was to collect prices, yield expectations, governance structures, historical developments, future scenarios, market assessments and impacts on politics and finances, as well as the collection of economic indicators for companies, investors and wind park projects. The sources for generating these findings were statistics, business reports, fund database and stock exchange data. Since the data is already generated, one speaks of this is classified as secondary data. Secondary data was originally collected for another purpose, but can also help to answer the research question within the context of this dissertation. Careful verification ensured that the secondary data is still up-to-date. The advantage of the use of secondary data is that the data is often public and can be used free of charge.
Figure 6 (p. 84) shows a summary of the structure of investigation with the applied methods in this dissertation. The figure displays the combina-

tion of primary and secondary data. After the data was selected, it was analyzed. The semi-structured interviews were all transcribed. After the transcription, the coding process followed. Codes are used to assign one or more codings to a text point. These codes can consist of terms, keywords or concepts. Furthermore, the secondary data was subject to analysis. Thus, the secondary data was evaluated and examined and from the point of view of the research context the data is utilized or linked to the results generated by the primary data. The resulting new insights form a further basis for analysis, interpretation and application. After the knowledge is generated from the sources, both primary and secondary data is passed through a triangulation, which serves as a plausibility check. "The common theme in discussions of triangulation has been the desire to overcome problems of bias and validity. It has been argued that the deficiencies of any one method can be overcome by combining methods and thus capitalizing on their individual strengths" (Blaikie, 1991, p. 115).

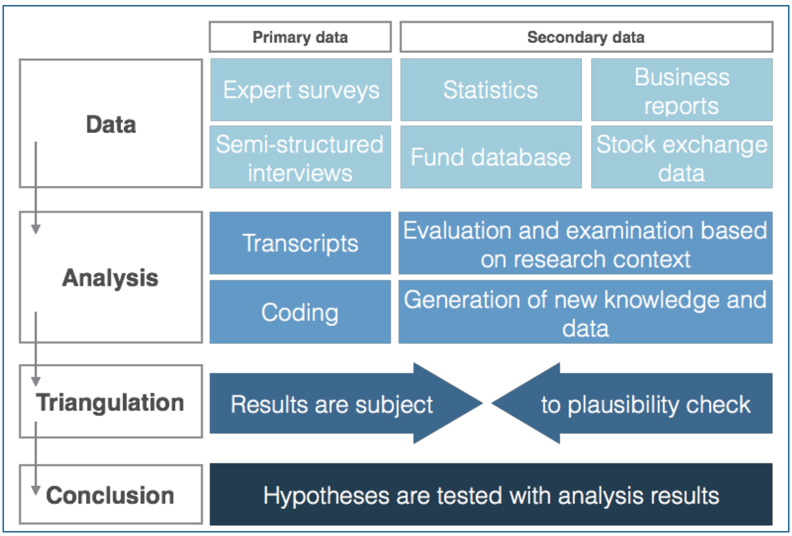


Figure 6: Structure of investigation with applied methods (Own illustration)

This means, for example, that the insights gained from the interviews are compared with findings from statistics or business reports. Reliability is made possible through the examination of the gained insights. This is to ensure that the same results of the study can be obtained under the same research conditions and the same knowledge can be obtained when the examination is repeated. Thus, the results could be replicated. After the triangulation as plausibility check, the conclusion is drawn. During this process, the hypotheses derived from the research question are proved with the results of the analysis. Thus, the hypotheses can be proved in the end and the interpretation can begin. Finally, the interpretation may give new evidence in answering the question of whether and how financialization takes place in the wind industry.

The research has tried to ensure objectivity at every step of the implementation. Objectivity here means that the results of the investigation are in no way affected. This means that the collection of the data was taken to ensure that there was no conscious or unconscious manipulation. Objectivity is also imperative when evaluating the data. But it has to be mentioned that during generating data from interviews or expert surveys complete objectivity is never given. The interviewer always has a certain previous knowledge, always comes from a specific culture and always has a certain intention to answer the research question. Once the data has been evaluated and checked for plausibility, the data is ready for interpretation. The interpretation of the results takes place without conscious distortion. Only in this way can a degree of interpretive objectivity be achieved.

### 3.1.2 Operationalization of the Hypotheses

Hypotheses are necessary to verify theories, which are derived from the higher-level research question and the key questions in chapter 2.4 (p. 72). Thus, the hypotheses were characterized with empirical content. The rules under which the hypotheses are proved and verified is called operationalization. The operationalization determines how a hypothesis become observable and measurable. In this way operationalization is of great importance in all scientific work, as it is often the basis for carrying out measurements. Operationalization ensures the traceability of the research procedure. It defines which data is collected by which method for determining the hypothesis. Therefore, indicators are defined which allow the detection of a particular question. The operationalized term thus becomes manageable by the indicators by defining what is to be understood in the context of the research process and how this can be measured. In the following, the operationalization is explained in detail and it is defined how indicators can derive from the hypothesis. At least one indicator is assigned to each hypothesis.

**Hypothesis 1a:** The structures of owners and investors of wind parks and the business activities of firms are shifting from the real economy towards the financial economy.

The individual actors who are involved in a wind energy project or are located in the wind industry and who are getting financialized can be identified as an indicator. The term real economy is referring here to a part of the economy which deals mainly with the production, distribution and consumption of goods and services. Alongside to the real economy is the financial economy or the financial sector. The financial economy includes all business activities which focus on financing, capital investments, payment transactions and risk management. The actors who are involved in a wind energy project can be determined from the semi-structured interviews, the expert surveys and the relevant literature. From this it can be determined how many different actors are involved in the production of a single kWh. Furthermore, it is possible to determine the nominal value of the price of a wind energy turbine. This can be used to calculate the development of the electricity production costs. If the investment costs per kWh produced are declining and at the same time the number of actors is rising, a competitive pressure in the market must ultimately arise. As a further indicator, the individual value-added shares of the respective actors can be used. This can be done both at the level of investments (CAPEX) and at the operational level of a wind park (OPEX). Based on the shares, it is possible to numerically determine the value each actor has added in the commodity chain. Through the interviews and technical discussions, it is possible to determine whether the German wind industry is a buyer's or a seller's market. The answers of the interviewees allow one to deduce who is the leading force in sales and transactions. As a final indicator, statistics of the ownership structure can be used to describe the structures of the wind industry.

**Hypothesis 1b:** To hedge risks and optimize returns, new financial products are created that extend the financial sector's field of activity, which leads to a change of actors and their functions.

If wind parks are funded, there are different ways to finance them. Banks can structure a certain form of project finance. A project financing of wind parks may not be a completely new product on the financial market, but this product can always be newly designed and modified. Indicators are, in this context, finance products for reducing risk or the reduction in capital requirements. Furthermore, in this hypothesis, the number of different financial products can be taken as an indicator. This means that the market for wind energy must be screened and analyzed focusing on the type and characteristics of products available and offered by financial service providers. As a further indicator, it is useful to analyze statistics showing how many energy funds have been placed in Germany. Additional focus can be placed on the stock market. New financial products created by the stock exchange to deal with certain risks and other products are an indicator of a further product field, which is developed by the financial sector.

**Hypothesis 1c:** Wind energy projects and electricity from wind energy are increasingly being traded and becoming an object of speculation, which changes the commodity chain's structure.

Statements regarding increasing trading behavior of projects from interviewees like managing directors or members of high management levels who actively shape the company's investment decisions can be used as an indicator here. These statements from the interviews can give an assessment of the experts on whether wind energy projects are traded more frequently now than in the past. In addition, the question of the investment strategy and the investment horizon can be asked. This can be used to determine whether wind energy projects are short-term or long-term investments. Thus, a higher and more frequent trading rate means shorter investment horizons, business focus on speculation and more generated trading fees for the financial sector. Quantitative figures from annual reports cannot be used in the context of this dissertation, since these are not publicly available and are treated with extreme discretion. The acquisition and sale of explicit projects is often not listed in these annual reports. The situation is different with traded kWh. Quantitative figures such as the trading volume and the daily price of traded kWh can be retrieved from the stock market. A time series can be created from different years. From this it can be deduced how the trading volume of kWh has changed over time. However, this data series of the trading volume must be compared with the actual energy consumption in order to obtain a meaningful interpretation.

**Hypothesis 2a:** The influence of the financial sector in the wind industry is increasing, which leads to a rising command and control position of financial actors in the commodity chain.

An indicator for this hypothesis is that the ownership structures of listed companies in the wind industry are changing. It can be shown in percentages how ownership structures develop over years and which actors are in possession of these companies. By listing the shares, it is possible to determine whether and to what extent companies from the financial sector are involved in wind industry companies. Furthermore, wind energy projects become more complex, which can be explained by the indicator of longer planning and implementation time. This means that in the case of more complex projects, more and more service providers are involved, providing consulting services to companies. Some of these consultancy services are also found in the financial sector. In addition, the development of financing volumes in the wind industry can be shown as a nominal indicator. It can be shown how the investment volume of energy funds is developing. The relation of the development of the annual total remuneration for all German wind parks can also be presented. This growing funding potential serves as a pull factor for financial services providers and strength the power position. The financial services providers on the one hand want to invest in the wind industry and on the other hand to finance wind parks. Another indicator is the detection of changes in the profit margins of the actors involved in the commodity chain. On the basis of profit margins and shares in the commodity chain, the actor's influence of the chain can also be concluded.

**Hypothesis 2b:** Due to the rising power position, the financial sector receives extensive command and control functions within the chain, creates market barriers, controls market entries and thus has decision making power not only in the financial economy but also in the real economy.

Case studies in which participants report on market barriers or control structures by the financial sector can be presented. As a basis for these statements, expert surveys and semi-structured interviews can be used. These can come from actors from the real economy as well as from the financial economy. As an indicator, statements can be drawn from the interview partners regarding how decisions are made and how they describe their own or their company's influence on the chain. As a further indicator, financing requirements can be cited by banks. In order to finance wind energy projects, there is a list of banks that registers which manufacturers and which experts are, for example, bankable. These lists are not public, but can be obtained from banks. Furthermore, it can be shown by statistics that remuneration per kWh decreases and thus the profitability of the projects diminishes. As a result, projects have to be optimized in different parts. As an indicator, the influence of the leverage factor and the relationship between equity and loan capital can be calculated and this factor can have a significant impact on the profitability of projects.

**Hypothesis 2c:** Decisions of corporate management are increasingly taken in a way that the business strategy is focused on shareholder value and thus the decision making is based on the return on investment.

Through questions during the interviews how decision making works, it is possible to ascertain the importance of shareholder value in decision making. The qualitative statements can serve as an indicator of a decision tendency that shows the importance of shareholder value in German wind energy companies. Furthermore, the interview answers regarding the expectation of return on investments and especially the changes of the expectations, can also be taken as an indicator of how certain decision making structures work. In this respect, the change in the investment horizon of investors and financiers can also be used as an indicator. By analyzing business reports from established funds in the wind industry it can be concluded which investment horizon is based on business models and whether these investment horizons have changed. It can also be used as an indicator of who makes business decisions. This can be concluded from the discussions with the interview partners. If, for example, managing directors of wind turbine manufacturers say that decision making is influenced by service providers such as attorneys and in other conversations or interviews this statement can be confirmed and thus be verified, this can be used as an indicator.

**Hypothesis 3a:** Changes in the institutional framework strengthen the position of the financial sector in the wind energy commodity chain.

As an indicator of changes in the institutional framework, the different modifications of the EEG can be used, which are leading to different remuneration and organization structures. The changes can be demonstrated and elaborated on the basis of modifications in the law. Based on the number of paragraphs and the system of the law execution, it is possible to interpret whether the framework conditions changed and how these changes affected the chain. The consequences for the industry, through the changes already made, can be worked out and analyzed. Hereby the focus is on the financial sector. Individual examples have to be worked out that suggest that the financial sector is gaining strength because of these changes and is able to perceive a stronger position of power in the chain. Key interest rates are a further indicator that can refer to changes in the underlying conditions. Key interest rates are an interest rate fixed by a central bank, with which the central bank enters into transactions with associated credit institutions. These interest rates have an impact on the entire chain. At low interest rates, investors move their capital from banks to other financial products to protect themselves from inflation. This shift promotes financialization processes. These financial products offer higher interest rates but also involve a higher risk. Indicators for a strengthening of the financial sector by changing key interest rates are statements by interview partners about the impact on their business model. Examples include the change in profit margins or the opportunities for financial service providers to take part in specific business models. This possibility for the participation of financial service providers is also reflected in the indicator of ownership structures. In the case of listed companies, the ownership structures can be analyzed in various business reports. Due to changing institutional frameworks, a causal link can be developed showing that changes in a company's ownership structure are caused by the institutional framework changes. A stronger power position of the financial sector could be perceived as an indicator because of the fact that the ownership structure changes in favor of the financial sector over the years. In general, however, the goal is to be able to prove or disprove this hypothesis and that a logical and causal argumentation is developed.

**Hypothesis 3b:** Through changes in the institutional framework, wind energy plays a larger role in the capital market and thus attracts investment from other investment sectors.

The equity-debt-ratio in wind energy projects and the change of this ratio is a very good indicator for mapping the role of wind energy on the capital market. Growing investment figures with a simultaneous reduction in the equity requirement necessarily leads to a higher share of the loan capital. This debt capital can be financed on the capital market. The trading volume of wind parks, which are listed on the stock market is also a very good indicator of this hypothesis. An increased trading volume indicates an increased interest in wind energy on the capital market. The trading volume of each share can be related to the actual revenue of the respective company. From this correlation, it can be concluded to what degree the interest of the respective company of the wind industry in the capital market is in relation to the actual profit that this company generates. The situation is similar regarding electricity traded on the exchange markets. An indicator of an important role in the capital market is a growing volume of traded electricity at the Leipzig electricity exchange. The traded amount of electricity can be mapped in proportion to the consumed electricity to find out to what extent trade is capitalized. This can be inferred from the importance on the capital market. A final indicator of market capitalization and the interest in the capital market is the frequency of trading wind energy projects. Therefore, qualitative insights from the interviews must be derived to prove a change of this trade frequency of projects. If projects are often traded and these transactions go through the capital market, this would confirm that the interest in the capital market is increasing with respect to wind energy projects.

**Hypothesis 3c:** Due to changes and a financialization of the industry, the readiness to assume risks increases, so that wind energy projects and the whole commodity chain are more susceptible to crises.

At a quantitative level green funds investing in wind energy projects can be evaluated. Here, the results can be evaluated on the prospected profit and capital losses and thus serve as an indicator of how risky wind parks in Germany are. Thus, it is possible to quantify what risk prevails and how high the probability of failing wind energy projects is for private investors. Another indicator of a rising liability to risk is the increasing complexity. This can be measured by identifying more complex planning phases, more complex construction methods and a more complex market environment. A more complex environment can lead to a business environment in which one can no longer consider and oversee all risks. This leads to higher risk tolerance and makes the chain more susceptible to crises. Another indicator is the measurement of the risk tolerance of the market participants. This risk tolerance is dependent on the business model of the respective market participants. In discussions with the interview partners, it can be shown whether the level of risk tolerance has changed. To measure crises, a political risk analysis can be conducted as an indicator. Hereby, the occurring risks, which are possible with every EEG amendment, can be listed. Changes in the number of possible risks over time make the liability to risk and therefore vulnerability to crises of the wind industry measurable.

## 3.2 Primary Data and Sources

### 3.2.1 Semi-Structured Interviews

The reason for choosing semi-structured interviews, which is the main source of primary data in this work, is due to the exploratory nature of this research method. The aim of this form of interview "[…] is to achieve a better understanding of a company's strategy, behavior, relationships and structure" (Schoenberger, 1991, p. 180). But the "[…] value of its qualitative and inductive aspects may be highest in periods of great economic and social change that pose new challenges to the analytical categories and theoretical principles underlying much quantitative research" (Schoenberger, 1991, p. 181). In such a rapidly changing industry as the wind industry is data generation by such qualitative interviews is the best choice. Thus, the greatest advantage of semi-structured interviews is that by using this method the rapid changes can be recorded and documented. Through the qualitative approach one investigates and discovers aspects that would not have been possible in a deductive or quantitative approach. In the interviews, this qualitative approach reveals aspects that would never have been discovered with a deductive or quantitative approach.

Semi-structured interviews are included in the group of non-standardized interviews. In addition to non-standardized interviews, there are still fully-standardized interviews and non-standardized interviews. In the case of fully-standardized interviews, the questions and the answers are the same for each interview and interview partner. The interviewer has prepared a questionnaire in advance. In this questionnaire, all questions are formulated in a fixed order. The questions are closed questions, which means that the interviewee cannot formulate the answers himself, but can only select one of the different predetermined response possibilities. In a semi-standardized interview, all questions are formulated and standardized but the questions are open and can be answered freely by the respondent. Above all, the standardized interviews are frequently used in quantitative research (Gläser and Laudel, 2010, p. 39).

In a non-standardized interview, as used in this dissertation, the complete opposite is the case. In this approach neither the questions of the interviewer nor the answers of the respondents are standardized and given. Non-standardized interviews were chosen to obtain qualitative statements on the research questions, which would not have been possible if the questions and answers were already set and fixed. For a standardized interview survey, the research question and the possible ways to answer this question is too complex.

In this dissertation, the interviews were conducted as non-standardized interviews. In the case of non-standardized interviews, it is also possible to distinguish different interview forms by their structure. In contrast to unstructured interviews, which do not have a pre-defined questionnaire, the semi-structured interview is defined by a question catalog. This interview is therefore semi-structured, since the guideline pre-determine which questions are asked to the respondents, and in which order. The advantage and reason why these semi-structured interviews were chosen in this dissertation is that these key question interviews have a higher degree of freedom. Thus, the researchers may deviate spontaneously from the guide in order to ask additional questions which may arise through the course of the conversation (Döring and Bortz, 2015, p. 359). This seemed to be a major advantage before the accomplishment of the interviews. It was also shown in the course of the implementation that this choice was very useful, since new aspects and topics could be picked up which helped to answer the research question. However, these questions were not yet known when preparing the guideline questions.

As has been shown by the allocation of indicators to the hypotheses in the methodology section, a large number of questions can only be answered with data generated in a qualitative manner. In the input-output analysis of commodity chains, one can answer the questions about the structure with quantitative data, but the analysis of governance and the institutional context of commodity chains with quantitative data quickly encounters limitations. Quantitative data can act as a basis or as a plausibility check for these questions, but in order to penetrate deeper into the questioning and the matter of governance and institutional context, the generation of qualitative data is indispensable. This is the only way to ensure the research captures as many facets as possible from different responses to the research questions.

In order to generate information on governance and the institutional context, the knowledge of experts from the interviews must be used. Experts are, in this sense, persons who have a certain function and therefore have special knowledge about this function and beyond. These people have a knowledge of the social contexts in which they act, operate and make decisions. Thus, experts of the wind energy commodity chain have an expert knowledge about the company in which they work and know how the structure of the commodity chain works.

In a guideline interview, the conversation resembles a dialogue that could also could occur in everyday life. In everyday conversations, there are also situations where one of the participants interrogating the other.

Standardized expert interviews are distinguished by the following three characteristics: (1) During the conversation, cultural rules of communication are defined, which also means that the interviewee and respondent may also refuse answers. (2) During the interview, there is a clear role allocation. The interviewer asks questions and the expert answers these questions. This role allocation is recognized by both parties. (3) The interviewer conducts the dialogue. This dialogue is coordinated with the research question by means of the preliminary questions developed in advance, and is thus directed towards a particular information goal (Gläser and Laudel, 2010, p. 112).

The semi-structured approach was deliberately chosen for the interviews, where questions are posed and defined in advance, but these questions can be answered very openly. This approach was chosen because questions about governance structures and shares of value added can be answered very openly. The interviewee does not have to choose between predefined answers, which leaves enough space to intercept new and interesting ways of viewing certain topics during the interviews.

As with any survey method, criticism can also be exercised when carrying out expert interviews. The criticism is due to the fact that the researcher has to rely on the statements of the conversation partner while collecting the data. Often there is no way for the researcher to control and verify the truth of statements. However, to avoid blind trust, certain statements can be tested for plausibility by obtaining a second or third opinion. This also leads to a further criticism of expert interviews, which must be mentioned here. To match certain statements with a second or third interview, it is possible that another expert can make a conflicting statement. This allows the status of experts to be relativized (Bogner et al., 2014, p. 4).

Finally, it should be noted that the qualitative research method was not carried out without a quantification. On the contrary, even suitable statistical evaluation procedures have been carried out. It is, however, important that in answering the research question, the approach to social reality is done through open procedures. The questions of financialization and commodity chains are particular fields of investigation where research must be developed primarily without the aid of standardized survey instruments. However, this open access to social reality and the renouncement of previously developed survey instruments does not mean that a theoretical lack of presupposition prevails. Rather, there should be the possibility of specifying, modifying and revising a continuous exchange process between qualitatively raised material and, at first, a still somewhat determined theoretical preconception (Hopf, 2016a, p. 17).

### 3.2.2 Selection of the Interview Partners

Semi-structured interviews are a qualitative research intention and do not claim to be representative in a statistical sense. Nevertheless, the interviews are intended to reflect the generality as individual analyzed cases. Therefore, the selection of the respondents' sample is of particular interest. There are several methods for determining the methods and criteria that can be used to create these samples (Flick, 1995, p. 78; Kelle and Kluge, 1999, p. 38).

There are two ways to define a sample of interview partners. Either the sample selection is defined in advance by means of different criteria, or the selection becomes more and more extensive during the working procedure with increasing knowledge (Flick, 1999, p. 79-83).

In this dissertation, the method of theoretical sampling by Glasner and Strauss (1979) was used to create the survey sample. This theoretical sampling is very suitable for this course of the study as it is well suited for explorative studies in which little is known about the research field. Data collection and analysis of the data is strictly synchronized. This means that the selection of interview partners was also dependent on the interviews already conducted. This means that the analysis results of the first interview have an impact on the selection and collection of the next interview partner. The selection ensures that as many different cases as possible are required in order to achieve a minimum and maximum contrast. The advantage of this approach is that the research field is covered as widely as possible. If the sample selection had been predefined in advance, there would therefore be a risk that all relevant areas of a field would not be taken into account when selecting the interview partners. Especially since the findings that can be drawn from an interview always

depend on the willingness to give an interview or on the availability of the potential interview partners (Glaser and Strauss, 1979).
The survey and the theory were modified, adapted and changed until the hypotheses of this dissertation and thus the underlying theory were sufficiently confirmed. The selection of the interview partners and the creation of the sample were finished when a theoretical saturation was achieved. This was made evident by the fact that no new findings could be generated in new interviews. This theoretical saturation was achieved in this dissertation with a total of 26 interviews.
Since the questions and hypotheses are answered from all areas of the commodity chain, it was also necessary to include interview partners from all areas of the commodity chain. The entire chain was divided into various process steps as shown in chapter 4.2 (p. 146). At least one interview partner had to be found for each individual commodity chain segment in order to analyze all process steps and the changes in the share of value added across the entire chain. As a result, companies from the wind energy sector were defined and assigned to these individual process steps. Due to the fact that the interviewees are experts from the respective fields, they are also referred to as expert interviews. This means that the interviewee is interesting not as a person but as an expert in a particular field. The results obtained from the interviews are therefore not individual cases, but the respondent is included as a representative of a certain group of actors in the investigation (Mayer, 2012, p. 38).
The companies and experts were then contacted. The interviewees were generally the managing directors of the companies or settled in the higher management. All interviewed experts were open to an interview. In no case was the request for an interview rejected.
The conduct of the interviews took place either in person or over the telephone. A total of 26 interviews were conducted in the period from January 27, 2015 to November 16, 2016. The interviews were all conducted in German. All codings cited in this dissertation are translated from German into English. The location of the interviews was either in the company's office, in a restaurant or over the telephone. It is therefore assumed that all interviewees could speak undisturbed and free from external influences. In all interviews, the conversation could be recorded

with a tape recorder. Permission was obtained at the interview before the interview with the respective persons. Thus, a total of almost 20,5 hours of interview material could be gained. The average interview duration of the interviews was 51 minutes. A list of all interview participants can be found in table 1, linked to the sector of the commodity chain in which the expert is located. Although many interviewees have given their permission to be named, for privacy purposes all interviews excluded personal data such as personal names and company names in all transcripts.

**Table 1: Overview of expert interviews and commodity chain function (Own table)**

| Interview | Date | Business sector | Location | Length [min] |
|---|---|---|---|---|
| INTVW 01 | 01/27/15 | Investor | Office | 51.5 |
| INTVW 02 | 04/24/15 | Politics | Office | 99.0 |
| INTVW 03 | 04/25/15 | Project developer | Office | 43.0 |
| INTVW 04 | 04/30/15 | Broker | Telephone | 57.5 |
| INTVW 05 | 05/07/15 | Fund Manager | Telephone | 67.5 |
| INTVW 06 | 05/11/15 | Project developer | Office | 22.0 |
| INTVW 07 | 02/28/16 | Project developer | Office | 35.0 |
| INTVW 08 | 02/29/16 | Manufacturer | Restaurant | 23.5 |
| INTVW 09 | 02/29/16 | Manufacturer | Restaurant | 27.5 |
| INTVW 10 | 03/08/16 | Electricity trader | Restaurant | 52.0 |
| INTVW 11 | 03/10/16 | Utility | Restaurant | 35.0 |
| INTVW 12 | 03/18/16 | Technical & commercial Management | Telephone | 43.5 |
| INTVW 13 | 03/30/16 | Project developer | Office | 55.0 |
| INTVW 14 | 04/01/16 | Bank | Telephone | 45.5 |
| INTVW 15 | 04/05/16 | Maintenance service provider | Telephone | 33.0 |
| INTVW 16 | 04/05/16 | Bank | Telephone | 50.0 |
| INTVW 17 | 04/13/16 | Planning association | Restaurant | 39.5 |
| INTVW 18 | 05/03/16 | Lawyer | Office | 42.0 |
| INTVW 19 | 05/03/16 | Financial service provider | Office | 43.5 |
| INTVW 20 | 05/11/16 | Consultant | Office | 45.5 |
| INTVW 21 | 06/09/16 | Service Provider for direct marketing | Telephone | 50.5 |
| INTVW 22 | 07/11/16 | Investor | Telephone | 45.0 |
| INTVW 23 | 07/14/16 | Financial service provider | Restaurant | 58.5 |
| INTVW 24 | 08/16/16 | Manufacturer | Telephone | 45.0 |
| INTVW 25 | 11/02/16 | Financial service provider | Office | 42.5 |
| INTVW 26 | 11/16/16 | Manufacturer | Office | 76.0 |

As can be seen in figure 7 (p. 99), all areas of the commodity chain were depicted. If one goes through the process steps of the commodity chain from front to back, one can see that all areas have been covered. Project developers (INTVW 03, INTVW 06, INTVW 07, INTVW 13) have the first idea of a wind energy project and develop the projects ready to build. In this project development process, the developers are dependent on politics (INTVW 02) and planning associations (INTVW 17). If the wind energy projects are ready to build the projects can be built by the manufacturers (INTVW 08, INTVW 09, INTVW 24, INTVW 26).

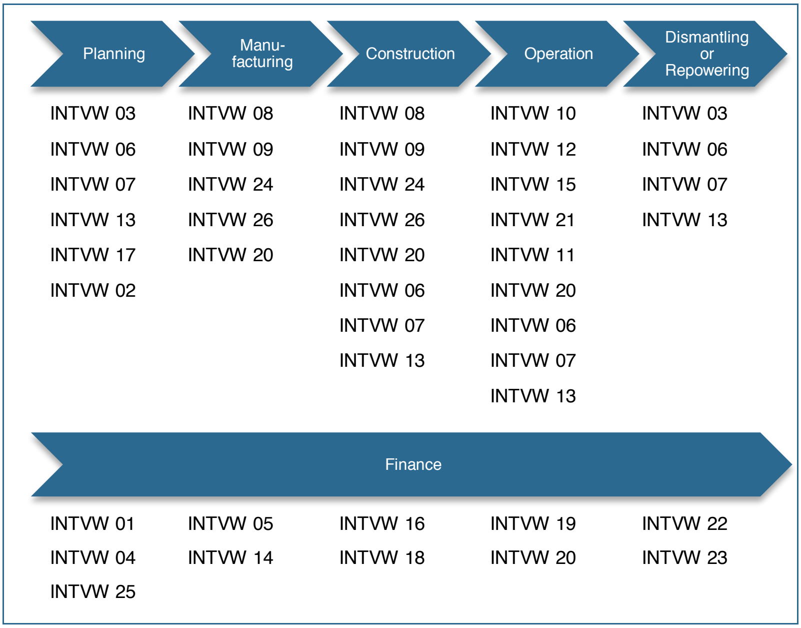


**Figure 7: Allocation of expert interviews and wind energy commodity chain (Own illustration)**

All wind energy projects are financed through a project financing by banks (INTVW 14, INTVW 16). Once the projects have been built, the wind parks must also be maintained by companies (INTVW 15) and managed technically and commercially (INTVW 12). In the end, project developers can also sell their projects to private investors (INTVW 01, INTVW 21), funds (INTVW 05) or utilities (INTVW 11) with the help of brokers (INTVW 04). These transaction processes rely on lawyers (INTVW 18), consultants (INTVW 20) or financial service providers (INTVW 19, INTVW 23). Electricity traders (INTVW 10) are positioned at the end of the commodity chain, which ultimately sell the kWh, which is produced by wind energy, to end customers. Since different actors are

also active in different phases, the same interview partners can also be assigned to different processes. In this way for example, a project developer can develop projects in the planning phase as well as contribute during the construction phase. In the operation phase, a project developer can also take over the commercial or technical management and is also responsible for the dismantling or repowering.
Since all the interviewees were managers or at a senior management level and had long-term experience in the wind energy sector in Germany, it was assumed that all interviewees had deep, area-specific knowledge. Finally, this area-specific knowledge is the essential criterion that has to be met when selecting experts. When selecting and especially when searching for experts, personal contacts were helpful, but they were never decisive for choosing an expert. Instead, the decisive selection criteria were area-specific knowledge and the professional competence of the interview partner.

### 3.2.3 Questionnaire and Questioning

The main problem while working with interviews lies in the knowledge difference between the interviewer and the interviewee. In contrast to the interviewee, the interest in knowledge of the interviewer lies in a scientific context. The interviewer wants to solve a research question. Therefore, the researcher has a scientific deficit in this area. The interviewee, on the other hand, has a different interest, which does not coincide with the interest of the researcher. Therefore, the interviewee also has different knowledge, observes differently and therefore also acts differently. These actions, such as knowledge, observation and action, are therefore also subject to different meanings. The researcher must therefore translate and transfer his interest in cognition into certain questions, which are adapted to the cultural context of the interviewee. This development of so-called central questions is a part of the operationalization, which is carried out. This operationalization is not limited to the creation of the guiding questions but also takes place in the development of the guideline (Gläser and Laudel, 2010, p. 138).
Since the interviews are semi-structured interviews, the questionnaire was prepared in advance. Although this questionnaire was prepared in

advance and filled with many detailed questions, always additional questions arose during the course of this dissertation, which were included in the entire questionnaire. For each interview, an individual guide was developed from this questionnaire specifically adjusted to the respective department of the interviewer. In addition, there were other questions that were interdisciplinary.

During the preparation of the guide, care was taken to ensure that a common thread was available in the interviews. The guideline served as a thematic framework, which was always focused on the research question and the question of financialization in the wind industry. All relevant topic complexes which had to be addressed in the interview were listed in the main questions. In each interview, the specific topic complexes were preceded by some personal questions. These personal questions enquired about the state and work experience of the interviewee in the wind industry, as well question regarding the position of the company in the wind industry and the company affiliation. The following thematic complexes were, for example, (I) personal questions, (II) analysis of the business model and structure of the GCC, (III) analysis of power structures, (IV) influence of the financial sector and (V) the political context.

In this questionnaire, the different questions were already pre-formulated in a specific order. However, depending on the course of the conversation the order of the questions could be changed in order to adapt to the narrative style and the topics of the conversation partner. The basic principles of qualitative research were taken into account in the preparation of the guideline. The procedure was not determined by the hypotheses. Thus (1) openness was given. Openness means that no predefined hypotheses should be examined. Rather, the goal is that subjective experiences, actions and attitudes should be recorded and analyzed. The guide must have (2) processability. Processability in this context means that the interpretations within an interview is not to be understood as static but must be understood as a process. For example, direct questions about the past and the present can lead to changes that are particularly important in the structural changes of the commodity chain. The last basic principle in qualitative research that has been taken into account is (3) communication. For example, the questions were designed to ensure that a corresponding level of speech was respected, the questions were understandable and a certain proximity to everyday language rules prevailed. These principles have ensured that the interviews have always taken account of the guideline, but were never closed to the process of communication (Misoch, 2015, p. 66).

The interviewer carries out a spontaneous operationalization during the preparation of the central questions as well as during the implementation. Although the interview covers the pre-determined key questions in a standardized framework, the process of communication between interviewer and interviewee described above is not regulated. This means that the placement of the abstract and the concrete must be improvised by the interviewer. Thus, the research questions which have been defined in advance must be transferred to specific interview questions. But this also happens the other way around. The respondents' answers must also be operationalized and assessed with regard to their possible theoretical significance. Thus the interviewer must constantly decide during the conversation whether and which responses of the interviewee are picked up and followed up (Hopf, 2016b, p. 69).

In order to answer the research question through the interviews, the research question must be transferred to the key questions. Hereby "[…] each interview question should be clearly connected to the purpose of the research, and its placement within the protocol should reflect the researcher's deliberate progression toward a fully in-depth exploration of the phenomenon under study" (Galletta, 2013, p. 45). However, care must be taken to ensure that the research questions are not passed on directly to the interviewees. There is a risk that the interviewees will be misled by the transmission of the direct questions and cannot freely communicate. There is also the risk that technical terms such as institution could be understood differently by the respondent than by the interviewer. In general, however, it must be noted that the possibility of a scientific analysis of the responses is very limited when the research questions are directly submitted (Gläser and Laudel, 2010, p. 109). Therefore, the research question was operationalized during the compilation of the lead questions in this dissertation, and thus the research question was only indirectly extended to the central key questions. A self-

interpretation of the interviewees about the causal connections with regard to the research question was thus excluded. Therefore, the statements could be tested for plausibility, and the gained knowledge could create in some areas a counter position which could be substantiated by other interviews or by other quantitative sources such as statistics.
The described assignment of the central questions to the hypotheses was made for each interview individually. In doing so, the questions were adapted to the company in which the interviewee worked, as well as the position and the respective role. Therefore, the same questions were not asked to each respondent. Furthermore, the questions on the respective products in the commodity chain and wind energy projects had to be tailored depending on the area of responsibility

### 3.2.4 Transcription of the Interviews

Qualitative data, such as that generated from semi-structured interviews, as well as quantitative data must be prepared in order to be analyzed. When spoken language is transferred into a written version, this is called transcription (Mayring, 2016, p. 89).
The goal of the transcription is therefore to produce a permanently available product, which faithfully reproduces the spoken conversation (Kowal and O'Connell, 2000, p. 438). The transcript must be prepared in such a way that it can be used for analysis and interpretation. "The goals of the analysis are to reflect the complexity of human interaction by portraying it in the word of the interviewees and through actual events and to make that complexity understandable to others" (Rubin and Rubin, 2011, p. 202).
This was done by transcribing all 26 semi-structured interviews. In the case of a transcription, the complete linguistic interview recorded on tape is transcribed. A first interpretation of the raw data is already carried out, since the spoken words are transcribed as they are understood by the interviewer. It should be noted that transcripts do not map the complete information of what was said and done in conversation. The creation and use of transcripts are constructive and theory-based processes. These processes result in a reduction of almost unlimited primary data, such as the original discussion. There is also a reduction in the processing of the

secondary data, for example, the recording of the audio tape of the interview. Thus, transcripts are always a selective construction (Kowal and O'Connell, 2000, p. 440).

The transcription of an interview must be done according to certain rules and guidelines. The respective transcription system is selected based on the nature of the research interest. For this purpose, various transcription systems are available, which can be distinguished by the extent of the writing of the acoustic data and the interpretation of these data (Flick, 2009, p. 300). Hereby different forms of transcriptions are available as standard orthography, literary transcription , eye dialect and phonetic transcription (Kowal and O'Connell, 2000, p. 441).

For geographic research, where the majority of examination focuses less on the exact linguistic utterance, and more on the content of the subject, a transcription in normal written German is usual. In the case of transmission to normal typeface, the characteristic of the spoken language remains, but the readability is considerably improved (Reuber and Pfaffenbach, 2005, p. 155). Since the analysis of the transcripts in this dissertation aimed to analyze the manifest content of the interviews, a literal transcription with the standard orthography proceeded. In the case of literal transcription, a complete textual version of the recorded interview is compiled. This means that each spoken word is also written in the same way and in the same order. In standard orthography, the spoken word is reproduced according to the norms of written language. This means that dialect and other linguistic features such as slips, accents, accents, word stretches or interjections are not taken into account. Furthermore, non-vocal information such as, for example, tone and speech volume was dispensed with during transcription.

At the beginning of each transcript the interview number, a pseudonym for the interview partners, such as project developers or bankers and the date on which the interview took place are listed on the front page. In the transcript, the statements made by the interviewer and the interviewee are clearly separated from each other by using paragraphs. In order to assign the paragraphs to the respective call partners, each paragraph (para.) of the interviewer begins with the abbreviation Q for question and the paragraphs of the respondent with an A for answer (Höld, 2007, p. 664). With

regard to the anonymity of the interviewees, the names of persons and companies were usually anonymized. For example, in some cases, the company name of the Danish wind turbine manufacturer Vestas was replaced by the synonym [manufacturer]. All the anonymizations made can be identified by the words placed in square brackets. If statements were made about companies which did not allow conclusions to be drawn from the interviewer or had given the interviewer the approval for the public use of the company name, such anonymization was waived.
After completion, all transcripts[20] were checked for correctness. After typing the written transcript was compared with the sound path recording. Hereby hearing and typing errors were improved.

#### 3.2.5 Coding of the Transcripts

Once the interviews are all transcribed, the coding can continue. The aim of the coding is to break up and understand a text and to assign and to develop categories and to organize them in the course of time (Flick, 1995, p. 165). At this step, a further interpretation by the interviewer takes place. There are both quantitative and qualitative coding. In the case of quantitative coding, the text is, for example, converted into numbers by questionnaires. Each response category is then assigned to a corresponding number. By this assignment to numbers, a statistical analysis can then be carried out. Since the focus was on an extension of the content context, qualitative coding was done in this dissertation. The qualitative coding is similar to the quantitative coding. However, the individual text passages are converted into text. The text of the interview is translated into coding text, shortened and thus generalized. The goal is that the interview text in the research process is prepared in consideration of the question and the defined hypotheses. The statements made by the interviewed respondent are converted into a code (Reuber and Pfaffenbach, 2005, p. 163).
In order to make the data accessible in order to be able to analyze it, the data must be evaluated using a method. In qualitative social research,

[20] The typing of audio files for some interviews was based on external help. These typewritten text passages were carefully collated word by word with the audio files for their correctness.

different evaluation methods are available. Two frequently used evaluation methods are the grounded theory and the qualitative content analysis. In the case of evaluation, the method for the formation of categories exists, but the collection and use of the categories is different for both. Therefore, coding also proceeds according to different rules. The Grounded Theory, which was developed predominantly by Glazier and Strauss (2008), is primarily suitable for the development of theory based on the systematical generated data (Glaser and Strauss, 2008, p. 12). The qualitative content analysis, which was mainly developed by Mayring (2015), is well suited to extracting descriptions of social facts from texts, which can be obtained from interviews, for example (Mayring, 2015, p. 12). Thus, the qualitative content analysis is very well suited for a systematic and theory-based processing of large amounts of text. Since the aim of this dissertation is to verify and analyze the financialization processes with the existing theory of the GCC by means of the German wind industry, decision was taken to undertake evaluation based on qualitative content analysis. The goal was not to derive a new theory based on practice from the grounded theory.

The aim of the qualitative content analysis is to analyze and interpret the fixed communication in the form of the transcript. At the same time, the result serves as an interpretative basis as well as a decision aid to carry out further data surveys. The interpretation can serve both to expand and to compress the data set (Flick, 2014, p. 409). Conclusions can be drawn from these analysis results to answer the research question about the financialization processes in the wind industry. The transcripts are being processed in such a way that a reduction of the complexity is given. In order to reduce this complexity, a category system is developed which defines which aspects are important for the evaluation and which are not relevant. This is done with the help of the formation of categories. In the method of qualitative content analysis, a category is understood to be an identifier or something characteristic. This identifier is then assigned to text passages in the analysis process (Kuckartz, 2009, p. 57).

The qualitative content analysis process consists of different stages. The first step is to determine which material is being analyzed. In this dissertation, all conducted interviews were analyzed. This is followed by the analysis of the emergence situation. Since all interviews were held as one-to-one conversations in closed offices, on the telephone or in restaurants, it is assumed that the interviewees could talk and give answers freely. The characterization of the material was the next step of the qualitative content analysis. Since all interviews were transcribed, the material was available as a literal transcription in writing from all interviews. The direction of the analysis follows. It was stated that the interpretation focus is on cognitive rather than emotional aspects. In the next step, qualitative analysis of the content of the material was undertaken according to the research question. This forms the theory-based differentiation of the question. Furthermore, the analysis technique must be determined. There are different methods, such as the method of abstracting, explication or structuring. A mixed form is also possible. If the method is chosen, the definition of the analysis unit follows, which determines which criteria are applied during the selection and categorization of the text sections. The final steps of the qualitative content analysis are the analysis of the material and the interpretation (Lamnek, 1993, p. 217; Mayring, 1989, p. 49).

In particular, the approach to the aforementioned formation of categories should be agreed according to the research question and the background knowledge of the researcher. As described above, there are different ways of forming the categories. Basically, a deductive or inductive approach can be chosen. The decision depends on the extent of the theoretical pre-knowledge and the chosen survey instrument. It should be noted that a combination of both approaches is also possible.

This combination of an inductive and deductive approach was chosen for the category formation in this dissertation. The basis for this decision making was the fact that comprehensive knowledge about the topic of wind energy, its actors and the respective processes in the commodity chain prevailed. In addition, the hypotheses resulting from the research question were already prepared before the interviews were carried out. Another reason was that a semi-structured interview form was used for the interviews. In this method, the categories are set up and defined before the analysis of the data material. Here, the goal is to extract fixed elements from the data material, and the entire data material is passed through predefined structures. The basis for the assessment of the material is the defined regulation criteria (Mayring, 2015, p. 65).

The different categories were thus derived from the already existing hypotheses. In order to avoid overlapping during the coding, the categories were assigned an example. Thus, a precise formulation of the categories was given. The deductive approach was partly combined with the inductive approach. In addition to the deductive categories, a so-called residual category was formed. From this residual category, the key and most important statements were then elaborated and transferred to another new category. These were, however, not an entirely new root category but subcategories. The new category formation was thus achieved by the inductive method. In addition to qualitative analysis, it was also possible to calculate how often which category was coded. This gives a better overview for which category is often coded and which has been coded very little. From this overview, findings can be drawn which may play a role in the interpretation of the main results (Mayring, 2015, p. 106).

In order to optimize the coding of the interviews, the computer-assisted software MAXQDA[21] was used. This commercial software can be used to support scientific projects and studies in which interviews, texts and media such as image, audio and video files have to be analyzed. The aim is to gain insights into the data material without anticipating the interpretation of the content by the researchers. MAXQDA can be used for both qualitative research, quantitative research and mixed-method research. The coding of the information in the transcripts took place with different codes. For a better overview, a special color could be assigned to each code, or to each code category. Encoding was done via drag-and-drop. All codes are stored automatically in the program. A modification of the codes or a different assignment of the codes can take place at any time. A statistical evaluation, the number of different codes and the number of codes in the respective interviews can be output automatically (MAXQDA, 2016).

[21] In this dissertation MAXQDA 12 Standard was used for the analysis and the coding.

**Table 2: System of codes and codings (Own table)**

| List of code categories | List of codes | Codings |
|---|---|---|
| **1. Key question: Structure** | | |
| | 1.01 Transition in to a free market | 8 |
| | 1.02 Change of actors and owners | 29 |
| | 1.03 Financial products and services | 19 |
| | 1.04 Increased trade and object of speculation | 11 |
| | 1.05 Professionalization and technical progress | 15 |
| | 1.06 Future development | 8 |
| | 1.07 Competition and consolidation | 41 |
| | 1.08 Reasons for outsourcing and takeovers | 9 |
| | 1.09 Profit margins | 25 |
| | 1.10 Change of profit margins | 27 |
| | 1.11 Real net output ratio | 19 |
| | 1.12 Leverage effect | 7 |
| | 1.13 Expected return | 10 |
| | 1.14 Term of investment | 4 |
| | 1.15 Change of return | 21 |
| **2. Key question: Governance** | | |
| | 2.01 Rising governance position of the financial sector | 28 |
| | 2.02 Reason for rising governance position | 37 |
| | 2.03 Financial sector has command and control function | 26 |
| | 2.04 Decision making is based on the return on invest | 11 |
| | 2.05 Increasing shareholder Value | 12 |
| | 2.06 Advanced service providers make decisions | 21 |
| | 2.07 Financial sector takes new fields of activity | 12 |
| | 2.08 Buyer's market and seller's market | 9 |
| | 2.09 Winners and losers of change | 15 |
| | 2.10 Inter-chain upgrading | 2 |
| | 2.11 Lead firms of the commodity chain | 20 |
| | 2.12 Decision making | 14 |
| | 2.13 Large companies benefit from changes | 20 |
| **3. Key question: Institutional Framework** | | |
| | 3.01 Political decision making | 7 |
| | 3.02 Interest rate policy and liquidity surplus | 13 |
| | 3.03 Planning associations and permit authorities | 11 |
| | 3.04 Institutional framework supports the financial sector | 8 |
| | 3.05 Wind energy and the capital market | 7 |
| | 3.06 Commodity chain is vulnerable to crisis | 18 |
| | 3.07 Policy creates security | 15 |
| | 3.08 Political influence on the commodity chain | 32 |
| | 3.09 Increasing investment pressure | 10 |
| | 3.10 Tender for remuneration | 8 |
| | 3.11 Change of risk tolerance | 9 |
| | 3.12 Increasing risk and complexity | 11 |
| | 3.13 Decreasing risks | 8 |
| | 3.14 Need for security rises | 9 |
| | 3.15 Risk carriers | 16 |
| **Total** | | **662** |

Based on the above computer-assisted software, all transcripts were coded. Individual results of this processing are shown in the following tables. In table 2 (p. 109), these different codes[22] are listed. There was a total of three code categories, which were based on the key questions and the associated hypotheses. There was the code category (1) structure, (2) governance and (3) the institutional framework. In the code category (1) structure, there were a total of 15 codes with 253 codings, the highest number of codings for any group. In the code group (2) governance, a total of 13 codes were developed, which were assigned a total of 227 text segments during coding. The last code group (3) institutional context had a total of 15 codes and is the smallest of the three code groups with 182 codings. A total of 662 codes were assigned to all 26 interviews.

All codings cited in this dissertation are translated from German into English. The number of codings assigned to each code varies greatly. For example, only two codings of the text could be assigned to the code "2.10 inter-chain upgrading". This makes it the code with the smallest number of codings. In contrast, a total of 41 codings could be attributed to the code "1.07 competition and consolidation", which is the code with most codings in this dissertation. This arises from the fact that no question of inter-chain upgrading was directly addressed to the interview partners. Instead, these statements came directly from the interview partners, which could then be coded in the transcription process to this code. On the other hand, the question of competition and consolidation is different. Here, the interview partners were asked the direct question with which companies they are directly competing. These circumstances therefore explain the differences in the number of codings.

Each interview had leading questions and a questionnaire, but new questions were also spontaneously developed during the conversation in order to deepen and pursue interesting statements of the interviewees and in order to ask questions, if necessary, which were not originally included in the questionnaire. This resulted in different conversations as well as interviews of differing durations. Coupled with the statements of the interviewees, different text segments could be coded for each interview.

[22] It must be noted that a distinction must be made between code category, codes and coding. A code category includes different codes or codings. A code represents a respective subcategory and coding means that a text segment can be coded (coding) and assigned to a code. Thus, several codings can be assigned to one code.

The difference in the number of codings per interview is shown in table 3.

**Table 3: List of Interviews and assigned codings (Own table)**

| Interview | Number of codings |
|---|---|
| INTVW 01 Investor | 33 |
| INTVW 02 Politician | 12 |
| INTVW 03 Project developer | 50 |
| INTVW 04 Broker | 14 |
| INTVW 05 Fund Manager | 40 |
| INTVW 06 Project developer | 29 |
| INTVW 07 Project developer | 37 |
| INTVW 08 Manufacturer | 24 |
| INTVW 09 Manufacturer | 25 |
| INTVW 10 Electricity Trader | 13 |
| INTVW 11 Utility | 24 |
| INTVW 12 Technical and Commercial Management | 30 |
| INTVW 13 Project developer | 27 |
| INTVW 14 Bank | 32 |
| INTVW 15 Maintenance Service Provider | 16 |
| INTVW 16 Bank | 28 |
| INTVW 17 Planning association | 11 |
| INTVW 18 Lawyer | 17 |
| INTVW 19 Financial Service Provider | 32 |
| INTVW 20 Consultant | 22 |
| INTVW 21 Service Provider Direct Marketer | 19 |
| INTVW 22 Investor | 18 |
| INTVW 23 Financial Service Provider | 32 |
| INTVW 24 Manufacturer | 18 |
| INTVW 25 Financial Service Provider | 30 |
| INTVW 26 Manufacturer | 29 |
| **Total** | **662** |
| **Average** | **25** |

In the interview INTV 17, which was conducted with a planning association, only 11 text segments could be coded. On the other hand, a total of 50 text segments could be coded at interview INTV 03 with a project developer, which is the interview with the highest number of codings in this dissertation. With 26 interviews and a total of 662 codings, the calculated average was 25 codings per interview.

### 3.2.6 Expert Surveys

In order to gain a deeper insight into the industry and to develop a background knowledge about wind energy, numerous expert surveys were conducted. These expert surveys also serve as a supplement to the semi-structured interviews. In expert surveys, for example, statements from the semi-structured interviews could be examined for plausibility. Furthermore, during the expert surveys, current topics, problems and issues from the wind industry could be picked up and discovered, which could be deepened in the semi-structured interviews or through other research.

**Table 4: Overview of expert surveys (Own table)**

| Occasion | Date | Location |
|---|---|---|
| WindEnergy Hamburg 2014 | 23/09/2014 – 26/09/2014 | Hamburg |
| Erneuerbare Energien Cluster | 27/11/2014 | Hamburg |
| Neujahrsempfang 2015 des Bundesverbandes Erneuerbare Energie | 11/02/2015 | Berlin |
| Landesmitgliederversammlung des BWE Mecklenburg-Vorpommern | 10/03/2015 | Grevesmühlen |
| Win the Auction | 12/05/2015 – 13/05/2015 | Warschau |
| Vorstellung Produktpalette Siemens Wind Power | 30/06/2015 | Struckum |
| 30 Jahre Nordex | 03/07/2015 | Hamburg |
| Vattenfall Energy Day | 11/09/2015 | Hamburg |
| 1. Windbranchentag Schleswig-Holstein | 14/09/2015 | Husum |
| HUSUM Wind 2015 | 15/09/2015 – 18/09/2015 | Husum |
| 2. Windbranchentag Niedersachsen-Bremen | 04/11/2015 | Hannover |
| 24. Windenergietage | 10/11/2015 – 12/11/2015 | Dobbin-Linstow |
| Siemens Wind Power Informationsveranstaltung | 15/12/2015 | Struckum |
| Teilfortschreibung der Regionalpläne Schleswig-Holstein | 12/01/2016 | Kiel |
| Bürgerwindpark – Zeichnung von KG Anteilen | 04/02/2016 | Struckum |
| Siemens Factory Visit | 22/03/2016 – 23/03/2016 | Brande |
| 71. BWE Windstammtisch | 04/04/2016 | Hamburg |
| Vattenfall Trading Floor Visit | 27/04/2016 | Hamburg |
| Bizz energy Delegationsreise Chile | 20/07/2016 – 29/07/2016 | Santiago de Chile |
| WindEnergy Hamburg 2016 | 27/09/2016 – 30/09/2016 | Hamburg |
| 25. Windenergietage | 08/11/2016 – 10/11/2016 | Potsdam |
| Neujahrsempfang 2017 des Bundesverbandes Erneuerbare Energie | 16/02/2017 | Berlin |
| EE-Werkstatt International "Erneuerbare Energien in Argentinien" | 20/02/2017 | Hamburg |
| 2. Windbranchentag Schleswig-Holstein | 06/04/2017 | Husum |
| Kieler Woche 2017 – Siemens Veranstaltung | 21/06/2017 | Kiel |

The expert surveys were conversations with industry representatives of the wind energy commodity chain. The experts were usually selected by coordinated appointments, whereby the experts had been researched and contacted to agree a date for the conversations. In addition, at many events, other expert surveys could be carried out without an appointment on-site. Here the selection happened by chance.

Table 4 (p. 112) lists all the events and occasions which have been visited during this dissertation to conduct expert surveys. The events took place between September 9, 2014 and July 13, 2017. The majority of the events took place in Germany, but also in Denmark, Poland and Chile. Events in which the expert surveys took place were wind industry events, such as the leading trade fairs for wind energy such as WindEnergy Hamburg or HUSUM Wind.

## 3.3 Secondary Data and Sources

### 3.3.1 Annual and Business Reports

In addition to the primary data, for this dissertation numerous secondary data was used as data basis. A large part of this secondary data was annual reports. Annual reports or also called business reports are reports of companies, which have provided information about the course of business of the past financial years. These annual reports[23] usually contain an overview of the overall market and the strategy as well as various highlights of the financial year. Key figures in the annual reports indicate the company's performance. These include the figures for financial performance, sales, technology performance, manufacturing and sourcing, social and environmental performance, risk management, shareholder and governance. Other key figures for an annual report can be found in the consolidated financial statements, which include the income statement, balance sheet, statement of changes in equity, cash flow statement, legal entities, management's statement and the independent auditor's report.

Annual reports of listed companies are free and publicly available. As a result, the annual reports were collected and analyzed for all key companies in the German wind industry and listed on the stock exchange[24] from 2010 onwards. Due to the detailed presentation of financial data, annual reports are very suitable as a further data source, which can be used in

[23] Since there are no uniform regulations, annual reports differ from each other. Key figures such as annual financial statements, however, are obligatory for annual reports (§ 329 HGB).

[24] A listing of the companies can be found in chapter 4.7.1 (p. 231).

addition to the interviews. Thus, financial key figures did not have to be discussed during the interviews. The key figures in the interviews could not have been as exact in correctness and deeply detailed as the figures listed in the annual reports. As a result, the annual reports are excellently suited to determine the company's key economic figures. For example, assumptions can be derived from the figures as to whether a company is performing well or badly because of the profit and loss accounts or how much the company is indebted. In the case of wind turbine manufacturers, it is also possible to calculate the percentage of the profit, for example, in the repayment of debts or in research and development as a result of the open cash flow data. This data can be used to build up a background picture and context that is very useful when analyzing the company and the interviews. Thus, the analysis and the deeper insight into the company enabled the interview questions to be aligned more precisely with the interview partners.

Another important key figure which can be taken from the annual reports of wind turbine manufacturers, is the production data. The market share of the respective company in the respective region and thus also for the German wind energy market can be calculated from the production data and the number of MW built in Germany, Europe and worldwide, which forms the scope of this dissertation. The firm's market share in the German wind market can be used to determine the market share of the company. Based on this, further research can be initiated. For example, the calculated figures and market shares can be used to determine which companies are suitable for an interview. Both very large market participants and very small market participants were identified and interviewed.

In addition to the financial ratios described in the annual reports, the shareholder structure of the respective companies is also illustrated in the listed companies. In Germany, there are publication and notification obligations for listed companies for so-called voting rights announcements. These voting rights announcements provide information showing whether a shareholder’s assets have exceeded or fallen below certain thresholds. This means that an announcement is made if an owner of shares holds a certain number of shares of a company and thus also has a certain volume of voting rights at, for example, general meetings of general meetings. If a threshold of percentages 3, 5, 10, 15, 20, 25, 30, 50 and 75 is reached or exceeded, the company must immediately report this to the issuer of the securities and the BaFin. This voting rights announcement is an excellent way to analyze the ownership structure of companies. For example, a series of annual reports can be used to create a time series showing how the shareholder structure has changed over the years. For example, the annual report with the announcement also serves as an indicator of financialization as shareholder structures develop in such a way that larger shares are held by actor from the financial sector.

### 3.3.2 Quantitative Statistics

Statistics were another important source of secondary data. Statistics are used in this dissertation mainly for two important areas. On the one hand statistics were used to be able to present certain developments in time and thus to show changes. For example, the development of key interest rates, the development of payment remuneration for wind energy onshore, financing volume of banks in wind energy, KfW interest rates, trend of specific investment costs per kW for wind energy, the development of wind park owner structures, traded electricity on the spot or futures market and the net electricity consumption as a temporal development. The second area, in which statistics were used, served as a plausibility check. Statements and findings obtained from the primary data of the interviews could either be proved or disproved with the help of secondary data. For example, statements in the semi-structured interviews on changes in the ownership structure of wind parks can be proved or disproved by cross-referencing them with figures.

The sources of these statistics were generally public and freely accessible. The statistics have been provided by recognized national and international organizations, institutions and offices. For example, data and statistics to analyze have been considered from the Federal Network Agency, the KfW, the German Wind Energy Association, the Electricity Exchange (EEX), the WTO, the Statistical Offices of the European Union, the Federal Statistical Office, the OECD, the WTO, the World Bank, the United Nations and other international organizations.

For this data, it must be noted that statistics that have a temporal dimension are to be taken with caution. Particularly in the case of monetary data, currency conversions can lead to various difficulties if the values are illustrated nominally. For nominal values, the values always refer to the respective year. Since nominal price increases caused by inflation are not calculated, developments on the time axis appear to be more extreme than they were in reality.

Furthermore, the data quality and actuality of data relating specifically to wind energy with regard to installed capacity, repowered or dismantled capacity, number of wind turbines, and special type of wind turbines vary according to the source. The processing and analysis of these statistics must be based on the assumption that the statistics with respect to wind energy data show errors and inaccuracies. This is because until 2014 there was no uniform and central reporting point for wind energy installations, which covers all wind turbines in Germany. A plant register was only introduced with the EEG 2014 according to which every newly built wind turbine must be registered. According to the regulation of the installation register, operators of plants for the generation of electricity from renewable energies are obliged to report new installations commissioned from August 1, 2014 (§ 6 EEG 2017). This database contains all the important information of the newly built wind turbines, such as the reporting date, the reporting reason, the exact plant number and the EEG installation key, which is specific and unique to each wind turbine in Germany. Further data such as the approval date and approval authority are reported, as well as the type, grid connection point, commissioning date of the wind turbine and on which parcel the wind turbine was built with exact coordinates. The recording of wind turbines in a publicly accessible register serves to measure the expansion of renewable energies. Through the recording, the expansion targets can be determined according to the EEG and the corridors defined there for the addition of wind energy installations on land. Thus, these values improve the data situation on the topic of energy generators and facilitate the fulfillment of their national and international reporting requirements. In the analysis of the change in the wind turbine stock in Germany in this dissertation, the data from the installation register have therefore not been included until

2014. Earlier data had to be collected from other sources such as statistics from the Federal Network Agency and BWE.

### 3.3.3 Market and Stock Exchange Data

In addition to statistics, data on the stock exchange were also used for the calculation of time series. Different data from different exchanges were used. Since the listed wind energy companies which are active in Germany are listed on different stock exchanges, the trading data of these companies also had to be obtained from different sources. The trading volume of shares was determined by the stock exchanges Xetra, Madrid SIBE and Nasdaq OMX Copenhagen. Data on electricity sales volume and prices were collected from the electricity exchange in Leipzig.
For each trading day, the shares traded and the value at which the share was traded can be viewed online. Based on these factors, the traded volume on the respective exchange in EUR for the selected companies could be calculated for each trading day. These daily results were then added up for each year. Thus, the stock exchange volume in EUR for each year could calculated. These results were then aggregated annually to obtain a time series over several years. Again, similar to the statistics, this included data in foreign currency. For example, the trade results of the Danish wind turbine manufacturer Vestas had to be converted because the stock exchange in Copenhagen exports the values in Danish krone. The values were calculated in this case at the respective daily rate in EUR. However, it must be noted that there are influences on the time series which may result from currency fluctuations.
In addition to the stock exchanges, the traded volume of the electricity exchange EEX in Leipzig was also analyzed and the changes interpreted. Two trading venues were analyzed: the spot market and the futures market. Since the electricity data could only be determined from 2002 onwards, inflation or currency fluctuations play a very minor or even no role as a possible falsification of these data series.
Data from the spot market, in which short-term supply of electricity is traded, was analyzed. The short-term traded electricity is sold either in the day-ahead market, one day before the physical delivery of the electricity from the producer or dealer to the customer, or in the intraday

market, on the same day of the physical delivery of the electricity. Furthermore, the trading data of the EEX futures market could be determined. The futures market is designed for longer-term business. Here, for example, electricity futures are traded for deliveries to be made later – in some cases only after several years. Such deliveries are intended for longer periods, for example for the long-term basic supply, which can then be supplemented by further basic load and peak load in the day-ahead trading. Electricity options are also traded on these futures. Together, the total annually volume on the EEX was calculated from the data of the spot market and the futures market. The development of the volume of electricity trading in Germany could be shown over the years.

### 3.3.4 Fund Database

In order to gain a deeper knowledge of fund investments in the wind sector, it was necessary to have a suitable source for these ratios. Since primary funding could not be implemented within this dissertation for financial and temporal reasons, secondary data had to be used.

After long-term research, the company eFonds Solutions AG was identified. This company operates a platform on which, according to the company's statement, a total of 700,000 holdings in 7,500 funds with EUR 21 billion equity are listed for providers and intermediaries. According to the statement, this database comprises nearly all new issues of closed-end investment funds and nearly all closed-end funds issued in the past. The basic data on this platform is public and free of charge. Furthermore, in this basic data the last and cumulative disbursement as well as the second market price traded at the fund exchange Germany are displayed (eFonds Solutions, 2016). From this database, it was finally possible to identify funds which offer participation in wind energy. This was the basis for further investigations. The launch year of these funds was determined and researched. Based on this data, a database could be created that lists holdings in wind energy between 1988 and 2016 as well as the respective investment volume.

However, the aspect of completeness has to be critically reflected in this funded database. Since the database is very extensive, it can be assumed that many funds are listed in this database. However, this is not a proof of completeness. In the search for other data on the wind industry, it was always possible to determine fund data from different years. All wind energy funds found during the research were checked to see whether the funds were also present in the database mentioned above. In this review, no fund was found which was not already contained in the database. Nevertheless, this is not proof of completeness, but only proves that it is a very extensive database, which however creates a very good starting position for further analysis.

## 3.4 The Wind Energy Commodity Chain as an Empirical Framework

### 3.4.1 Physical Perspective of the Product Wind Energy

An important component which characterizes the empirical framework of this dissertation is the definition and demarcation of the commodity chain wind energy. To do this, the commodity chain analysis must define how and where the boundaries are defined. An approach which has been chosen to aid to this delimitation is the consideration of the final product. In this approach, the entire commodity chain is viewed working backwards from the final product. The end product of the commodity chain is a produced kWh of wind energy. For this kWh a certain price is paid for the production. This price paid at the end of the chain or the reimbursement of the respectively produced kWh can then be counted backwards. All areas which are remunerated by the payment of these kWh are thus part of the commodity chain.

There are different types of wind turbines with different scales. The research focus of this work lies on common wind turbines with a capacity between around 1.0 MW to 5.0 MW. As shown in figure 8 (p. 120) the main components of a wind turbine are the foundation, the tower, the nacelle, the generator, and possibly gearbox, the hub and the rotor blades. The foundation depends on the turbine's size, height and especially the soil condition. The tower is directly connected with the foundation. There are also different types of towers, which depend to the turbine manufacturers, which use different systems. Steel towers, concrete towers, hybrid towers of concrete and steel, lattice towers and even timber towers[25] were constructed and are available on the market. On top of the tower the nacelle is attached. Inside the nacelle, the generator and possibly the gearbox are located, which are connected to the hub. At the hub three rotor blades are mounted.

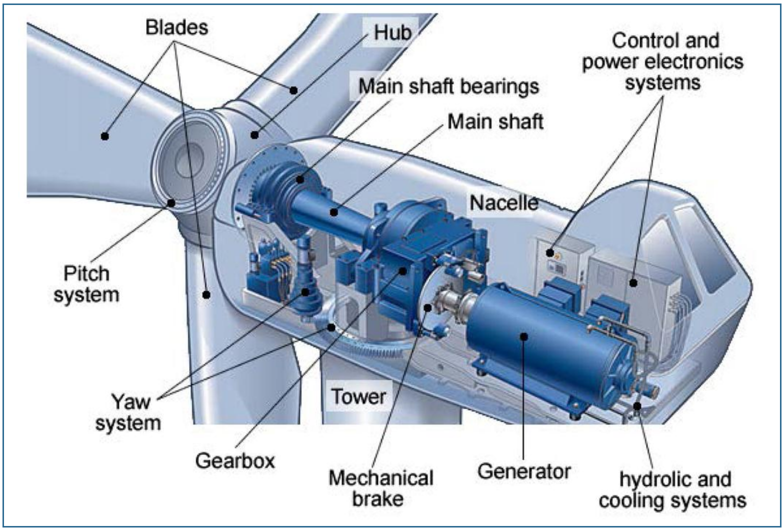


**Figure 8: Typical main components of a utility-scale wind turbine with gearbox (Takoutsing et al., 2014, p. 2602)**

Each commodity chain forms the production and service processes around one commodity. The commodity itself is the center of the whole chain. While analyzing the commodity of wind energy it has to be defined if wind energy can be defined as a normal commodity like any other consumer products or goods, which can be produced, distributed and consumed.

According to the law of physics which asserts the conservation of energy, energy is can never be created or destroyed (Young et al., 2007). This implies that energy remains unchanged over time in a closed system. But if the sum of energy in a system remains constant, then this in turn means that energy cannot be produced and therefore also not consumed. But if

[25] The company TimberTower already erected a wind turbine with a wooden tower.

energy cannot be produced, how can one see energy as a commodity and thus how can be exist a commodity chain around wind energy?
Although due to the principle of conservation of energy the production of energy is not possible, transformation of energy within a system is possible. The first law of thermodynamics, which is derived from the law of conservation, states that each system has an internal energy. This internal energy can only be changed by the transport of energy in the form of work and / or heat across the boundary of a system (Young et al., 2007). The change of energy, such as the electric power generation from wind energy, needs some kind of work. This generation of a particular form of energy from another form of energy can be understood as production. This form of renewable energy has to be transported from the wind site to the consumer location. Thus, wind energy, such as electrical power, can be seen as a commodity, which can be produced, distributed and consumed.
Wind energy is a renewable energy source that uses kinetic energy from moving air masses in the atmosphere. This kinetic energy, harvested with the wind turbine's rotor blades, will be transformed into mechanic work, which drives a generator for electricity production. The generator converts the kinetic energy into electric energy and feeds it into the electrical grid. This transforming process is subject to fundamental physical laws.
One of the most important laws regarding transforming wind energy is the so-called Betz's law[26], which calculates the maximum of mechanical energy that can be extracted from an airflow. The reason is that through the energy release and transforming the flow velocity decreases which leads to an air congestion. Due to this air congestion a part of the flowing air has to avoid the rotor (Hau, 2008, p. 82). With complete extraction of energy from the wind, the air masses would completely decelerate the rotor and would block the rotor for following air masses. Also, with no deceleration no energy can be extracted from the wind. So the maximum absorption of kinetic energy lies between these two extremes (Gasch et al., 2013). According to this physical law, the turbines maximum absorption of kinetic energy through the rotor accounts for 16/27 or 59.3 %.

[26] Albert Betz (1887-1968) was a German physicist who first described the airflow through a wind turbine. Thereby he established the basics of aerodynamics and wind energy.

This value is independent of the turbine's type, blades, generator and scale. The value of 16/27 is also known as Betz's coefficient or power coefficient ($c_p$) (Hau, 2008, p. 85).

Betz's law is independent of the way in which energy absorption works. The absorption can occur by resistance or by buoyancy. Wind mills with a horizontal axis such as post mills[27], tower mills[28], smock mills[29] and also modern wind turbines are moved by buoyancy which have a higher power coefficient as wind mills moved by resistance (Gasch et al., 2013). Today utility-scale wind turbines can reach between 75 % and 80 % of this power coefficient's limit. The rotor blades are shaped like the wings of airplanes. The cross section of the rotor blades is designed so that the air masses at the top of the blade have to cover a larger distance than those on the bottom. Thus, the flow rate above the stronger convex blade's surface is greater than on the flat surface. These differences cause various flow velocities, which cause buoyancy (Kuypers, 2012).

There are three different classifications of wind turbines, based on the turbine's size and production capacity: (1) residential-scale, (2) industrial/commercial-scale and (3) utility scale. (1) Small turbines with residential-scale are normally used by small businesses, farms and individual homes for remote power or battery charging and have a capacity between 400 watts to 50 kW. Normally these turbines operate at a hub height of approximate 10 m. (2) Medium-sized turbines with industrial-scale are used in light commercial or industrial and village applications for remote grid production and have a capacity between 50 kW and 250 kW and a hub height of approximate 25 - 50 m. (3) Large wind turbines with utility scale are the turbines usually installed in wind parks for commercial electricity production (Ayee et al., 2009, p. 6). These turbines have a capacity between 1 MW and 6 MW (onshore) with a hub height of

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[27] Post mills are counted among the oldest wind mill type in Europe and were already in use in the 12th century (Gasch et al., 2013, p. 20).

[28] Originally tower mills were common in the Mediterranean region since the 13th century. They were used for irrigation. At the beginning they could not be aligned to the wind direction (Gasch et al., 2013, p. 21).

[29] Smock mills were developed to power plants in the middle of the 19th century with a large range of applications. Also the outer form has been designed in consideration of aerodynamic issues (Hau, 2008, p. 11).

around 70 m - 160 m. These turbines generate electricity for sale in electricity markets and are the focus of this dissertation.
However, it is important to distinguish between the installed capacity, which depends on the technical design or specification, and the real produced energy fed into the grid, which depends not only on the technical design and turbine's specifications, but also on wind conditions like wind speed, wind directions, wind availability and other factors. According to the already mentioned physical laws and electric power transformations the achievable electric power increases proportionally to the cube of wind speed. This means that doubling the wind speed results in an eight times higher energy production. It becomes clear that wind speed is one of the most important factors for the general use of wind energy and therefore it is the key factor for economic efficiency.
However, in order to produce the product of wind energy, different process steps are necessary. These process steps are interconnected and thus form together the commodity chain. In figure 9 (p. 124) the different process steps are listed so that the chain can be structured[30] more easily. As illustrated in figure 9, first of all a wind park has to be planned. Certain wind and environmental reports must be completed. In addition, the site on which the wind park is to be built must be leased or purchased. Approvals for the construction and operation must be obtained and a grid connection point hast to be applied for. The infrastructure for cables, paths and crane pads are planned. Once all planning and legal questions have been clarified, the turbines can be ordered from a turbine manufacturer. The manufacturer then produces the turbines, including the main components such as tower, nacelle, gearbox, generator and rotor blades. Once all the parts and components are finished, these can be transported to the site. Inside the wind park, construction companies build the road access, the crane pads, install a grid connection and pour foundations. The manufacturer can now erect the turbines on-site. Once the wind park is finished, constructed and connected, electricity can be produced, which ultimately represents the finished product of the commodity chain.

[30] A detailed explanation of all process steps of the wind energy commodity chain can be found in chapter 4.2 (p. 123). There, the individual process steps are further broken down and explained in detail.

However, in order to be able to produce electricity, various services take place throughout the operation process. The turbines have to be serviced and repaired. The wind park has to be supervised by technical and commercial management. Both the wind park and the infrastructure have to be insured. The electricity is traded on the exchange by a direct marketer. Even after the decommissioning of a wind park, further processes in the commodity chain are taking place. The wind park has to be dismantled. If the turbines are not sold at the secondary market, the turbines are usually recycled. In addition, there is the possibility of repowering with newer and larger turbines.


Figure 9: Commodity chain processes of wind energy (Own illustration)

In summary, it can be said that certain inputs have to be made for the production of one kWh. The wind turbine itself is a prerequisite which also entails considerable costs. As described above, there are certain risks. Is the wind blowing in the wind park as projected? Is the right product, with the right wind turbine, generator and rotor size planned and built? Or would one have had to be built the wind turbine at a higher hub height? All of these decisions involve certain risks, which also affect the profitability of a project. In addition to these physical conditions which influence the commodity chain and the product wind energy, it is now necessary to clarify the financial framework for this product and the impact on the commodity chain.

### 3.4.2 Financial Perspective of the Product Wind Energy

Behind each commodity chain lies a price that has to be paid for the commodity and with which the commodity will be remunerated. In the case of the wind energy commodity chain the remuneration of wind energy or the wind park itself will be calculated by two input variables: (1) the actual amount of the produced kWh by the wind park and (2) the revenue that is paid per kWh by the feed-in tariff.

The actual amount of produced kWh (1) is known after installation and commissioning the wind turbine (EEG 2014). Only the amount of produced kWh that is feed-in to the public grid and has been counted by a calibrated metering point will be compensated. Thus, losses caused by shut downs, park losses or by grid losses for instance are not compensated. For investments in wind energy projects it is essential to calculate risks and profitability based on wind assessments[31] and site measurements. The wind yield strongly depends on the turbine's technical specification, and especially on the wind speed at hub height.

It has to be mentioned that the wind yield rises proportionately to the cube of the wind speed. While doubling the wind speed, the wind yield increases eightfold. Therefore, wind assessments are of critical importance for profitability calculations and financial consideration.

The revenues (2) that are paid for the produced and delivered kWh differ from country to country. In Germany, which is the focus of this investigation, the revenues of the feed-in tariffs are defined by the German Renewable Energy Act (German: Erneuerbare-Energien-Gesetz or EEG). The rate of the feed-in tariff depends on the commissioning date of the wind turbine. The duration of the guaranteed revenue for which the feed-in tariff is paid may be applied for up to 20 years[32]. Implemented as a central controlling instrument, the aim of the EEG is the promotion and expansion of renewable energies to create a secure renewable energy supply.

Based on these two variables a first extrapolation of the projects revenue can be made. These revenues are matched by expenditures. Due to the guaranteed feed-in tariffs for 20 years in Germany the financial structures are also designed for the same period. Within this long period, one must distinguish between capital expenditures (CAPEX) and operational expenditures (OPEX).

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[31] Wind assessments are describing the wind condition forecasts on the specific site. The yield calculations for the planned wind turbines are based on existing wind information from meteorological stations nearby the site or from measuring masts in the planned wind park.

[32] For a detailed description of the EEG and its remunerations see chapter 4.4.5 (p. 222). Since EEG 2017, the remuneration fees are known already before building the wind park.

The CAPEX are the investment costs, which are payments made to acquire long-term assets such as new equipment and machinery or property. In the case of wind energy projects, CAPEX may be the costs for the purchase of project rights, costs for the BImSchG approval, construction of road and crane pads, the foundation, the wind turbine itself and costs such as compensatory and substitute measures resulting from the approval certificate. These costs occur before or during the greenfield and construction phase. These costs are incurred before a single kWh can be produced. Thus, there is still no compensation for production.

If the wind turbine is installed and in operation, electricity can be produced. The kWh is remunerated. This payment, which in Germany is paid per KWh produced for 20 years, can be counted and can be offset against the production costs. A wind energy project is therefore profitable if the proceeds can generate more money than CAPEX had to invest initially.

However, the investment also incurs costs during the 20 years and other costs such as land lease and maintenance must be taken into consideration. These operating costs must be deducted from the annual profit. Every expenditure that has to be paid during the operating phase of the wind turbine are OPEX. OPEX include payments for turbine maintenance, insurance or land lease contracts, as well as payments for the technical and commercial management or insurance. A considerable OPEX factor is also the financing, since, similar to a real estate purchase, the wind park is to a certain extent externally financed. As a rule, this debt is higher than the equity ratio. A full amortization of the investment is therefore only possible after several years of operation.

In summary, it can be said that the profitability of wind energy projects consists of three different factors. On the one hand (1) the location quality. The quality of the location indicates the percentage of energy generated by a wind turbine in relation to the yield of this wind turbine at the reference site. The yield that a wind turbine would provide at this location is called the reference yield[33]. The reference location is defined as a

[33] The reference yield is a type-specific performance indicator for wind energy turbines. According to the EEG, it is defined as the amount of electricity determined for each type of

location quality of 100 %. Since the wind is not uniformly distributed in Germany there are strong regional differences. The reference quality can be used to determine the quality of the site. If the calculated yield is 20 % below the 100 % reference yield, this is, for example, an 80 % location. This means that the higher the yield of the wind park, the better the quality of the site.

The second factor affecting profitability is (2) remuneration. The quality of the site has an impact on the remuneration paid. According to EEG 2014, the reference income and the location quality can be used to calculate for how long the increased initial remuneration is paid. Thus, a compensation model was created that compensates less windy locations at a slightly higher rate than windier ones, in order to compensate for their higher project costs. This means that the higher the energy yield is at a real wind energy location, the shorter the period the initial starting fee will be paid for. In order to create time incentives, the remuneration is reduced. This means that depending on the start-up date of the wind park, a different remuneration is paid. The later a wind park is connected to the grid, the lower remuneration the wind park receives.

In addition to the quality of the site and the remuneration, the final factor affecting the profitability of wind energy projects is the (3) cost of electricity generation. Since wind energy projects are designed for a period of 20 years and the compensation according to the EEG is also paid for 20 years, the electricity production costs represent the costs per kWh of wind energy on average over the service life of 20 years. This is the sum of the CAPEX and the OPEX for 20 years, which is calculated by the number of kWh produced in 20 years.

Figure 10 (p. 129) shows the average electricity production costs for wind parks in Germany. As the OPEX and CAPEX have different impacts at the different locations and the wind speed at the sites is different, the electricity generation costs are also differentiated according to the site quality.

wind energy turbine including the respective hub height, calculated on the basis of a measured performance curve in five operating years (EEG Appendix 2 of § 49 reference yield).

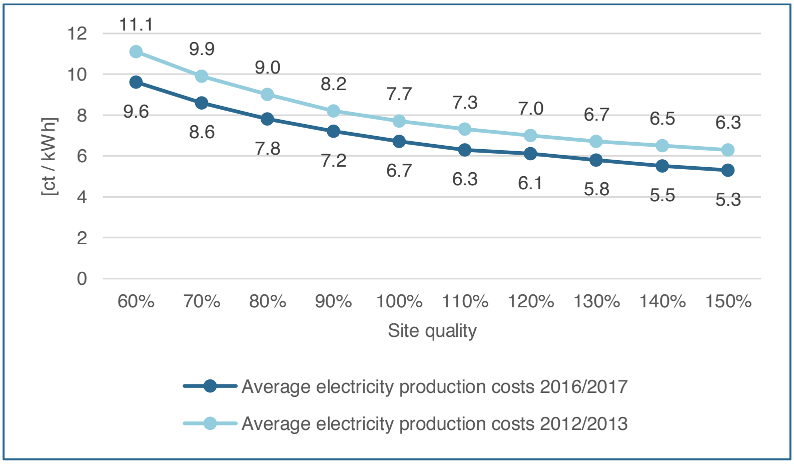


**Figure 10: Average electricity generation costs in ct / kWh 2012/13 and 2016/17 (Deutsche WindGuard, 2015, p. 32)**

As can be seen in figure 10, the average power generation costs for onshore wind energy in ct / kWh are significantly lower in windy sites than in sites with less windy conditions. In addition, the power generation costs determined from 2012/13 are compared with the values determined from 2016/17. It is clear that electricity production costs have fallen since 2012/13. This is due to cost reductions and the increase in the full load hours of the technology used. In particular, however, the reduction is due to the changes in financing parameters. On average, the average power generation costs fell by 12 % (Deutsche WindGuard, 2015, p 32).
In order to generate profitability, the initial investment costs have to be recovered over the years. During the aforementioned 20-year operating period, the OPEX must be counted against the income from the electricity in the cash flow calculation. The difference remaining after the deduction is the profit for the wind park operator and the investor. These profits and distributions would have to be taxed. Here the general tax rates, which are dependent on company form and investor, have to be applied.

### 3.4.3 The German Wind Energy Market as a Case Study

Wind energy is one of the strongest and fastest growing sectors of all renewable energies. As described, wind energy continues to advance in many respects. The current trend in wind energy can be described by four different factors. Wind energy is getting (1) higher, (2) bigger, (3) more efficient and, above all, (4) cheaper. These factors explain why wind energy is generating an ever-increasing and significant contribution to the energy supply in Germany as well as worldwide. Changes of energy supply in the world are noticeable on the markets. On the one hand, global energy supplies are growing. On the other hand, climate change, the uncertain supply situation for other energy sources and decreasing costs are driving demand for renewable energies.

In order to carry out the described analysis of financialization processes and changes of governance in an industry, an empirical framework in which the hypotheses can be examined must be defined in advance. Since the wind energy market in any country in the world is very dependent on the respective feed-in system, it makes sense to equate the empirical framework with national boundaries. Due to the different remuneration systems, it is assumed that the markets may have different actors and may have differing governance structures, but the logic behind the change processes will be the same in all markets. It is assumed that the development process of the wind industry in each country is the same, but that each country has a different development.

Because of this fact, it is necessary to choose a market as an empirical framework that is already highly developed, that also has a great significance on a global level and which is a pioneer market that other countries emulate. Therefore, it was decided to define Germany as an empirical framework. In Europe, Germany is the most important market for wind energy and, as figure 11 (p. 130) shows, by far the country with the highest installed capacity of wind energy in Europe. In Germany in 2015 about 88 TWh of electricity were generated from wind energy. Overall, the expansion of installed wind turbines in Europe last year generated a record level of 13.8 GW, according to the study. Germany was the market's driver with 6 GW and a share of 43 %. As early as the 1990s, a legal remuneration system was installed in Germany, which has been steadily developed since then. Thus, the capacity of wind energy up to 2015 was increased to 44,947 MW[34]. The addition of the new installed capacity in 2015 amounted to 6,013 MW, which corresponds to just under half of the new installed capacity in the EU (HSH Nordbank, 2016, p. 19).

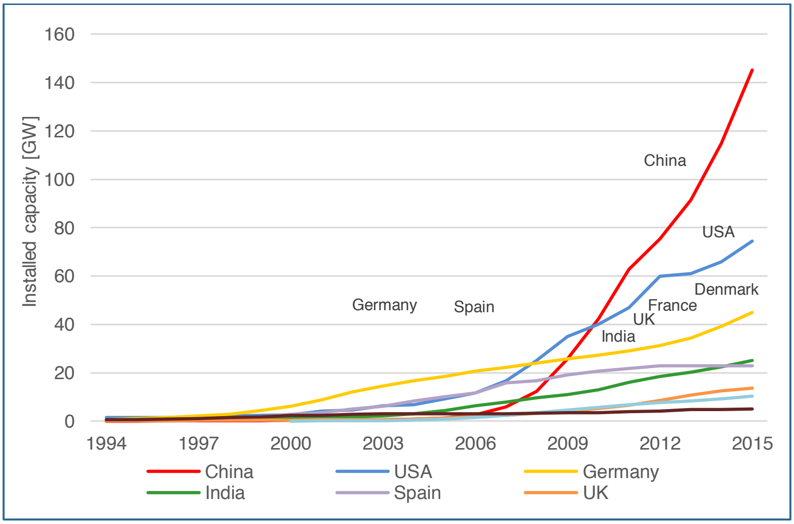


**Figure 11: Development of worldwide installed wind energy capacity (Own calculation based on AWEA, 2017; BTM Consult, 2015; EWEA, 2016; GWEC, 2017, 2016)**

Although wind energy is the most booming renewable energy industry in the world, the development of wind energy differs in each country, as figure 11 shows. In 1994 the five countries with the highest installed capacity were the USA, Germany, Denmark, India and the Netherlands. This picture had already changed by 2002. About 85 % of the world's installed capacity was installed in the five countries Germany, Spain, USA, Denmark and India. Since 2007, China replaced Denmark in the top five. As figure 11 shows, Germany was the country with the world's largest wind turbine installation from 1997 to 2007. Since 2008 Germany has been overtaken by the USA. It is very interesting that since 2010

[34] It should be noted that 3,295 MW of these total installed capacity of wind energy in Germany is achieved by offshore wind parks, which corresponds to a share of approximately 7.3 %.

China has had the largest installed capacity and has been able to expand rapidly over the last few years.

Based on these figures, the choice of Germany as an empirical framework appears to be useful. Germany has shown steady growth since the beginning, has been the country with the most installed capacity for many years, and had the world's third-largest and Europe's largest wind energy capacity in 2015.

Another interesting aspect that will affect the industry is that Germany would like to significantly reduce its annual installation figures, initiated by law. In comparison, the other countries are still relying on strengthening the wind energy sector and are advocating increasing capacity. This change could also trigger governance changes and could serve as an indication of what can happen in other countries, if one day they want to throttle their development targets of wind energy. The existing market readiness of wind energy on the German market is a final reason to take Germany as an empirical framework. In Germany, the further development of wind turbine engineering and the size of the turbines, especially in the inland, have progressed so far, that new business and growth areas could be developed. Even though in Germany only a few particularly suitable areas are available for the use of wind energy, there is considerable potential in the exchange from old to new efficient technology, especially in Northern Germany through so-called repowering of old wind turbines, which creates new business areas and possibly also governance changes. Such a great potential and an existing need for repowering as it prevails in Germany is more or less unique around the world. The changes and experiences that can be drawn from that can also be used in other countries in subsequent years, making Germany an ideal area to investigate in this dissertation.

# 4 Finance and its Importance for the Wind Industry

## 4.1 Development of the Wind Industry in Germany

### 4.1.1 Early Beginnings in the Pioneering Phase

Due to industrialization in Europe, the historical windmill, used for grinding cereals and similar purposes, disappeared. Subsequent research and development of windmills focused on producing electricity. From a scientific point of view, the publication of Betz's law in 1920 and 1925 could be considered the first milestone for wind energy research. It calculates the maximum power, which can be extracted from wind. On the back of this publication, Hermann Honnef designed a wind turbine with five rotors and six blades each, which was possibly the first draft, based entirely on scientific evidence (Schaffarczyk, 2012, p. 37). Until the 1940s a series of attempts followed without significant success (Hau, 2008, p. 23-36; Heymann, 1997, p. 161-340; Schaffarczyk, 2012, p. 36-44).

But during and immediately after the Second World War, wind energy became increasingly important. The reason for this was that strategic resources such as fossil fuels had become short in supply. Parallel with the expansion of the power grid, many technical innovations for wind turbines were introduced at this time, which allowed a wide-ranging introduction of wind turbines for electricity generation. The main reasons for this increased interest in wind energy were the rapidly increasing demand for electricity and the need for supply security without dependence of imported fossil fuels (Schaffarczyk, 2012, p, 36). Different European countries resumed the development of wind turbines. The most significant developments took place in Germany, Denmark and the USA, which led to a series of turbines with many technical developments and improvements.

Nevertheless, almost all important technological developments in the research and development of wind energy were terminated in the 1960s. In summary, two main reasons for the failure of the wind energy development can be noted. All WTG were more or less improvised. In practical operation, they showed numerous shortcomings due to technical faults and to organizational failure. Perhaps most importantly, primary energy prices were extremely low. With these low energy prices a profitable operation of wind turbines was not possible, and thus wind energy was uncompetitive in comparison to conventional energy sources (Hau, 2014, p. 44). In addition, nuclear power was seen as the solution for all future energy problems (Schaffarczyk, 2012, p. 45).

The publication of the study "The Limits to Growth on behalf of the Club of Rome" in 1971 and 1972, and the oil crisis which began 1973 after the proclaimed oil embargo and the extreme increases oil prices, led to a rethink by politicians and the public. Topics such as development and promotion of new technologies, higher energy efficiency, energy consumption, environmental pollution and security of energy supply, grew in significance and urgency (Schaffarczyk, 2012, p. 41).

These circumstances led to a turning point also for wind energy, and led to a comeback particularly in Denmark, Sweden and in Germany. In these countries, different programs were adopted or institutions established, with the aim to promote wind energy and to explore its benefits through various wind energy projects. For instance, in 1974 in Denmark an expert commission found that it should be possible to produce 10 % of Danish electricity demand from wind energy, without causing technical problems in the public power grid. Furthermore, the private operation of small wind energy turbines was supported by subsidies. In Sweden the National Swedish Board for Energy Source Development was established, with a ten year budget of around 280 million Swedish Krona for the development of wind energy (Hau, 2014, p. 46).

In Germany, the focus of wind energy development lay in the public funded project called Growian (or Große Windenergieanlage, German for: large wind turbine). The aim of this project was technology testing[35]. The planning phase of the Growian started in 1976. The operating phase began in 1983 and was terminated in 1987 due to technical and construc-

[35] The Growian was installed at the Kaiser-Wilhelm-Koog, along the North Sea coast in the district of Dithmarschen, in Schleswig-Holstein. The turbine had a 3.0 MW turbine with a hub height of 100 m. The rotor had two blades with a rotor diameter of 100.4 m and had a downwind drive, which means that the wind blows from behind and the rotor runs on the leeward side of the tower (Hauschildt and Pulczynski, 1996, p. 45 - 54).

tion faults (Hauschildt and Pulczynski, 1996, p. 46). In addition to the Growian project other projects as the Voith WEC-520 or the project Mopoteros, which had only one blade, were also built. A few years later the wind energy projects Aeolus II followed in cooperation with Sweden and the WKA-60 on the island Helgoland (Hau, 2014, p. 50).
Regarding financial aid or finance it can be noted that "[a]t least fourteen German suppliers of turbines received funding for 124 turbines in the period 1983 - 1991" (Bergek and Jacobsson 2003, p. 12). The technique of wind turbines and electricity production was indeed scientifically discovered and proven as far as possible, but there was still a lack of practical implementation and experience. Political incentives were scarce and limited to state subsidies. From an industrial point of view, there were only a few wind energy companies that manufactured and sold wind turbines. For instance, in 1986 and 1987, when seven new German firms entered the industry, only 15 and 44 turbines were installed respectively (Bergek and Jacobsson, 2003, p. 12).

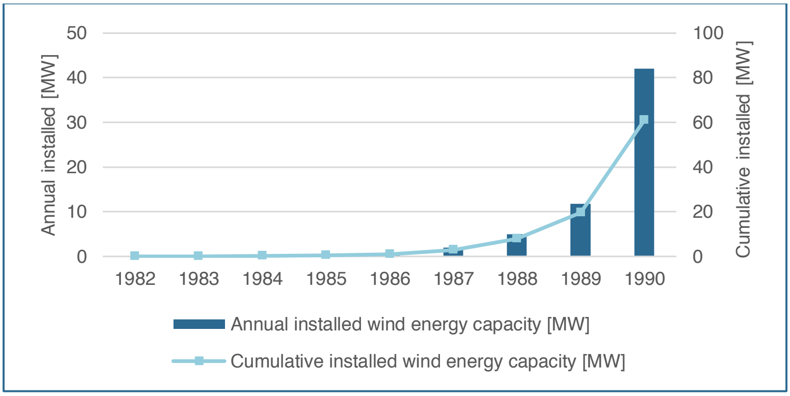


**Figure 12: Installed wind energy capacity onshore between 1982 – 1990 (Bergek und Jacobsson 2003, p. 12)**

As illustrated in figure 12, in total 225 WTG were installed between 1982 and 1989. This corresponds to a total installed capacity of 19.7 MW. When compared to an average turbine with a capacity of around 3.0 MW it becomes clear, that the wind industry in Germany still had a long way to go. However, the crucial point was that the politics adopt no legally binding rules for energy feed in regulations nor remuneration for energy from wind energy sources. But in September 1984, Schleswig-Holstein defined as the first federal state mandatory guidelines for the design, installation and operation of wind turbines (Heymann, 1997).

### 4.1.2 Growth of a New Industry in the Foundation Phase

On December 7, 1990, the Electricity Feed-in Act (German: Stromeinspeisungsgesetz or StrEG), the predecessor of the EEG, was adopted in Germany. From January 1, 1991, it regulated for the first time two significant objects: it governed the obligation of utilities to take electricity from renewable sources and to remunerate the electricity from renewable sources. Thus, the utilities "[…] are required to pay 90 % of the average revenues from electricity sales […]. The Feed Law proved highly successful and added large capacities of wind power generation in Northern Germany" (Edinger, 2012, p.75). Thus, table 5 shows that the remuneration for wind energy projects lay between 0.165 DM and 0.173 DM for each kWh fed into the German grid. According to the official conversion rate this is equal to 0.084 EUR / kWh and 0.088 EUR / kWh. For comparison, the feed in tariff for turbines that feed into the grid for the first time in 2015 with the increased initial tariff was 0.089 EUR / kWh.

**Table 5: Remuneration rates for wind energy fed into the grid 1991 – 1998 (Own table based on Edinger, 2012)**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|
| [DM/kWh] | 0.166 | 0.165 | 0.166 | 0.169 | 0.173 | 0.172 | 0.172 | 0.168 |
| [EUR / kWh] | 0.085 | 0.084 | 0.085 | 0.086 | 0.088 | 0.088 | 0.088 | 0.086 |

In comparison to today, the Electricity Feed-in Act did not aim to implement significant new capacity installations. It was only initiated to support small electricity producers and to allow them to feed in to the national grid. Although the Electricity Feed-in Act encouraged some investments in renewable energy sources, the Act had no extensive impact on the German energy market. Nevertheless the implementation of the Electricity Feed-in Act was the beginning of a long series of laws and

regulations for the promotion and support of all renewable energies and thus also for wind energy (Ströbele et al., 2012).
Alongside the Electricity Feed-in Act, there were other state funding incentives such as for R&D expenditure, support measurements from the federal states and subsidized loans. Furthermore, two programs for the support of wind energy in Germany were established. The so-called "250 MW wind" program[36] was a support for the wind turbine' operators with scientific monitoring and the so-called "Eldorado wind" program[37], which was established for promotion of wind turbine manufacturers. A total of approximately EUR 341 million (DM 667 million) was issued for wind energy in the period between 1975 until end of 2001. Only around EUR 152 million (DM 297 million) was spent on the "250 MW wind" program (Hoppe-Kilpper, 2004, p. 28).
The aforementioned state funding incentives and the important planning security for investors were deciding factors for the wind energy boom in the early 1990s. In general, the investors were the farmers and landowners who erected wind turbines on their own land (INTVW 03 Project developer, 2015, para. 19). As the feed-in tariff did not depend on the specific site and therefore on the wind conditions, the feed-in of wind energy was particularly attractive in the Northern regions close to the coast, and led to an increase of WTG installations.
Over time, wind turbine technology improved and turbine manufacturers achieved increasing sales figures. During the early 1990s, the installation of WTG with a capacity between 20 - 150 kW was particularly popular. But since the mid-1990s turbines of the 800 kW class have become more popular in the German market and thus they have become a new industrial standard. According to a survey of turbine manufacturers in figure 13 (p. 137), the average capacity of newly installed wind turbines

[36] After different turbine demonstration programs and the commissioning of the first wind parks the program "100 MW Wind" was established in 1989. The objective of this program was to reach an installed capacity of 100 MW within five years. Because of the high number of requests, the program was modified in 1991 and expanded to 250 MW (Ohlhorst, 2009, p. 130).
[37] The aim of the "Eldorado Wind" program was the entry facilitation of the German wind energy sector into the export sector. Thus since October 1991, the German Federal Ministry of Education and Research has supported the testing of wind turbines under different climatic conditions than those prevailing in Germany (Hoppe-Kilpper, 2003, p. 34).

increased from 170 kW in 1992 until 1,280 kW in 2001. This represents an increase of over 650 % in 10 years.

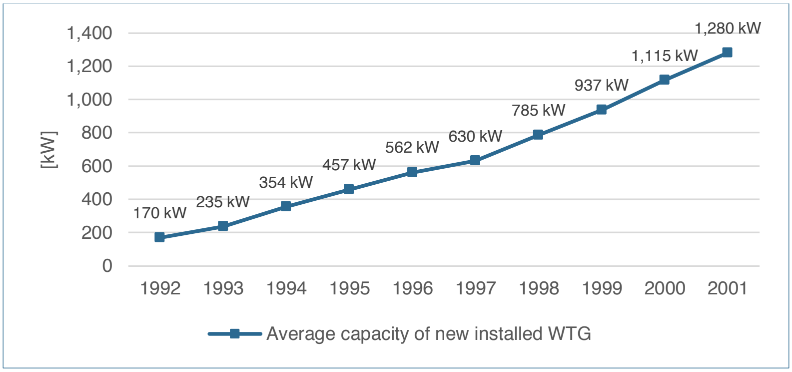


**Figure 13: Average capacity of new installed WTG 1992 – 2001 (Own illustration based on BWE, 2002, p. 4)**

The increasing technical development and the increasing demand for turbines due to the planning security and the feed in tariffs have led to a strongly increasing number of installed turbines and as well as an increase of the installed capacity in Germany as shown in figure 14 (p. 138). In the period between 1990 and 2000 more and more WTG were also built in inland areas and in the low mountain ranges in Germany (Fraunhofer IWES, 2012, p. 10). Thus, the installed turbines increased from 488 turbines to 9,375 turbines, which implies an increase of 1,821 % in the period of 1990 until 2000 (BWE, 2002, p. 4; Fraunhofer IWES, 2012, p. 9). The capacity of the installed WTG increased from 61 MW in 1990 and 6,057 MW installed capacity in 2000.

As can be seen in figure 14 (p. 138), the annual installed capacity has almost doubled since 1999. The reason for these high annual installation rates was a change in the Building Code in 1997. Since then WTG have been considered privileged construction projects (§ 35 BauGB). Another reason was in the year 2000 the adoption of the Act for the Priority of Renewable Energies (EEG 2000).

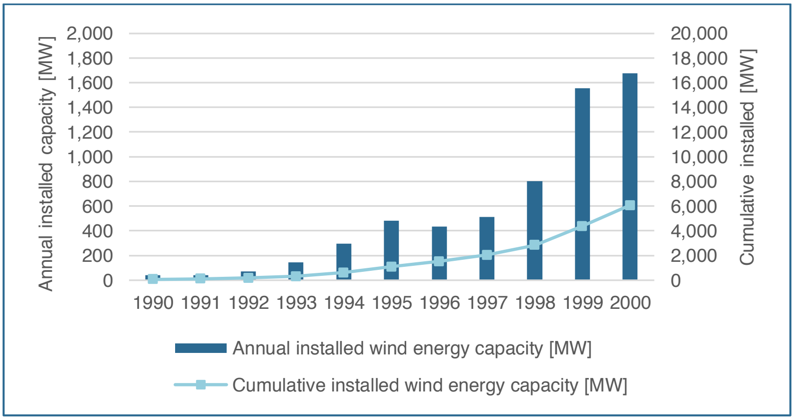


**Figure 14: Installed wind energy capacity onshore between 1990 – 2000 (Own illustration based on Fraunhofer IWES, 2013)**

In the 1990s there were almost no project financing. According to a German banker, the first wind energy project financing was established between the mid and late 1990s. A significant force to make wind energy projects financially viable was the introduction of the EEG[38]. Through the twenty-year fixed remuneration, the banks were able to take part of the risk out the business (INTVW 16 Bank, 2016, para. 7).

### 4.1.3 Competition and Consolidations in the Boom and Specialization Phase

This chapter gives an overview of the development of the wind industry in Germany since 2000 until today. In 2000 the German government decided to phase-out nuclear power and to advocate the increased use of renewable energy sources. Thus, on March 29, 2000, the Electricity Feed-in Act was replaced by the German Renewable Act. The introduction of the EEG had a huge impact on the German wind energy market. It is doubtful whether this market would have developed without this catalytic effect of subsidization and risk reduction (INTVW 01 Investor, 2015, para. 77).

[38] The EEG and its impact on the German market will be explained in the following chapter 4.4.5 (p. 187).

Within the EEG significant improvements for wind energy were implemented as a fixed feed-in tariff over the operation period of the turbine, staggered by the site location of the turbine. Furthermore, in contrast to the old electricity Feed-in Act two central reforms were implemented: The Transmission System Operators[39] (TSO) were obliged to accept electricity which comes from renewable energy sources and were obliged to priorities them over electricity from fossil or nuclear sources. The TSO are even obliged to expand their grids, if necessary, to accept the energy from renewable energy sources. The second reform of the EEG was the implementation of a redistribution and circulation mechanism throughout Germany. This means the TSO are allowed to pass on the expenses which result from the EEG, to the end consumer. In the following five big EEG, further amendments occurred (EEG 2004, EEG 2009, EEG 2012, EEG 2014, EEG 2017).

Through the introduction of the EEG, it was now possible for banks to structure non-recourse financing. For wind energy projects, there was no more market price risk in the German wind energy market (INTVW 16 Bank, 2016, para. 7). This opened the doors for banks and other financiers into a completely new industry. As a result of these political decisions, the foundation was laid for the growing influence of the financial sector in the wind energy sector.

The financial incentives by the EEG's feed-in tariffs had very important implications in Germany at a national and regional level over 20 years. The operation of wind energy turbines spread across Germany, from the coast in the north to the inland in the south. Due to the reference yield model[40] wind turbines could also operate economically in light-wind locations. This building boom of turbines in regions with lower wind conditions has led to a specialization within the turbine manufacturers. The manufacturers began to develop turbines which are optimized for

[39] According to the German Energy Management Act (German: Energiewirtschaftsgesetz or EnWG), the mission of a TSO is defined as "operating and maintaining a stable, reliable and efficient power supply network in an unbiased manner, optimizing, enhancing and expanding this in line with demand." (§ 11 (1) EnWG). In Germany, there are in total four TSO: Tennet TSO, 50Hertz Transmission, Amprion and TransnetBW.

[40] For further explanation and analysis of the reference yield model see chapter 3.4.2 (p. 104).

these lower wind conditions (Agora Energiewende, 2013, p. 6). The turbines' rotor diameters were enlarged and the hub height increased for a greater capacity. But even for strong wind conditions the turbine technology has evolved steadily, and this evolution process continues. The generators, the rotors and the hub height were getting bigger and higher. In contrast to the failed government research efforts, the quick success of the wind turbine manufacturers was based on the gradual and steady increase in performance of the turbine. This technical progress has been accompanied by steadily increasing quality standards (INTVW 03 Project developer, 2015, para. 77).

The process of concentration of manufacturers in the wind turbine market began in the late 1990s and increased steadily. By 2001, only 10 manufacturers had significant revenues (Staiß, 2003). In 1995 there were a total of 132 manufacturers, but 104 manufacturers left the market. (Kammer, 2011, p. 120). Some smaller companies ceased operation and disappeared from the German market, during a phase of an extensive mergers and acquisitions. Only very few manufacturers were left out of this consolidation process (Kammer, 2011, p. 153). First companies start to convert in to a joint stock company. One very famous example is the company REpower Systems AG. The REpower Systems AG was formed in 2001 from the merger of the companies Jacobs Energie, Brandenburgischen Wind- und Umwelttechnologien GmbH (BWU), pro + pro Energiesysteme GmbH & Co. KG (Rendsburg) and Denker & Wulf (REpower Systems AG, 2011).

Despite this success story, there were also blocks in the phase of specialization, and the first signs of crises. For example, in the years 2002 and 2006 there was an over-supply of wind energy projects on the German market. These projects were usually overestimated by excessively high wind assessments. As more wind was expected in advance, these projects came into financial difficulties. One of the largest financiers for these projects was Commerzbank. Due to difficulties in many projects, Commerzbank had to separate from many projects (INTVW 26 Manufacturer, 2016, para. 7).

With the progress of technology and the advancing age of the operating turbines (INTVW 12 Technical and Commercial Management, 2016, para. 53), the repowering potential has grown steadily. Repowering refers to replacing wind turbines from the first generations with modern turbines. Modern wind turbines have a higher efficiency, whereby the cost of generating electricity by wind power is minimized. The modern turbines can also be better integrated into the electrical grid. According to a study of the German Wind Energy Institute[41] (German: Deutsches Windenergie Institut or DEWI) "more than one third of all new wind turbines erected in Germany onshore (619 of 1,761 WTG) were realized in the form of repowering projects. Repowering installation therefore reached a total capacity of 1,729 MW. The share of repowering in the overall new installation was in the same range as in 2012 and 2013, regardless of the fact that wind energy development has risen to a new all-time high" (Neddermann, 2015, p. 39).

Since the beginning of the 2000s, it was assumed that there will be not enough space for onshore wind energy in the immediate future. The turbine technology for low-wind sites had not yet been developed for an economic operation, and some German states politically blocked further expansion of onshore wind energy. These factors were the reason why the government inserted also feed-in tariffs in the EEG for offshore wind energy to stimulate the development of wind energy in the sea. Today offshore wind energy is a mainstay of the German energy revolution. In 2010 alpha ventus[42], Germany's first offshore wind park was put into operation. It was a pioneer project of the utilities EWE AG, E.ON Climate & Renewables GmbH and Vattenfall New Energy GmbH (alpha ventus, 2010, p. 50). By the end of 2014 a total capacity of 2,313 MW offshore wind energy was installed in Germany, which corresponds approximately 23 % of the expansion target of the EEG to install 10 GW by 2020 (Fraunhofer IWES, 2015a, p. 53).

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[41] The German Wind Energy Insitute (DEWI GmbH) was founded in 1990 in Wilhelmshaven by the German state Lower Saxony with the aim to support the wind energy industry.

[42] The offshore wind park alpha ventus is located in the German North Sea. It contains in total 12 wind turbines (6 x Areva Multibrid M5000 and 6 x REpower Systems 5M) with a total capacity of 60 MW (alpha ventus, 2010, p. 21).

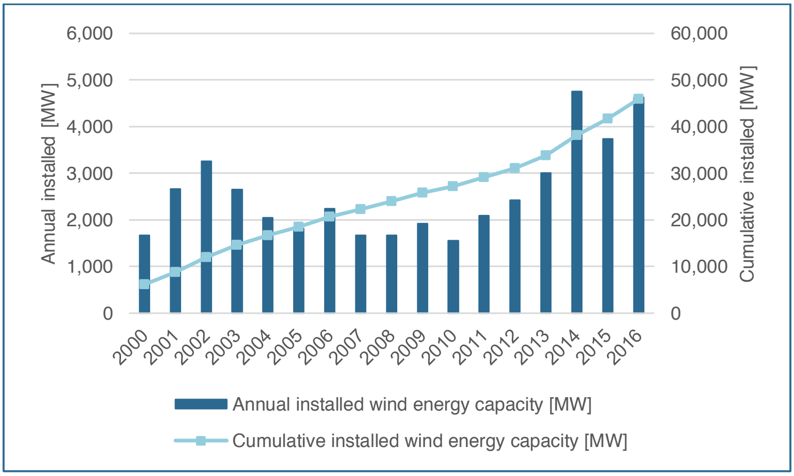


**Figure 15: Installed onshore wind energy capacity between 2000 - 2016 (Own illustration based on Fraunhofer IWES, 2015b)**

The planning security for the investors, the differentiation of the manufacturers within their portfolio to serve the market in strong and low wind regions (INTVW 06 Project developer, 2015, para. 33) and regulated feed-tariff environment have led to a strongly increasing number of installed turbines and as well as an increase of the installed capacity in Germany, as shown in figure 15. In the period between 2000 and 2016 the cumulative installed capacity increased from 6,095 MW to 45,911 MW in 2016. The capacity of the annual installed capacity also grew. In 2016 there were almost three times more capacity installed per year than in 2000.

### 4.1.4 Global Development and Outlook in a Globalized Economy

The global wind industry enjoyed successful development with steady growth since the beginning of installing wind turbines in the 1990s. According to the Global Wind Energy Council[43] (GWEC) at the end of

[43] The Global Wind Energy Council or GWEC was established in 2005 and "is a member-based organization that represents the entire wind energy sector. The members of GWEC represent over 1,500 companies, organizations and institutions in more than 80 countries, including manufacturers, developers, component suppliers, research institutes, national

2014, a total of 369.6 GW was globally installed. As measured by annual wind turbine installations, 2014 was a record year with more than 51 GW of new installed wind energy capacity worldwide that represents a market growth of almost 16 %. This corresponds to EUR 88.9 billion of investment in the wind energy sector, which accounts for over 39 % of all investments in the clean energy sector (GWEC, 2014, p. 6).

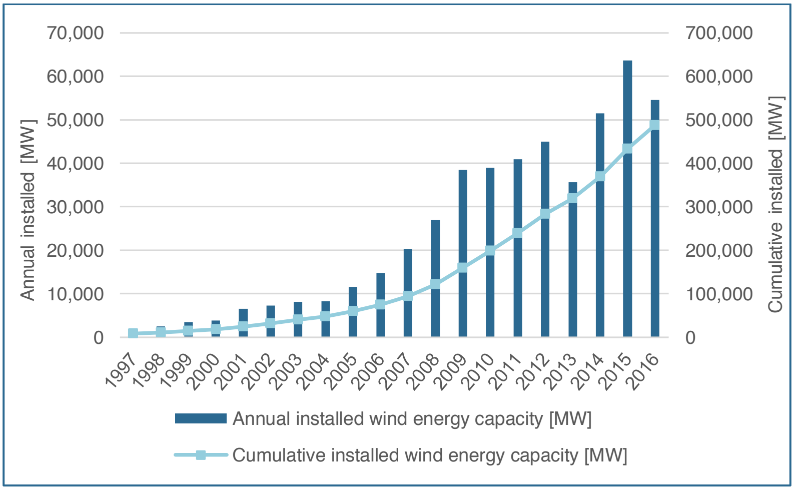


**Figure 16: Global installed wind energy capacity between 1997 – 2016 (Own illustration based on GWEC, 2017, 2015, 2014)**

As one can see in figure 16, the global cumulative installed capacity of wind energy rose enormously between 1997 and 2016. In fact, generation capacity has more than doubled in the last 5 years alone. Considering the growth rates from the global annual installed wind capacity in 2013 the installation decreased by over 20 %. This decline is related to the economic reduction and modifications of feed in tariff systems in Europe and the political uncertainty in the US. Nevertheless, the average growth rates in the last ten years (2007 - 2016) was more than 20 % per year. The highest amount of annual capacity was 2015 with 63,633 MW. This

wind and renewables associations, electricity providers, finance, insurance companies and law firms” (GWEC, 2014, p. 78).

capacity, which was installed in only one single year worldwide, amounts to more than the total installed capacity in Germany in the whole-time period between 1990 and 2016.

Figure 17 shows that in 2016 a total of 486,749 MW cumulative capacity was installed worldwide, of which 168,690 MW was in China (34.7 %), 82,184 MW in the United States (16.9 %) and 50,018 MW in Germany (10.3%) (GWEC, 2017, p. 3). Thereby the three biggest countries, measured by the cumulative wind energy capacity, hold more than half (61.8 %) of worldwide capacity.

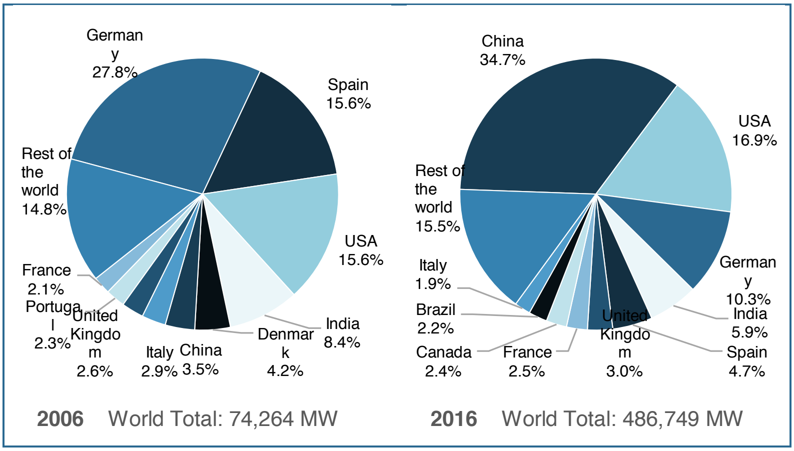


**Figure 17: Top 10 countries with cumulative installed wind energy capacity[44] (Own calculation based on GWEC, 2006, p. 7; GWEC, 2017, p. 3)**

By the end of 2012 the installed wind energy capacity contributed potentially 500 TWh per year, which is equivalent to around 3 % of the global electricity demand (WWEA, 2012, p. 4). As figure 17 shows, the cumulative capacity installed worldwide has increased from 74,264 MW in 2006 to 486,749 MW at the end of 2016, which represents a six-fold increase. Despite this increase, the share of the ten biggest wind energy countries has hardly changed (2006: 85.2 %; 2016: 84.0 %). It is im-

[44] It must be mentioned that the figures of the wind energy capacity include onshore and offshore wind energy.

portant to mention, that there is no non-OECD-state within the top ten, neither in 2006 nor in 2016.
Following the new developments of the wind energy industry in Germany, the outlook can be divided into two different levels. Hereby, the following questions are important: in which direction, will wind energy technology develop? How are the market conditions for wind energy structured in the future?
Evidence suggests that adjustments that the limits of maximum height and capacity have not been completely reached. Today the largest onshore turbines have a total rotor blade length of more than 140 m (for instance Siemens SWT142, Enercon E141,). The actual capacity size of new wind turbines lies at around 4.0 MW. Also, today the capacity of some onshore turbines has reached a total capacity of more than 7.5 MW (for instance Enercon E126 with 7,580 kW).
In specific regions in Germany there are height restrictions of 200m. For a wind turbine with a rotor of 117m (for instance Nordex N117 2.4 MW or 3.0 MW), the concrete hybrid tower has a height of 141.5 m not to exceed the 200 m height restrictions with the turbine's rotor length of 58.5 m. Now the tower manufacturer Max Bögl Wind AG has announced it will build a concrete hybrid tower with a height of 160 m (WID, 2015). Also, the wind turbine manufacturers now have high hub heights in their portfolio (for instance: Vestas V126 with 166 m hub height, Nordex N131 with 164 m hub height). It may be expected that the development of this height increase continues to around 180 m, which would have a large effect on low wind sites.
However, it should be noted that with increasing size, the used building masses will also increase. Therefore, it takes great effort to optimize the balance between increasing manufacturing costs and increasing electricity production in favor of economic efficiency.
The market conditions are already significantly changing and this will continue in the near future. In the EEG 2014, it is determined that the financial support for electricity from renewable energy sources has to be determined by a tender process from 2017 onwards. The background of this political decision were the new guidelines on State aid for environmental protection and energy aid 2014-2020 of the European Commis-

sion, which determine that from 2017 funding for any renewable energy production in the EU with a certain project size must be clarified by a tender process (Europäische Union, 2014, C 200/26).

At a global level, the global wind market is dominated by a few major players. Germany has so far been an exception in terms of the diversity of actors (INTVW 22 Investor, 2016, para. 41). The developments in Germany are therefore further analyzed in the following in order to be able to derive a development prognosis.

## 4.2 Wind Energy Commodity Chain and its Division of Labor

The wind energy global commodity chain includes five main processes: planning, manufacturing, construction, operation and dismantling or repowering. However, to feed this chain, the resource wind is necessary. Figure 18 gives a detailed overview of the process steps in the commodity chain. This chain not only covers the area up to commissioning of a turbine or a wind park, but also the time period thereafter. Thus, the entire life cycle of a wind park is depicted in this chain; from the first idea of a wind energy project in the planning phase to the dismantling and recycling the turbine parts and components.


**Figure 18: Commodity chain processes of wind energy (Own illustration)**

Since the planning period takes several years and usually the operating time of a wind park is 20 years and sometimes even longer, the analysis of this commodity chain takes a period of about 30 years. These different process steps do not need to take place in a chronological sequence, but can also take place in parallel. All five process steps are explained and analyzed in detail.

### 4.2.1 Planning Greenfield Investments

The whole planning process up to the WTG construction on the site is controlled by the project developer. The size and working activities differ from project developer to project developer. In the German market, there are project developer companies consisting of only single person but also there are big international companies operating in different countries. A good example for these internationalization processes in the German wind energy market is the company wpd AG: Founded in 1996 by Gernot Blanke and Klaus Meier in Bremen, the company grew into an international stock company operating in 17 different countries. The wpd AG is not a unique case. As already described in chapter 4.1 (p. 132), the whole wind energy market was characterized by a lively phase of mergers and acquisitions. Again wpd AG can be used as a good example: in 2006 wpd AG had acquired shares of more than 5 % of the competitor Energiekontor AG, which is also a project developer (Energiekontor AG, 2006). In general, project rights for wind energy projects are frequently traded. Thereby the traded projects can have very varied project status. Thus, land lease contracts for the wind turbines sites can be traded, the building permits for WTG can be traded and also the project rights can be sold and bought as turnkey[45]. The risks until the commissioning are usually carried by the developer or his appointed general contractor.

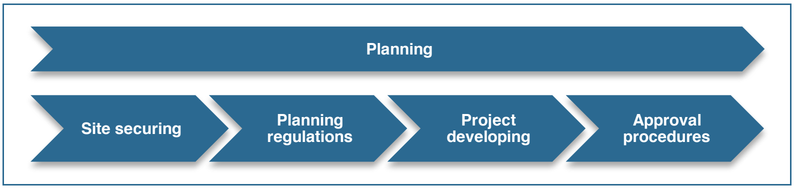


**Figure 19: Commodity chain phases of the planning process (Own illustration)**

In general, the planning process for wind energy projects can divided into four different planning phases as illustrated in figure 19.

[45] The term turnkey means that the wind park will be handed from the seller to the buyer. The buyer, normally the investor who plans to operate the wind park, takes over the wind energy project when the wind park is completely constructed and already commissioned. Any operation of the wind park is possible without additional effort from the end customer.

The first phase of the planning process is the securing of specific sites. The sites are secured by land lease contracts between the landowners and the project developers. The contracts run for 20 years and where applicable with an extension for five or sometimes ten years. The 20-year duration results from the feed-in tariff of the EEG, which is paid for 20 years. The lease of the land for the landowners normally ranges between 6 % and 8 % and sometimes 10 % of the feed-in revenues per year (INTVW 07 Project developer, 2016, para. 11). Depending on the revenues, it becomes clear that the land leases can vary widely. In regions in northern Germany with correspondingly more wind than in the south of Germany, the landowners therefore also demand more for their land. The landowners are very well networked and informed. However, as a result of the networking, land owners with sites with less strong wind conditions are influenced by the other land prices in the north. This results in regional price increases for less windy regions (INTVW 07 Project developer, 2016, para. 17). With regard to the profit margin, however, it can be said that the land owner has the largest profit margin of an entire wind energy project with respect to the capital invested (INTVW 09 Manufacturer, 2016, para. 21).

If the site is secured, the project developer can continue with the second phase of planning, particularly with the process of planning regulations. According to the Building Code (§ 35 BauGB) WTG will be accepted as a privileged building construction project in outskirt areas[46]. However, at local or regional level in Germany it is possible to control where wind turbine construction takes place, with the planning instruments of so-called regional plans and urban land-use plans. In Germany, there are four levels[47] of spatial planning, on which the particular level has specific influence to control the development of wind turbine construction. At the (1) federal level, there are only informal instruments such as the concept

[46] Outskirt area is a term used in the German planning law relating to the admissibility of construction projects and includes all sites and plots that are not within the scope of a development plan and are not in a built-up district.

[47] It must be noted that there is an additional framework for spatial planning at the European level the so-called European Spatial Development Perspective.

of spatial order and thus at this level there is no influence[48] to control the spatial development of wind energy. At the level of the (2) federal states, regional development programs or national development plans can be formulated. At the level of the (3) administrative districts, the planning associations or planning region can develop regional planning programs or regional plans. Usually different districts merge to form one single planning region. Exceptions are the city-states and for instance the federal state North Rhine-Westphalia, where each district forms a planning region itself. This level of the planning associations may be the most significant and important level for project developers because this level decides whether and where exactly WTG can be constructed. At the (4) municipal level, land use plans and development plans decides for example the exact sites where the turbines have to be erected, the rotor diameter or the maximum building height which all have also enormous influence on the park layout and selection of the wind turbine.

**Table 6: Declaration of designated areas for wind energy (Own compilation based on ARL, 2017)**

| Type of designated area | Declaration |
|---|---|
| Priority area | Priority Areas are designated for one particular spatially impacting land-use as wind energy. Other land-uses than wind energy with a spatial impact are excluded if they are incompatible with either the priority function or use or with the goals of spatial planning (§ 7 Abs. 4 S. 1 ROG and § 11 Abs. 7 LplG) |
| Restricted area | The use of wind energy has specific significance during the consideration; however, wind energy is still in competition with other forms of land use. |
| Suitable area | These areas are appropriate for particular spatially impacting measures. In so doing these land-uses are precluded from other parts of the planning area. |

At the level of the planning region, specific areas where WTG can be constructed are defined in the planning program or the regional plan. In these areas three different kind of areas can be observed, which are explained in detail in table 6 according to § 8 Abs. 7 ROG.

[48] The German Federal Government has enormous influence on the wind energy development in general, such as through the determination of the reimbursement of feed-in electricity by renewable sources but no spatial influence exists at this level.

The planning regions have to renew their regional plans after a certain time. The formation of a new regional plan proceeds in various phases, which are summarized in table 7.

First, the reorganization or modification of the planning program or the regional plan has to be resolved by the planning authorities. Thereupon a development program will be proposed, in which specific criteria for the designation of wind energy areas are laid out. Due to the current law of the Federal Administrative Court, a coherent and comprehensible spatial planning concept for the entire planning area is required for the planning control of wind energy. This includes a transparent assessment process in determining the different areas where wind energy is possible. Here the focus lies on determining the taboo zones for wind energy. The taboo zones have to be distinguished between hard taboo and soft taboo zones or also soft and hard criteria.

**Table 7: Process phases of planning programs (Own table modified after Regionaler Planungsverband Westmecklenbug 2013, p. 32)**

| |
|---|
| Decision on the reorganization or modification of the planning program or the regional spatial development program |
| Processing and development of first draft program |
| Decision on the first draft program |
| First involvement phase of the public and the authorities |
| Consideration of comments and suggestions, revision of the program design |
| Decision on the revised draft |
| Second Involvement phase of the public and the authorities |
| Consideration of comments and suggestions, revision of the program design |
| Decision on the new planning program |
| Submission to the state government for consideration |
| Decision of the state government about the program and legal notice |

A hard taboo criterion may be, for example, the fixed distance of 1,000 m to settlement areas. So, within the exclusion area of the settlement and the respective distance of 1,000 m no wind turbine can be erected. The function of soft taboo criteria is also the exclusion of wind energy, but it can be carefully considered on an individual basis. This new assessment balances the public interests and the privileged position of wind energy.

Therefore, the use of wind areas is not outright forbidden by soft taboo criteria. As an example, for a soft criterion, the minimum size of a suitable wind energy area of 35 ha can be mentioned. This means that in an individual analysis also a wind energy area with only 32 ha can be included in the regional plan, if all other requirements are met. A lack of differentiation between these criteria leads to the nullity of the planning program or the regional plan.

After the final definition of the criteria and the determination of the exact program, the decision of the first draft program follows. This implies an early involvement of the public and the authorities. All participants, public agencies and private individuals have the opportunity to express their opinions to this draft program. After the consideration of all the comments and suggestions of the different parties, the planning authorities revise the draft program.

After these revisions, a decision is taken on the second draft program. The public is again involved in the planning process. Again, all participants, public agencies and private individuals have the opportunity to express their opinions. After the second consideration of the comments and suggestions, the planning authorities finish the planning program or the regional plan.

If too many inconsistencies still occur after the second consideration it is possible that the planning authorities start the process for a third program draft and a third participation of the different parties. If the planning authorities decide on the finished program, it will be submitted to the state government for consideration. The state government also decides on the planning program that leads to a legal notice.

As this detailed description of this process makes clear, this designation process can take years. For example, the update of the regional plan in the planning region Westmecklenburg was resolved in 2013 (Regionaler Planungsverband Westmecklenburg, 2016, p. 10). However, after consultation with members of the regional planning association in Westmecklenburg in November 2015, the designation of wind energy areas is still not expected in 2017[49]. The reality has shown that in some planning regions it may take more than 5 years to designate new wind energy areas (INTVW 17 Planning association, 2016, para. 22). The reasons for this slow process are several participation procedures, different expert opinions or individual views of the sites. Approval of a wind park is only possible once the spatial planning program has been completed (INTVW 07 Project developer, 2016, para. 37). At this point it should be emphasized that through many interview partners and due to many discussions with participants of the wind industry, it becomes clear that the designation of wind energy areas by planning associations, is seen as a key problem for the progress of the wind industry in Germany (INTVW 11 Utility, 2016, para. 13). According to interviews with a planning association and other interviewees, the reasons for the long duration are often the understaffing of the planning association, alongside the complex procedure with evermore distance criteria and the fear of procedural errors (INTVW 07 Project developer, 2016, para. 39; INTVW 17 Planning association, 2016, para. 11; INTVW 17 Planning association, 2016, para. 5, 27, 34). Based on a number of visits to planning association meetings at various planning regions it is clear that the designation issue is an emotional subject for the public. The proponents of wind energy, consisting mostly of project developers and landowners who benefit from the land leasing fees are confronted with citizens' initiatives and nature conservation associations[50].

After the step of planning regulations, the next step of project development is the detailed planning and a micrositing of a wind parks. A wind park layout will be created by the project developer to achieve the best possible result, taking into consideration wind conditions on the site, turbine type, noise and shadow emissions from the turbine and environmental aspects. The project developer who secured the relevant sites

[49] It is important to note that although a designation of wind energy areas in 2017 is carried out at a regional level it will be restricted at a federal level due to the planned tendering procedure for wind energy.

[50] At this point this discussion cannot be more extended because of the thematic framework. However, this issue has enormous potential to be explored, as new solutions must be found. According to the conducted interviews it turned out that some planning organizations are overstrained by the designation of wind energy sites.

commissions an advisory opinion regarding species and nature conservation, which are influenced by the planned wind park. In the detailed wind park planning, annual yield calculations from different turbine types and other necessary project-related expert reports are combined. Hereby modern measurement and monitoring technology, such as wind measurement masts or acoustic telemetry procedures (Sound/Sonic Detecting and Ranging or SODAR) are used. Forecasts of noise and shadow emission, nature and species protection reports and sustainable and coordinated internal road and cable construction are very important to realize a socially equitable and sustainable wind energy project. In all planning steps, the nature conservation assessment of the potential wind park area stays particularly in focus. Project developers instruct experts and environmental consultants with detailed technical expert opinions to gain comprehensive findings on the species and their habitat through long-term analysis. Another key component is the planning of the electrical systems in the range of medium and high voltage as well as the planning of the network connection and the necessary cable routes which can have also influence to the nature and the environment.

With the completion of the detailed planning, the project proceeds to the approval phase according to the Federal Emission Control Act (BImSchG). The application documents are compiled, including all emission reports (for instance noise and shadow reports), detailed plans and landscape management compensation measures. Then these documents are submitted to the responsible authority. If the approval according to BImSchG is granted, the approval is always related to official requirements. For instance, elevated sound levels from the WTG can cause a necessary shutdown at certain times, mostly at night or sometimes the WTG have to drive in a sound-reduced mode, which leads to a reduction of the revenues. Other requirements are related to decommissioning guarantees and compensation measures are determined. The dismantling guarantee must be submitted to the approval authority. This is to ensure that the wind turbines will be dismantled after operation of usually 20 years and no industrial ruin remains. From a legal point of view, a new and additional construction of a wind turbine within an already existing wind park is allowed and leads to a wind shading to the existing turbines but it has to be guaranteed and proven by expert opinions that the stability of the existing wind turbines is not affected. Usually certain distances must be adhered to, to ensure that the design criteria as stability and turbulence of the affected WTG are respected. As a basic rule, distances are five times of the rotor diameter in the main wind direction and 3 times of the rotor diameter in addition to wind direction. If the stability of other wind turbines is at risk, it can be specified in the permit that the WTG has to be switched off in certain sectors. This results in a reduction of the expected earnings.

Through steadily growing knowledge and an increasingly professionalization of the processes, the authorities have also become increasingly demanding over time. This is also linked to the ever-increasing size of wind parks, which must meet more and more regulatory requirements due to their size (INTVW 13 Project developer, 2016, para. 81). It must be kept in mind that authority and policy must be separated from one another. Thus, it is possible that the interests of ministers are not compatible with the processes of the approval authority (INTVW 02 Politician, 2015, para. 11).

Each of these mentioned planning phases have a different time, cost and investment structure. The phase of preliminary investigation takes an average of a little more than a year. The costs in this phase are on average EUR 10/kW. The planning phase is usually completed within two years. The time needed to prepare the BImSchG application requires an average of three years. The costs of this phase are on average EUR 30/kW. The time from the beginning of a wind energy project to the installation is on average around four years. The costs of the approval stage are – similar to the planning costs – on average EUR 30/kW. Thus, the total planning process from site securing, managing the planning regulations including the project development and approval procedure takes approximately 5 years. The considered project development expenses until receipt of the BImSchG permit are on average EUR 70/kW (Pietrowicz and Quentin, 2015, p. 56).

Obtaining a permit according to BImSchG for WEA concludes the phase of the planning process. The manufacturing and construction phase of a wind park project can then begin.

### 4.2.2 Manufacturing Wind Turbines at an Industrialized Level

After planning wind parks, the manufacturing of the wind turbines within the wind energy commodity chain follows. however, it should be mentioned that the commodity shift from planning to manufacturing does not follow mandatory in a chronology. R&D of the turbines or the manufacturing of specific components generally takes place as specific steps of the planning process. To order a turbine at an Original Equipment Manufacturer (OEM) specific requirements must be met, such as a down payment and a presentation of the building permit for the wind turbines. These are defined as conditions in a contract for work and materials. If all the requirements are met by the purchaser, the turbine will be officially added to the manufacturing process and the contract for work and materials become operative. From this date the delivery time begins, which accounts normally between six and twelve months. Within this time the OEM has to assure to deliver the WTG to the site, construct it and get it connected to the grid.

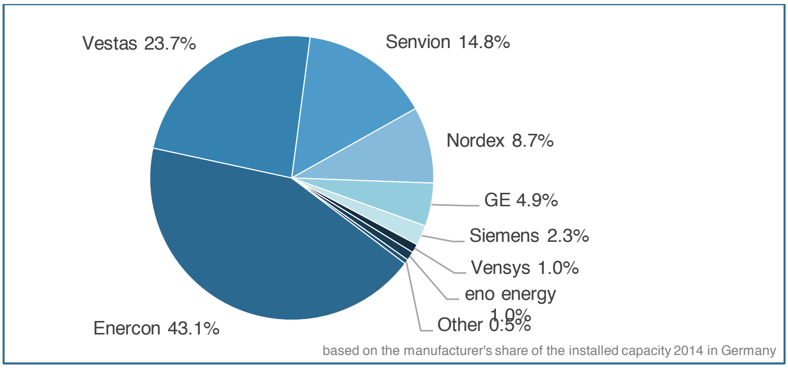


**Figure 20: Wind turbine manufacturers shares in the German market (Own illustration based on Deutsche WindGuard, 2015, p. 4)**

After the OEM's market shakeout, the German wind turbine market is controlled by only a few manufacturers. As one can see in figure 20, the German onshore market was dominated by four OEM in 2014: Enercon has installed 2,042 MW which accounts for 43.1 % market share, Vestas had 23.7 % and 1,092 MW installed followed by Senvion (formerly

REpower Systems) with 14.8 % and 703 MW and Nordex with a share of 8.7 % and 413 installed MW. Their total share of newly constructed turbines in 2014 was 90.2 %, which corresponds to 4,370 MW from a total of 4,750 MW.

In this chapter, the focus lies on the major OEM and differences between the various corporate strategies will be identified. The distinction of the corporate strategies is based on the three phases of the commodity chain part of manufacturing, which are illustrated in figure 21: material processing, component processing and assembling.

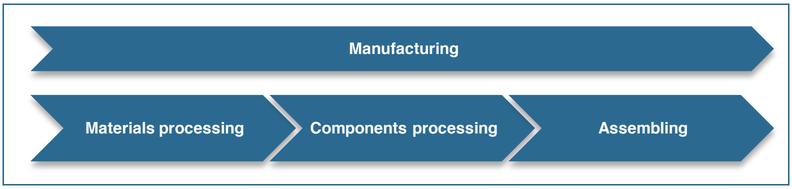


**Figure 21: Commodity chain phases of the manufacturing process (Own illustration)**

The typical weight of a turbine lies between 200 and 400 tons. Due its strength and durability, steel plays one of the most important roles in the manufacturing a turbine. Hence it is no surprise that steel accounts for 90 % of a turbine's weight (Ayee et al., 2009, p. 12). Depending on the height of the turbine's tower at least 100 tons of steel are needed. "The rotor is constructed from approximately 45 % steel, with the hub being made of 100 % steel, and the blades being made up of 2 % steel and a combination of fiberglass (78 %) and adhesive (15 %). Steel accounts for between 87 % and 92 % of nacelle components" (Ayee et al., 2009, p. 12).

It is estimated that there are 8,000 parts installed in a WTG (Ayee et al., 2009, p. 14). In order to prepare these parts, in the first phase of manufacturing a wind turbine, raw materials are transformed to intermediate products by processing the materials. Intermediate products are, among others, metal parts, castings or fiberglass. The corporate strategies of the manufacturers are very different because of the vertical range of manufacture. Within the material processing, the manufacturing of castings has emerged as a key role. Since turbine components such as rotor hubs, machine carriers, axle journals and stators have become bigger in the multi-megawatt class over the years, this can lead to shortages. Normally, turbine manufacturers do not have their own foundry for castings and thus the manufacturers are dependent on foundries. For components that are manufactured with one single cast up to 100 tons of mass, there are only a few foundries that can handle such masses (Gasch et al., 2013, p. 113). Regarding the vertical range of manufacture, Enercon is an excellent example for a very deep integration into the manufacturing commodity chain. Enercon is the only wind turbine manufacturer with its own foundry worldwide. The production in the foundry takes place according to a series and flow production. After casting the parts are brought via its own Enercon railway company to the further production facilities (Ziem, 2010, p. 17).

In the following phase of manufacturing the main components are manufactured. The main components are blades, generators, gearbox and tower components. The different corporate strategies from the OEM are reflected in the different vertical range of manufacture. Table 8 shows for instance the vertical integration of Gamesa turbines and its breakdown of component supply.

**Table 8: Breakdown of component supply for Gamesa turbines (Own table based on Wind Directions, 2007)**

| | Blades | Central Software | Gearboxes | Generators | Power Electronics | Tower |
|---|---|---|---|---|---|---|
| Design | 100 % in-house | 100 % in-house | 50 % in-house | 50 % in-house | 60 % in-house | 100 % in-house |
| Manufacturing | 100 % in-house | 100 % in-house | 50 % in-house | 55 % in-house | 60 % in-house | 30 % in-house |
| O&M | 100 % in-house | 100 % in-house | 100 % in-house | 100 % in-house | 100 % in-house | 100 % in-house |
| WTG Cost | 20 % | 5 % | 15 % | 10 % | 5 % | 20 % |

It must be mentioned that the integration highly varies from OEM to OEM. For instance, the case of the OEM Vensys: the very low vertical integration in the manufacturing commodity chain results from the extended licensing business that Vensys operates. Vensys develops wind turbines with its own R&D departments and sells these licenses to other OEM, so they can manufacture their own turbines within a license or franchise model. License holders are the OEM Goldwind, which is the largest wind turbine OEM in China, ReGen Powertech in India, IMPSA Wind in Brazil and the Arab Organization for Industrialization in Egypt. Only after the admission of Goldwind as a co-shareholder of Vensys, it was possible to manufacture Vensys turbines in own production facilities (Vensys, 2015).

The exact opposite of this corporate strategy is the attempt to penetrate the whole manufacturing commodity chain. The OEM Enercon manufactures all main components on its own. Furthermore, Enercon is the only OEM that does not order main components from subcontractors and suppliers. Moreover, Enercon extends its market penetration into the area of subcomponents and also into the material processing. Estimates assume that Enercon has a vertical range of manufacture of around 80 % (Machatschke, 2008; TMWAT, 2010, p. 4).

Between these two extremes, other OEM in the German market such as Vestas, Senvion, GE, Siemens, Gamesa and eno energy have varying degrees of integrations. The highest share of in-house manufactured components are the rotor blades and the tower components.

The reason for this high share is that knowledge and R&D for blades rose at the same time as the wind industry began to grow. Thus, the position of manufacturing blades within the commodity chain had to be filled by the OEM. For other main components, such as generators and gearboxes, commercially available products and models could have been used. Companies that have been already established in these markets could evolve to direct sub-contractors for the OEM (Kammer, 2011, p. 165). Another reason for the high percentage of the in-house blade manufacturing is that during the blade manufacturing a high share of value added takes place. Thus blades are the still the key components, especially for the further development of the WTG (Hau, 2014, p. 282). Expert opinions assume that it is nevertheless important to develop and manufacture rotor blades in-house. If a manufacturer relies on standard rotor blades from external rotor blade manufacturers, one cannot differ aerodynamically from the competition (INTVW 08 Manufacturer, 2016, para. 19).

The different strategies have both advantages and disadvantages which are summarized in table 9 (p. 159). With a high level of vertical range of manufacture the OEM have only a low level of dependence on subcontractors, but with a low dependence on subcontractors the OEM has only large capital requirements. But manufacturers can dictate their subcontractors' or suppliers' prices. This is however only related to large quantities to achieve economies of scale (INTVW 08 Manufacturer, 2016, para. 14).

**Table 9: Comparison of vertical range of manufacture (Own table based on Gasch et al., 2013, p. 113)**

| High level of vertical range of manufacture | | Low level of vertical range of manufacture | |
|---|---|---|---|
| **Advantage** | **Disadvantage** | **Advantage** | **Disadvantage** |
| Low dependence on subcontractors | Large capital requirements | Low capital requirements | Dependence on subcontractors |
| High value added | High risk of fluctuating capacity requirements | High flexibility | Low value added |
| Easier quality assurance | | License production | |

This strong position of manufacturers against their suppliers was not always like this. According to a CEO of a wind turbine manufacturer, 2007 was a high phase of demand for components. The suppliers of components had entered into long-term supply agreements with the manufacturers and were already at full capacity. For example, there was a shortage of gearboxes at this time. This resulted in additional players entering into the commodity chain. Thus, new actors from for example the automotive or mining industries established themselves in the wind industry, and have produced gearboxes for wind turbines. As a result, the situation in 2011 and 2012 had changed since many capacities are freed by the appearance of new suppliers for wind turbine components. The resulting oversupply has improved the situation for manufacturers (INTVW 24 Manufacturer, 2016, para. 26). To be independent of its suppliers, a high level of vertical range into the commodity chain is necessary.

OEM with high level of vertical range are present in more production steps and positions of the commodity chain and can thus they can create more value added and the quality assurance is easier to control. In contrast, OEM with a lower integration in the commodity chain are more flexible and can additionally create value added by license production.

In the last commodity chain phase of the manufacturing process, the subcomponents and main components are assembled into large components. Large components are the assembled blades, the assembled nacelle, the drive train, the hub, and the assembled tower components. The drive train is comprised of the components of the generator, gearbox, clutch, brake and rotor shaft. The blades are connected with flanges matching for the hub. Tower segments are also connected with flanges.

In the assembling process of the OEM, the nacelle is the key component, because most of the components come together in the nacelle. The nacelle design differs between OEMs, which make it easy to determine which turbine is from which OEM. The design and appearance of the turbine do not affect the turbine's electricity production but design and appearance is determined by the technology. Turbines with greater capacity and longer rotors are usually longer and wider than turbines with less capacity or smaller rotor blades, because stronger forces are acting on the components of these more powerful turbines.

Typically, the nacelle will be assembled in the own facilities of the OEM. This saves rework on the site, ensures quality and saves a lot of time and thus also costs. Then on the site, the large components only need to be composed and connected. The assembling has been gradually professionalized by the OEM. According to a Nordex production engineer "[…] the two shifts are now standard and firmly embedded in all processes. This step increases the production capacity significantly. We have made the entire production process and designed the work content of individual stations leaner and more efficient. Thus we could reduce the effective working time of three hours by fifteen minutes" (Nordex, 2015, p. 4).

Table 10 (p. 161) clearly shows that the wind industry is today a global commodity chain. The table shows the biggest wind turbine OEM in Germany and their subsidiaries in different countries. With the increasing internationalization of the wind industry and the increasing shift from the core markets to other European and non-European markets, the competitive situation and the pressure on turbine prices for OEM have tightened.

**Table 10: Branches from selected wind turbine OEM in 2015 (Own survey)**

| Enercon | Vestas | Senvion | Nordex | GE | Siemens | Vensys[51] | eno energy |
|---|---|---|---|---|---|---|---|
| Australia | Argentina | Australia | Chile | China | Australia | Brazil | France |
| Austria | Australia | Austria | China | France | Brazil | China | Germany |
| Belgium | Austria | Belgium | Denmark | Germany | Canada | Egypt | Sweden |
| Brazil | Brazil | Canada | England | India | Chile | Germany | UK |
| Canada | Bulgaria | China | Finland | Ireland | Germany | India | |
| China | Chile | France | France | Italy | Greece | | |
| Costa Rica | China | Germany | Germany | Poland | Japan | | |
| Croatia | Denmark | India | Ireland | Romania | Morocco | | |
| Estonia | France | Italy | Italy | Spain | New Zealand | | |
| Finland | Germany | Netherlands | Norway | Turkey | Norway | | |
| France | Greece | Poland | Pakistan | UK | Puerto Rico | | |
| Germany | India | Portugal | Poland | USA | South Africa | | |
| Greece | Ireland | Romania | Portugal | | Spain | | |
| Ireland | Italy | Sweden | Romania | | UK | | |
| Italy | Japan | Turkey | South Africa | | USA | | |
| Japan | Mexico | UK | Spain | | | | |
| Latvia | Netherlands | USA | Sweden | | | | |
| Lithonia | New Zealand | | Turkey | | | | |
| Netherlands | Philippines | | Uruguay | | | | |
| Norway | Poland | | USA | | | | |
| Poland | Portugal | | | | | | |
| Portugal | Romania | | | | | | |
| Romania | Singapore | | | | | | |
| Spain | South Africa | | | | | | |
| Sweden | South Korea | | | | | | |
| Switzerland | Spain | | | | | | |
| Turkey | Sweden | | | | | | |
| UK | Taiwan | | | | | | |
| Uruguay | Turkey | | | | | | |
| | UK | | | | | | |
| | USA | | | | | | |

As table 10 shows, the German OEM Enercon has increased to a world-wide operating company with more than 50 subsidiaries in 29 countries. The Danish OEM Vestas with subsidiaries in 30 countries is the biggest OEM worldwide.

With respect to the margins of manufactures, it can be said that the margins are very similar to those of the industry of plants and mechanical engineering. There are currently no reasons why the margins should be higher for plant manufacturers in the wind industry than in other plant

[51] Vensys' subsidiaries are from the following license holders: Pernambuco, Energwind/IMPSA wind in Brazil, Urumqi/Xinjang, Goldwind in China, AOI in Egypt, Andhra Pradesh, ReGen Powertech in India (Vensys, 2015).

industries (INTVW 24 Manufacturer, 2016, para. 20). The goal of wind turbine manufacturers is for EBITDA margins between 6 % and 7 %. In some cases, this can also rise to 9 %, but the business results are in a single-digit EBITDA margin area (INTVW 24 Manufacturer, 2016, para. 22). Regarding only the single wind turbine, however, some manufacturers expect margins of about 20 % (INTVW 09 Manufacturer, 2016, para. 35). According to a CEO of a large wind turbine manufacturer, the highest margins are earned when a manufacturer understands the market and the market prices, especially when entering into a new market with the right turbine at the right time. Then they can enjoy a period of about two years in which the manufacturer earns more money. "But here again, if you enter the new market first, you have the first risk, but you have the opportunity to make money" (INTVW 26 Manufacturer, 2016, para. 41).

Banks have an enormous impact on the wind energy commodity chain. Because, depending on the bank’s risk profile, they can decide which turbine manufacturer they finance and which they do not. All large manufacturers are financed in Germany by banks. However, smaller manufacturers experience difficulties. According to a banker, although smaller producers are financed, but additional parameters for financing are applied for smaller wind turbine manufacturers (INTVW 14 Bank, 2016, para. 25).

The bankability of a turbine is the decisive factor for the success of a manufacturer. If the bank denies the turbine’s bankability, the product is virtually unsaleable on the German market. The bank's influence is so high, for example, that the bank can decide that no components from outside Europe may be installed within the turbine. (INTVW 24 Manufacturer, 2016, para. 30). But the manufacturers also know about this power of the banks, and organize bank days to advertise the turbines for the banks (INTVW 26 Manufacturer, 2016, para. 29). Furthermore, interview partners have reported that some banks prefer certain manufacturers and thus give projects with exact these manufacturers special financing conditions compared to other projects with other manufacturers (INTVW 26 Manufacturer, 2016, para. 29). This can lead to market manipulation, as the financing and its terms are a decisive factor for the project’s profitability.

### 4.2.3 Construction and Installation of Wind Parks

Within the construction phase of the commodity of wind energy projects, coordination plays a significant role. The central and crucial point is the delivery date of the turbine. The whole construction process is divided into three phases as shown in figure 22: the coordination and control function is performed by the project management from the OEM. If the site of the wind park is prepared and large components are ready, the transportation and logistics phase begins and the wind turbine components will be delivered to the site. After the arrival of the components on the site, the turbine will be constructed. The project management accompanies this process through to commissioning of the WTG. As already mentioned in the previous chapters, the phases are organized by a logical sequence and not by a time sequence.

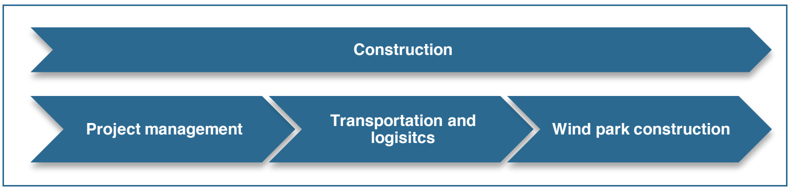


**Figure 22: Commodity chain phases of the construction process (Own illustration)**

The construction process includes a combination of many different actors and companies: OEM, suppliers, project developers, logistic, transport and construction companies, authorities, investors, distribution system operators and many others. On top of this logical chain stands the project management. The project management is carried out here at different levels, by different actors.

Depending on the extent of the contract for labor and materials between the investor and the OEM, the project manager controls this process. Normally, the contract includes the delivery of the different turbine components to the site, the construction and the commissioning of the wind park. Thus, the project manager of the OEM takes the wind energy project over from the OEM sales department after the contract enters into force. From this moment, the project manager has the coordination and the control of the companies for the construction of the foundation, the crane and the logistics company, the company for the tower erection and the company for construction the turbine. Additionally, the project manager also controls the in-house activities of the OEM as the construction team, the commissioning team and the team for installing the electric system and the remote control. As the exact delivery date of the WTG on the site is the central and crucial point, the project manager coordinates the transport and logistics, as well as the just-in-time delivery of large components in the wind farm and the construction.

Due to the ever-increasing number of wind turbine components and the large amount of space needed within the wind park, the wind turbines are usually constructed with a just-in-time delivery. The just-in-time delivery is implemented within the commodity chain management to reduce the storage to a minimum, which means that most components arrive at the site one day before or in the night before the components are installed on the site. This requires that each stage of the commodity chain knows exactly how much time it takes to manufacture a component and to deliver the components to the site.

If delays occur due to problems on the construction site or delivery problems due to shortages of supply, it can incur significant additional costs. Depending on the assignment and the contract details, the additional costs have to be paid by the OEM or the investor. For example, the OEM pays for delays due to bottlenecks in production. Costs due to delays caused by bad weather or problems due to the road construction fall to the investor.

Due to the steadily increasing wind turbine components, the commodity phase of transportation and logistics is becoming more demanding. Due to the height and weights, heavy goods transports are used. Table 11 (p. 165) illustrates these large and heavy dimensions of the individual wind turbine components. According to the BWE, approximately 95 % of the necessary transportation for the construction of wind turbines is subject to approval and most of the heavy and special transports have to be escorted by the police due to the dimensions and weights.

**Table 11: Weight and transport dimensions of wind turbine components (Own survey)**

| | Nacelle | Drive train | Hub | Blades | Tower segments |
|---|---|---|---|---|---|
| **Weight**[52] | 50 tons | 50 tons | 25 – 30 tons | 8 – 12 tons | 45 – 70 tons |
| **Length**[52] | 10 – 12 m | 3 – 4 m | 3 – 4 m | 35 – 60 m | 10 – 35 m |

In 2013 the four EOM Enercon, Vestas, Nordex and Senvion performed approximately 30,000 heavy transports combined. In 2014, they performed approximately 39,000. For this purpose the transport and logistic companies have received about 70,000 permits from the approval authorities (BWE, 2015, p. 1).

Since the large components typically override a width of 3.5 m, the components are subject to strict movement restrictions. As more disturbances occurred in the transport commodity chain, it can be recognized that these stringent requirements began to be reduced. For instance, Nordex made an agreement with the city Rostock to ease these restrictions. Since the beginning of 2015 Nordex can transport its nacelles even during the day in certain traffic intensive time windows, and only two escort vehicles are needed. According to the head of industrial engineering of Nordex: "We were allowed to transport the major components only with a police escort and only at night. However, we did not have enough capacity to store them for long. It was necessary in the course of production expansion [...]to make this agreement" (Nordex, 2015, p. 5).

The transport possibilities are versatile and challenging. The large components have to be transported from different production facilities to one site, which is located in the wind park. According to Nordex's head of project's logistics the transport costs are between EUR 80,000 and EUR 160,000 per turbine (Bottler, 2011).

The WTG components can be transported not only on the road but also by train or by ship. Transport by ship is particularly important for transit to other countries and markets, where the producing OEM has no own production facilities. Also in the transport and logistic phase the vertical

[52] All data are approximate values and refer to a turbine with a capacity of around 2.5 MW, a rotor diameter of about 80 -120 m. Weights and lengths are inclusive of transport racks and blade bolts. Weights and lengths vary depending on the manufacturer. The tower is very varied due to the total height of the tower, the rotor size and the type of tower (steel or concrete-steel hybrid).

integration into the commodity chain depends on the corporate strategy. As already mentioned the manufacturer Enercon has a deep integration in the commodity chain of wind energy. For example, Enercon operates a train to transport its components, and it also maintains its own cargo ship. That can be seen also in Enercon's transport and logistic strategy. Enercon's motivation for building its own cargo ship were the "increase [of] demand and special requirements for transport of wind turbines and parts, [the] conventional cargo vessels [were] not optimal for Enercon freight and [the] demand for sustainable shipping" (Enercon, 2013, p. 6).

The third and last phase is the construction itself. At the beginning of the wind park construction roads are constructed to allow access to the future turbines. At each future turbine site, a crane pad and storage areas are established. In the next step, usually local construction companies build the foundation for the planned turbine. The foundation is poured on-site and is covered with the excavated soil. If the foundation is approved by the experts, the tower construction can begin, wherein a crane is used. There are different tower concepts. Either the tower is poured on-site, or it is composed of prefabricated tower components. The tower can be made of steel or concrete, or the two materials are combined in a so-called hybrid tower. The nacelle is then placed by a crane on top of the tower. The blades can be connected to the hub separately one by one, or the all blades linked through the hub can be pulled up at once. Meanwhile, each turbine has to be connected to the local power grid. Therefore, electrical cable is laid and electrical substations and transformer stations are installed.

When erecting the plant telescopic mobile cranes, lattice-boom crawler cranes and tower cranes are used. Telescopic mobile cranes can drive on public roads and therefore they are economical to transport. They can be set up quickly on a small area. This crane can drive in the wind park from turbine to turbine with retracted telescopic boom. The lattice-boom crawler crane can drive with complete equipment on suitable terrain from one WTG to another, which saves time for assembly and dismantling, and thus it saves also costs. With tower cranes, the turbines can also be erected at higher wind speeds. Another advantage of tower cranes is that they are easy to transport and installation requires only a small area.

When constructing the wind park, the OEM use external assembly companies, which erect the WTG on-site, and external crane companies, or the OEM performs the construction work itself. This varies from OEM to OEM. Again, the company Enercon is a good example of how a wind turbine OEM can penetrate the entire commodity chain. According to an own survey Enercon it is the only OEM, that has cranes in its stock. The crane constructor Liebherr has configured a tower crane with the requirements formulated by Enercon and was used for the first time in 2014 (Enercon, 2014).

Regarding the construction of a wind park, an experienced financial service provider summarized the margins and risk of this phase as follows: "Probably one of the lowest margins will be generated during construction. [...] The greatest risk lies in civil works. Erecting the turbine is routine, more or less. This also spreads back to a few large service providers, which are engaged by the WTG manufacturers and for them it is the daily business. The turbines are erected and something unexpected rarely happens" (INTVW 19 Financial Service Provider, 2016, para. 41).

After completion of the wind park and a successful test phase, the wind park is handed over to the investor. From that time, the investor is responsible for the operation and the economic success of the wind park.

### 4.2.4 Operation of a Long-Term Investment

The regular operation of a wind turbine begins upon the approval of the turbine by the investor or the operator and the manufacturer. The turbines are designed to run for 20 years. The tasks that need to be addressed at this time are varied and are divided in different phases, as illustrated in figure 23 (p. 168).

All phases like maintenance, technical management, commercial management, direct marketing and insurance which are listed in figure 23 (p. 168), do not take place sequentially, but simultaneously over the entire lifetime of the turbine.

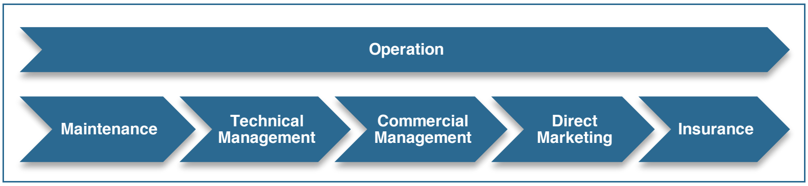


**Figure 23: Commodity chain phases of the wind park operation (Own illustration)**

To ensure safe operation of the turbine, the turbine must be serviced regularly. The maintenance can be carried out either by the manufacturer or a third party. It should be noted that there is a growing competition in the market for maintenance (INTVW 09 Manufacturer, 2016, para. 59), as more and more third parties penetrate this market and endanger the monopoly of the OEM (INTVW 15 Maintenance Service Provider, 2016, para. 6).

With maintenance contracts, one can distinguish between different types. A so-called basic maintenance covers the remote monitoring and troubleshooting of the WTG. Since the turbine and its different components can be monitored remotely to react quickly in case of incidents of the system and thus the downtime can be reduced to a minimum. This increases the turbine's availability. The WTG must be serviced regularly. This is usually done in a 6 - 12 month cycle according to the operation and maintenance manual, which is specified by the manufacturer. Furthermore, preventive maintenance can be optimized by inspections and servicing the turbine, which goes beyond a standard routine maintenance.

Another option in maintenance contracts, which goes beyond routine maintenance and remote monitoring, is a contract for spare parts and service. In this case, the defects and errors will be corrected directly on the site of the turbine. By ensuring the supply of spare parts, the OEM manages the spare parts repair, spare parts procurement and warehousing. In addition, the OEM guarantees a certain availability of the wind turbine. In general, the availability of single turbines is 95 %, and the availability of turbines in wind parks with at least three wind turbines is 97 %, depending on the service contract.

In addition to the aforementioned options of routine and remote monitoring of the spare parts and service agreement, a maintenance agreement that cover both options can be chosen, including non-scheduled service work. In particular, this work includes the unscheduled maintenance and repair of major components. Furthermore, condition monitoring can be performed. Hereby, an early detection system checks irregularities in the drive train by vibration sensors.

Meanwhile, a full maintenance concept, which covers all above mentioned maintenance and inspections, is a basic requirement of the financing bank. The risk for the operator has to be minimized. Otherwise the equity ratio rises. The risk of technical damages is accordingly transmitted to the OEM, or if possible to the independent service provider. The first manufacturer to offer a full maintenance concept was the WTG manufacturer Enercon. This was driven by investors who in turn were driven by the banks that wanted to reduce risk (INTVW 15 Maintenance Service Provider, 2016, para. 5). The maintenance business has changed considerably in recent years. 10 years ago, the maintenance business was an accessory for the sale of turbines. Since then the manufacturers have developed new maintenance concepts and thus expanded their product range. The driving force behind the development of these new products was the financial sector. Both customers and financiers have called for these new maintenance concepts, which also include availability of the turbines and major repairs (INTVW 15 Maintenance Service Provider, 2016, para. 4). Now the maintenance business is very attractive for a manufacturer because it ensures a regular income. These revenues are planned annually and in the long term (INTVW 08 Manufacturer, 2016, para. 41). It can be assumed that the maintenance costs range from about EUR 20,000 to EUR 25,000 per MW (INTVW 15 Maintenance Service Provider, 2016, para. 15).

Meanwhile the area maintenance has been optimized by the maintenance providers. The market for the service sector is very competitive, as there has already been a controversy about the fact that one can earn very good margins in this business area (INTVW 22 investor, 2016, para 13; INTVW 22 investor, 2016, para 51). Margins in the maintenance sector even exceed the margins in the WTG sales (INTVW 26 Manufacturer, 2016, para. 38). Therefore, more and more independent service providers are also establishing their service and maintenance businesses in the

German market. The advantages of the service business are summarized by a CEO of a large wind turbine manufacturer as follows: “stable sales, stable cash flow, long-term investments. [...] Every manufacturer looks closely at how long the average term of contracts are. Because the longer the runtime, the more stability it brings. And these are recurring business when doing a good job” (INTVW 26 Manufacturer, 2016, para. 33).

With most turbine purchase contracts, a full maintenance contract is a precondition. If the investor or subsequent operators of a wind park prefers a WTG from a particular manufacturer, the investor must bind himself for several years to the manufacturer. Thus, the manufacturer is here at a higher position in the chain governance. This leads to the high share of full maintenance contracts. Between 90 % and 95 % of all new wind turbine have such contracts (INTVW 12 Technical and Commercial Management, 2016, para. 54).

In addition to the manufacturing, there is the technical management. The technical management includes all other technical inspections and services which are not covered in the full maintenance contract with the OEM. The technical management is a performance that is demanded by the banks for financing. The technical management is often offered by the same project developers who also brought the wind energy project to approval status. The performance of the technical management also ensures the project developers a secure income for several years. As a rule, the contracts are limited to a few years with automatic renewal. Sometimes contracts are agreed for 15 years, which leads to an enormous planning security with respect to budget for a project developer. When selling wind parks, these contracts must also be taken over. This means that the wind park is blocked for another technical operator for a long time (INTVW 12 Technical and Commercial Management, 2016, para. 21).

The remuneration of the technical management is highly dependent on the contractually agreed scope. In general, the remuneration is linked by a percentage to the feed-in revenues. Mostly there is also a determined minimum remuneration. Since the service range can vary greatly from the respective operator and by the requirements of the operator and the investor, a comparison of remuneration cannot be developed in general terms. However, in recent years, it can be noticed that there is a price decline for remuneration. As reasons for this, for example, the standardization of various processes and the increasing competition between the technical management operators can be mentioned (INTVW 12 Technical and Commercial Management, 2016, para. 10, 31). Furthermore, it can be observed that although the percentage payment decreases, that does not necessarily mean that also the nominal value falls behind. This is because the remuneration of electricity per WTG tends to increase due to larger generators, larger rotors and higher hub heights, but the workload for the technical management per WTG remains more equal, and in newer turbines even decreases.

However, the margins for technical operators have become very small due to the growing competitive pressure. Some sources even refer to a loss-making venture (INTVW 12 Technical and Commercial Management, 2016, para. 28). This will result a market shakeout regarding technical operators (INTVW 12 Technical and Commercial Management, 2016, para. 41).

While it is very difficult to generate income with technical management, it is important for a project developer to operate management. Only in this way the investors, who are in direct contact with the operator, can be tied to the project developer (INTVW 06 Project developer, 2015, para. 11). A further possibility is to use technical management as a sales portal in order to be able to sell further engineering services (INTVW 12 Technical and Commercial Management, 2016, para. 33).

In addition to the technical management, each wind energy project needs commercial management. Similar to the technical management, the project developers have specialized in commercial management. The major tasks of the commercial management are the preparation of the financial statements with consultation with the relevant accountants, performance of accounting, payments, cost control and contract negotiations, claim management, creation of annual investment and economic plans, organization of the general meetings with the shareholders, and reporting on the current technical and economic status. Thus, the commercial management of a wind park takes care of all administrative services and monitors the entire financial accounting, the financial statements, the tax accounts and monitor and control all payments, including the disposition of the loan funds. Thus, the commercial management is a key position in the operating phase of the commodity chain. The entire liquidity flow runs through this central management. The feed-in remuneration is credited to the project company's account by the network. The commercial management controls these accounts and pays all invoices for example, for full maintenance, technical management, insurance, land leases and miscellaneous. For these mentioned reasons, it is not in the interest of the investor to outsource commercial management to external companies. Depending on the investor and its investment strategy, the investor wants to have perfect access to all relevant cash flows. This investment strategy also has influence on the duration of the contracts for the execution of the commercial management. Similar to the technical management, it is also in the interest of the commercial management company to make agreements with the longest possible maturities to generate a constant source of income for the company. The remuneration for the commercial management is also defined as in the technical management. The high of remuneration depends on the agreed scope. There are several models of compensation for use, which can also be combined with each other. It can be a fixed agreed for a price arrangement, a compensation depending on the feed-in remuneration of the turbines, a remuneration depending on the availability of the wind turbines or a remuneration depending on the adherence to a pre-arranged maintenance budgets (BWE, 2014, p. 4).

In accordance with the EEG 2014 and the EEG 2017, electricity from renewable energies is promoted through the payment of a market premium or feed-in tariff. Since the EEG 2014, direct marketing has not been mandatory for the operator. Prior to this, the wind park operator was able to market its produced electricity on a voluntary basis and received a premium in addition to the feed-in tariff.

Direct marketing means that the produced electricity is traded and sold directly at the electricity exchange, for example on the spot market of the EEX. On the stock market, electricity from wind energy is traded and sold equal as conventionally produced electricity at market prices. After the sale, the wind park operator receives the proceeds from the electricity exchange sale together with the market premium. The sum of the exchange income and the market premium corresponds at least to the amount of the feed-in tariff which is regulated by the EEG. The direct marketer charges the operator for his service a fee. This fee is usually due per kWh, which the direct marketer company trades on the exchange. The fee that the direct marketer can offer depends on the market value of the respective wind park. Two factors are important as to how this market value is composed. The more diverse yields the wind park generates in contrast to the broad mass of wind parks in Germany, the higher the market value. The second factor that determines the market value depends on the existing portfolio of the direct marketer. The better the wind park can be integrated into the existing direct marketer's portfolio and the more synergy effects[53] result from the integration, the higher the market value of a wind park.

The service of direct marketing is thus interchangeable. Therefore, the price is crucial to the success of a direct marketer because based on the price the investor decides whether or not to use a direct marketer. Nevertheless, the financial sector plays a decisive role in the choice of the direct marketer. The bank must accept the direct marketer because the direct seller must have financial reliability (INTVW 21 Service Provider Direct Marketer, 2016, para. 33). In the case of direct marketers who are not known to the bank, additional costs are incurred because the bank has to check the contracts of the direct market operator (INTVW 21 Service Provider Direct Marketer, 2016, para. 41).

Nevertheless, it should be noted that direct marketers initially had very high margins. For this reason, many direct marketers emerged. This increase in direct marketers ultimately led to a price pressure (INTVW 21 Service Provider Direct Marketer, 2016, para. 19). Due to the high price pressure and the low margins in the renewable energy sector, many direct marketers are now moving their business focus to energy management in industries. This process leads to a necessary market clearance (INTVW 21 Service Provider Direct Marketer, 2016, para. 19). In the case of price

[53] Synergy effects can arise if the specific wind park has a strategic geographical location. From the weather data and production data of this wind park, conclusions can be drawn about how wind conditions develop in the nearby wind parks. This increases the forecast quality, and the direct marketer can more accurately forecast its electricity production.

pressure, large direct marketers have the advantage that they can cross-subsidize direct marketing through other business areas (INTVW 21 Service Provider Direct Marketer, 2016, para. 21). Especially "over the last two years, the benefit of the operator was that the direct marketing costs could be greatly reduced. Now we are also at the point that wind parks are priced based on their performance and less overall prices are given" (INTVW 21 Service Provider Direct Marketer, 2016, para. 17). Nevertheless, it should be noted that "the direct market operator carries the operator's overall risk that could arise in the trade" (INTVW 21 Service Provider Direct Marketer, 2016, para. 31).

The last major relevant block in the operating phase of wind energy projects is insurance. Insurance companies have become increasingly important over time. Certain insurance contracts for the operating time of the wind park are required by the banks to receive project finance. Among the major insurances, the most important are the machinery insurance, the machinery business interruption insurance and the operator's liability insurance. The machinery insurance is a technical property insurance, which protects the WTG against unexpectedly occurred damage or destruction. The machinery business interruption insurance protects the operator and provides insurance coverage for the damage caused by the interruption of the WTG operation, for example due to technical damage. The last important insurance during operation is the operator liability insurance. This insurance provides the operator and the investor insurance against claims for damages by third parties which have arisen in connection with the operation their wind energy parks.

#### 4.2.5 Dismantling or Repowering Wind Parks

A wind energy turbine has a planned service life of 20 years. If the operation cannot be extended above this time, the WTG has to be dismantled, the parts recycled and the site has to be restored in to its original state. The specific processes of the dismantling or repowering phase are demonstrated in figure 24 (p. 175), which consists of repowering, dismantling, secondary market and recycling.

The manufacturing and the operation of a WTG are designed for exactly 20 years. Therefore, the permits are also granted only to 20 years. For every extension of fatigue life[54] longer than 20 years, the manufacturing costs would increase and thus the sale prices. But continued operation is still possible if the relevant reports are presented to the approval authorities for further operation (Holzmüller, 2013, p. 79). There is yet no standardized method for this extension process. The mentioned reports have been prepared separately and individually for each wind turbine (Iken, 2012, p. 51). From an economic perspective, further operation is only reasonable if the income exceeds the cost for operation and maintenance.

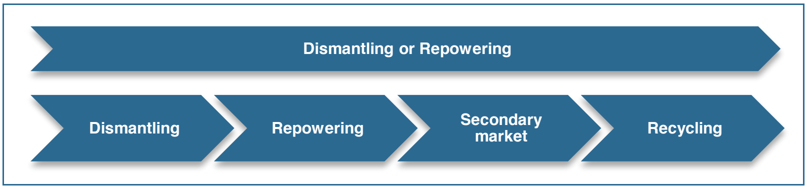


**Figure 24: Commodity chain phases of the wind park repowering or dismantling (Own illustration)**

When the operation after 20 years will not be extended by the operator, the WTG has to be dismantled. This is firmly fixed in approval according to BImSchG. By now, the approval authorities require specific dismantling guarantee when issuing the permit. The dismantling guarantee constitutes a security which has to be deposited with the authorities. The guarantee amount is meanwhile approximately EUR 150,000 (Own survey) for each turbine.

The dismantling of the WTG is similar to its installation and erection. With the help of a crane, the turbine can be dismantled and taken away by trucks. First, the blades are separated from the hub, then the hub and the nacelle will be removed. The tower is then unscrewed and disassembled into its individual component parts. The foundation must also be removed. However, in land lease contracts it is normally agreed that the foundations must only be removed to a specific depth, so that agricultural use is possible.

[54] The fatigue life is a theoretical assumption and is also-called the planned service life. To calculate this period, evidence of load capacity, stability and serviceability were examined.

Generally, the investor and operator of a wind park has to consider the possibility of whether repowering[55] is possible due to planning regulations and if repowering is economically profitable. To make repowering attractive for investors, the EEG created policy incentives such as the so-called repowering bonus. In the EEG 2012, the initial tariff was increased by 0.5 eurocent per kWh if a wind turbine is replaced by a new turbine with more capacity. The operator receives the bonus if the installed capacity of the new turbines is double that of the replaced turbines and the number of repowering turbines did not exceed the number of the replaced turbines (§ 30 EEG 2012). During the EEG 2014 amendment the repowering bonus was abolished. Thus 2014 was the last chance for investors to receive the repowering bonus and add this bonus in their investments' cash flow. Therefore, it is not surprising that in 2014 more WTG were built – with a capacity of 4,745 MW – in Germany within one year than ever before. It is assumed that repowering will become a new growing branch of business in the wind industry (INTVW 03 Project developer, 2015, para. 127). According to a DEWI survey "[t]he analysis of wind energy development in 2014 shows that more than one third of all new wind turbines erected in Germany onshore (619 of 1,761 WTG) were realized in the form of repowering projects. Repowering installation therefore reached a total capacity of 1,729 MW. The share of repowering in the overall new installation was in the same range as in 2012 and 2013, regardless of the fact that wind energy development has risen to a new all- time high. The total capacity of the old wind turbines decommissioned last year is 386 MW, which means that in 2014 a net growth of onshore wind energy capacity of 4,359 MW has been identified" (Neddermann, 2015, p. 39). Major obstacles while realizing repowering projects are the planning and approval regulatory framework. Also in repowering projects, the developer has to pass the same planning steps (see chapter 4.2.1, p. 147) as in a normal planning and approval procedure. The problem is that in repowering projects the old turbine sites are not identical to the new planned turbine sites because the planning and

[55] Repowering describes replacing older wind turbines with larger, more efficient, modern turbines on the current state of technology. The total number of turbines decreases while the total wind park capacity increases.

approval regulatory framework has often changed over the years. This means that if old wind turbines are dismantled outside of wind priority areas, there is neither a legal obligation nor special approval process for repowering projects. However, new wind turbines can often only be built on the designated areas (see chapter 4.2.1, p. 147). At municipal level there is currently no consistent approval process which regulates where repowering wind turbines can be built (BWE, 2012a, p. 12).

Through repowering, a secondary market for turbines has established. Before the wind turbines can be recycled or scrapped, the operator and investor has the option to sell the turbine in the secondary market. Most of the available turbines in the secondary market come from countries like Germany, Denmark and the Netherlands, where wind energy has been developed for several decades and where is now a large secondary market for used wind turbines and their components. It can be recognized that there are two different types of buyers on the secondary market. On the one hand buyers for used wind turbines come from countries where wind energy has not yet progressed very far or where specific feed-in tariffs for smaller turbines exist. For instance, buyer countries in Eastern Europe, Africa or Asia. On the other hand, the second type of buyers of used wind turbines can be found in Germany. Here it can be observed that used wind turbines are purchased for spare parts and components. If the operator is not able to perform a repower of his turbines on his site, but he wants to extend the turbines operation, the continued operation often depends on spare parts from other turbines. For these old turbines, no more spare parts are being produced and so the operator has to fall back on used parts. It is expected that the secondary market will become increasingly important in the coming years since the amount of wind turbines has increased steadily in recent years.

If all previously discussed processes of the commodity chain are passed through, only the process of recycling or scrapping the turbine remains. According to a survey from the Fraunhofer Institute for Chemical Technology it is clear that 80 - 90 % of the materials used for wind turbines are already recyclable. As figure 25 (p. 178) shows, a wind turbine consists of concrete, steel, composite materials, electronic components, copper, aluminum and polyvinyl chloride, and service fluids.

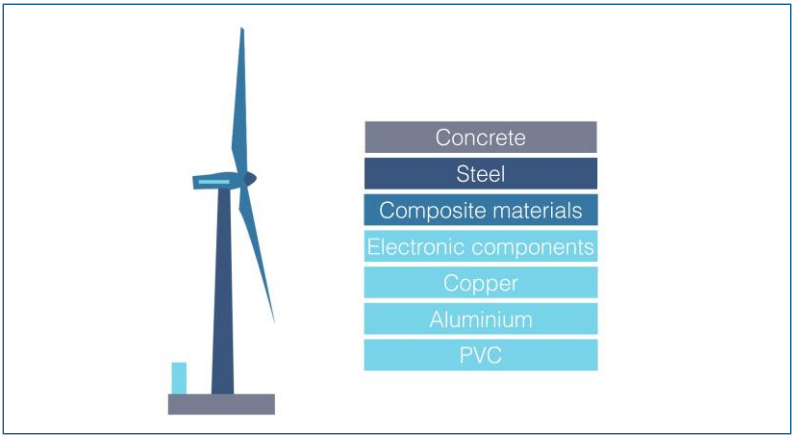


**Figure 25: Construction and material composition of a wind turbine (Own illustration based on Fraunhofer, Seiler 2014)**

The scrap flows melted back into the cycle in steel production. The concrete foundation is crushed by jackhammers. The resulting concrete rubble will be used for road gravel. Steel and copper can be sold for the price of raw materials and can be recycled for other constructions again. The steel can be melted down and can put back into the cycle of steel production.

The electronic components, copper, aluminum, polyvinyl chloride, and service fluid can also be processed and directly used in production again (Seiler et al., 2013, p. 1).

However, the blades and the nacelle material – which consist of composite materials – are an exception. This is the most complex part of disassembling the wind turbine. the disassembly of the rotor blades and the nacelle material. In order to transport the blades in normal trucks without excessive length, the blades have to be sawed up on-site. Recycling rotor blades are still a problem, since they are assembled from composite materials. Separating the individual layers is too costly, therefore, the blades are usually shredded and can be used for example for energy recovery in furnaces of cement production (Kaiser and Seitz, 2014, p. 34).

Although an entire recycling industry has developed in Germany since the beginning of the wind energy development about 25 years ago, but it can be notices that the turbines' operators are not making use of the possibility to recycle the wind turbine components to a considerable extent. After receiving the dismantling permit, the dismantling services are often advertised for bids and are relatively expensive in comparison. It can be assumed that smaller wind turbines are just taken down by the operators and the materials are not been recycled (Kaiser and Seitz, 2014, p. 34).

## 4.3 The Financial Sector and its Advanced Wind Energy Services

### 4.3.1 Structuring Project Finance

The capital requirements result from the wind energy project's capital expenditures (CAPEX). The manner in which the capital procurement proceeds is of less importance for the project's technical operation. However, it has to be noted that costs[56] for these capital procurements need to be taken also into account for the statement of CAPEX. Therefore, these costs play an important role for the projects rate of return and the financial service provider's share of the commodity chain. According to a consultant for wind energy, the main financial service providers are banks, consultancy firms as PwC or KPMG, legal advisors as Hogan Lovells or Osborne & Clark as well as other financial institutions (INTVW 20 Consultant, 2016, para. 9).

Usually the largest share of the CAPEX is provided via finance, whereby the financing bank puts up capital as loan capital. The loan capital complements the equity capital from the investor to represent the CAPEX. The relation of loan capital and equity capital depends on the risks of the projects. The ratio in developed onshore markets amounts to approximately 80 : 20, whereas in the offshore wind energy project business at least 30 % equity capital is required (Schaffarczyk, 2012, p. 74). However, through the interviews, it emerged that there are some projects that were 100 % funded by the bank (INTVW 22 Investor, 2016, para. 15).

[56] For a detailed discussion of capital costs shifts, see chapter 4.4.3 (p. 179).

Possibilities for financing onshore wind energy projects, as well as offshore wind energy projects, are very varied in the German market. Nonetheless, while structuring a finance for wind energy projects most investors choose a project finance instead of a corporate finance or investment finance. This choice results from the fact that wind energy projects constitute a closed circle in a stable legal and economic framework. Hereby the risks for investors are minimized, due to the so-called non-recourse financing.
The three main characteristics of a project finance are illustrated in figure 26, which contrasts project finance and corporate finance. The characteristics of a project finance are (1) the cash flow related lending, (2) the risk-sharing and (3) the off-balance-sheet financing.

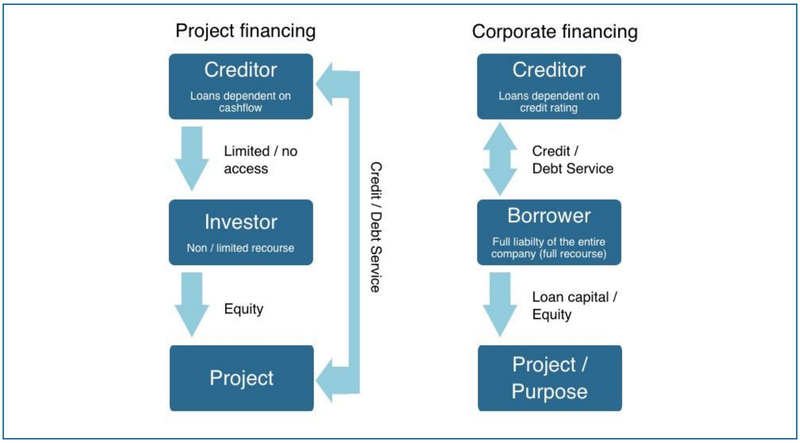


**Figure 26: Comparison of project finance and corporate finance (Own illustration based on Böttcher and Blattner, 2013, p. 15)**

As figure 26 shows, in contrast to the corporate financing, at a project financing creditors – normally commercial banks – solely involve the wind energy projects related cash flow. Creditworthiness and the credit history of the companies are of less importance.
The so-called (1) cash flow related lending is the central role of a wind energy project and is described in the following definition of project finance: “A financing of a particular economic unit in which a lender is

satisfied to look initially to the cash flow and earnings of that economic unit as the source of funds from which a loan will be repaid and to the assets of the economic unit as collateral for the loan" (Nevitt and Fabozzi, 2000, p. 1). The stability of the cash flow is secured for a total of 20 years[57] by the steady earnings guaranteed through the valid feed-in tariffs by the EEG. However, the amount of the cash flow depends on the project's wind conditions, which constitute one of the highest credit risks from the viewpoint of the lenders. Therefore, the calculation of income is based on at least two wind reports, which are demanded by the bank (INTVW 03 Project developer, 2015, para. 91), and in consideration of the turbine's availability and grid losses.

The so-called debt service coverage ratio (DSCR) is important for credit risk rating, which is in general calculated by dividing the net operating income by the debt service[58]. The net operating income is defined as the earnings before interest, taxes, depreciation and amortization (EBITDA). This means, with a DSCR of 1.0 the available income from the electricity revenues covers only the principal repayment and the interest payment. Hence in the repayment plan a limit is defined below which the DSCR should not fall.

Typically, most financing banks in the German market require an average DSCR ratio of 1.30 for the whole financing period, which normally lasts between 15 and 17 years, and a DSCR ratio of at least 1.10 for each year within the financing period to ensure loan payments will be covered (BWE, 2012c, p. 25). Figure 27 (p. 182) shows a typical DSCR development of a wind energy project over 20 years. Thereby the development of the DSCR is largely influenced by the loan repayment structure. As illustrated in figure 27 a constant repayment structure leads to a constant DSCR. Thereby the average DSRC is 1.36 and the minimum DSCR is 1.10 over the 20 years.

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[57] According to the EEG 2014, the remuneration rate for each EEG-plant is granted for 20 years, in addition to the year of commissioning. The amount of remuneration for the produced kWh depends on the energy source, the size of the plant and the date of commissioning of the plant (for further explanation see chapter 4.4.5, p. 187).

[58] $\text{DSCR} = \frac{\text{EBITDA}}{\text{Principal Repayment+Interest Payment}}$

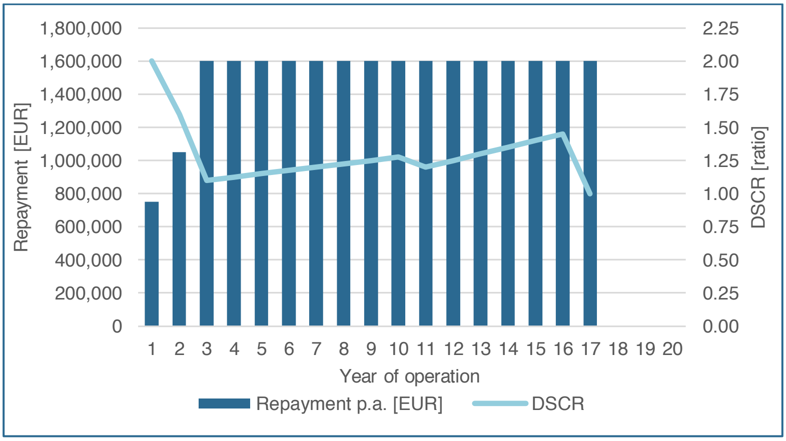


**Figure 27: DSCR development of a 6 WTG project (14.4 MW) in eastern Germany (Own illustration)**

A linear repayment would lead to a lower DSCR at the beginning and then to a slowly increase of the DSCR. The example shows a lower repayment in the first two years, which increases the DSCR significantly and creates flexibility if reserves for debt service or maintenance costs have to be established from the current cash flow (Markus et al., 2011, p. 610).

Among the cash flow related lending, another main characteristic of a project finance is the so-called (2) risk-sharing. The project finance is structured in a way that the risk is spread over different involved parties and project stakeholders. The objective of risk-sharing is to distribute project risks among different stakeholders. This helps to ensure that the project process can continue and operation does not come to a standstill if sudden problems or obstacles occur. This means risks of individual project services are passed through to the respective service providers and the remaining risks remain with the loaners and equity investors. In this context, risks are shared among all project stakeholders, so each participant bears that risk which he judges best, influences and / or can carry (Decker, 2008, p. 34). Therefore, the risks do not remain solely with the investors and loaners, but are also passed through to the manufacturers and their subcontractors in the form of contracts for labor and materials and thereby conditional warranties or guarantees for example. However, these risks are normally passed through in the commodity chain governance from top to bottom. The specific structure of risk-sharing may be an integral part of the finance requirements and the financial commitment of the loaner. Depending on the loaner's entry point, risk-sharing already occurs within the greenfield or construction phase. For instance, the investor can make contracts with the turbine manufacturer that certain delivery periods for specific turbine components must be complied with, or that the WTG commission is guaranteed at a specific date. Time guaranties will become more and more important with the quarterly degression[59] of the feed-in revenues by the EEG, which began in 2016. Depending on the specific project situation or the structured risk-sharing, the loaner can demand for additional recourses from the equity investor. Three main finance structures can be identified: full-recourse, limited-recourse and non-recourse finance. In a full-recourse finance the loaner has full recourse to the assets, which the equity investor has defined. Hence, the bank or the loaner transfers all risk to the investor. Hereby, the aspects of the project financing are reduced to the feature, which is outside the balance sheet of the investor. This type is comparable to a normal secured credit and actually cannot be understood as a true project finance (May et al., 2013, p. 182). In return, limited recourse and non-recourse finance can only be realized if the equity investor gives the necessary securities via the project company to the loaner. This implies that for example the financing bank has full security over the whole wind park and every asset that a so-called Special Purpose Vehicle (SPV)[60] owns (Vinter and Price, 2006, p. 180).

The third and final feature of a project finance is the so-called (3) off-balance-sheet financing. Hereby, project credits, which the loaner has

[59] The degression is spread over the quarters, the exact feed-in tariff will be adapted at the beginning of each quarter. The target corridor is between 2.4 - 2.6 GW. If the new installed capacity moves within this corridor, the degression per quarter will be 0.4 %. This corresponds to an effective degression of 1.59 % per annum (BMWi, 2014, p. 25).

[60] A Special-Purpose Vehicle (SPV) is "a legal entity created to fulfill narrow, specific or temporary objectives" (Arnold, 2013, p. 415). Regarding wind energy, a SPV is created with the sole objective of producing, buying and selling electricity which has been generated by a WTG. The names Special Purpose Company (SPC) and Special Purpose Entity (SPE) are also common.

given to the project company, are reported in the balance sheet of this project company. Thus, the annual financial statements from the investors and their companies are not affected by raising credits. The advantage for the investors of not having the finance on their own balance sheet is that the investors' credit standing remains unaffected, as the debt of the project company will not appear in the balance sheet of the investors and their balance sheet ratios are not affected by the wind energy project (Böttcher and Blattner, 2013, p. 8). This described off-balance-sheet financing is possible if the equity investor's share of the SPV is below 50 %. Equity capital participation up to 50 % is only reported in the balance sheet as a normal investment in other companies (Böttcher and Blattner, 2009, p. 21). In order to bundle all of the risks and to form a corporate definition, an independent project company, a SPV will usually be established. This holds all rights, to build a WTG and to operate the necessary infrastructure to produce and sell electricity for at least 20 years. In Germany the SPVs usually have the legal form of a GmbH or GmbH & Co. KG, thus the liability mass of the project company is limited to the capital contribution of the shareholders and the project related assets (Przybilla, 2014, p. 62).

Historically, project financing has always been structured at the end of a project. However, this will change in the future. Banks and the financial sector are becoming more important and, as they are able to enter the project in earlier phases of the project, they can also have more influence (INTVW 08 Manufacturer, 2016, para. 53). As a CEO of a financial service provider firm summarizes, "the whole situation and structuring of the project can thus be made a bit more investor-friendly" (INTVW 23 Financial Service Provider, 2016, para. 3).

### 4.3.2 Leveraging and Optimizing Finance

The reasons why investors and operators of wind energy projects prefer a project finance to realize their wind park investments vary, and depend strongly on the investor's investment strategy, the return on investment expectations and the amount of equity, which can be provided by the investor.

One of the main reasons for structuring a project finance is the leverage effect. If the remaining parameters are correctly defined, the investor can benefit from this effect enormously. The leverage effect can lead to an increase of the internal rate of return. The following table 12 explains this effect on the basis of real numbers of a small wind park with an investment volume of EUR 10 million while comparing different equity and debt ratios.

**Table 12: Comparison of equity and debt ratio with impacts on internal rate of return (Own calculation based on Yescombe, 2013, p. 14)**

| | | Low leverage | High leverage |
|---|---|---|---|
| Investment costs (CAPEX) | | EUR 10,000,000 | EUR 10,000,000 |
| a) | Equity | (40 %) EUR 4,000,000 | (10 %) EUR 1,000,000 |
| b) | Debt | (60 %) EUR 6,000,000 | (90 %) EUR 9,000,000 |
| c) | Interest rate on debt (p.a.) | 1.5 % | 3.0 % |
| d) | Revenue from the project | EUR 400,000 | EUR 400,000 |
| e) | Interest payable [(b) x (c)] | EUR 90,000 | EUR 270,000 |
| f) | Profit [(d) – (e)] | EUR 310,000 | EUR 130,000 |
| **Return on equity (IRR) [(f) / (a)]** | | **7.8 %** | **13.0 %** |

When comparing both columns, the low leverage and the high leverage example, the initial situation with the CAPEX of EUR 10,000,000 is the same, because both examples refer to the same wind energy project. The low leverage example is financed with an equity debt ratio of 40:60, while the high leverage example has an equity debt ratio of 10:90. Funds usually structure their finance with 60 % debt financing (INTVW 05 Fund Manager, 2015, para. 11). Nevertheless, higher leverage ratios are the general rule. An employee of a major German bank has stated that the average for wind energy projects is about 15 % equity (INTVW 14 Bank, 2016, para. 19). According to an investor for wind energy projects, the reason for low ratios of 10 % equity comes from the fact that banks have to spend their money and have to invest the money into the market (INTVW 22 Investor, 2016, para. 15).
Through the calculation in table 12 it becomes clear that although the high leverage example has a higher interest rate on the debt due to the lower equity and the linked higher risks, the high leverage example has a considerably higher return on equity or the Internal Rate of Return (IRR). However, this trend of equity debt ratio is increasingly shifting. The interviews have shown that the duration of the financing can be prolonged and extended (INTVW 14 Bank, 2016, para. 13). At some sites,

such as in Northern Germany, for example, 0 % equity financing is possible due to the very good wind conditions. Nevertheless, the bank would always like to see the investor with a small share of equity in the project (INTVW 14 Bank, 2016, para. 17). According to a German banker "that's why the equity debt ratio has settled at 20:80 [...]. But then the market participants became more creative. After the loss of the limited partners[61], who made the deposits in cash, it has gone so far that then one has also worked with shareholder loans. Or appropriate contributions in kind were then included as equity or anticipated margins. Therefore, there are some ways in which one can then credit that" (INTVW 16 Bank, 2016, para. 21).

**Table 13: Comparison of required revenue with consistent IRR (Own calculation based on Yescombe, 2013, p. 17)**

| | Low leverage | High leverage |
|---|---|---|
| Investment costs (CAPEX) | EUR 10,000,000 | EUR 10,000,000 |
| a) Equity | (40 %) EUR 4,000,000 | (10 %) EUR 1,000,000 |
| b) Debt | (60 %) EUR 6,000,000 | (90 %) EUR 9,000,000 |
| c) Interest rate on debt (p.a.) | 1.5 % | 3.0 % |
| d) Return on equity [(a) x 7 %] | EUR 280,000 | EUR 70,000 |
| e) Interest payable [(b) x (c)] | EUR 90,000 | EUR 270,000 |
| **Revenue required [(d) + (a)]** | **EUR 4,280,000** | **EUR 1,070,000** |

The cost controlling in particular will have enormous impact on the tender of wind energy in Germany. To get a feed-in for electricity by wind energy sources the investor has to win a specific amount of capacity. The wind park, which can currently offer the cheapest electricity feed-in remuneration, will receive a feed-in contract. In table 13 the same wind park as in table 12 (p. 185) is shown. In both, the low leverage finance and the high leverage finance cases, the investor strives for an IRR of 7 % which is actually a fairly standard market condition. As calculated in table 13, the return on equity is EUR 280,000 with a low leverage, and a lower return of EUR 70,000 with a high leverage. In contrast, the payable interest is lower with the low leverage finance than with the high leverage finance, which results from the amount of debt and the interest rate

[61] In this context, the loss of the limited partners refers to the change of the investor structure in the German onshore wind energy market. In the past, there were a lot of private investors who participated in wind energy projects. Due to the increasing investment costs, it is getting steadily more difficult for private investors in the wind industry to get access to wind energy projects.

on the debt. When these two factors are combined, it becomes clear that despite the higher finance costs of the high leverage finance, less revenue is required to reach the same IRR requirement of 7 % than with a low leverage finance. These lower costs lead to a more competitive business case, which is of high importance for the wind energy tender model in Germany.

One of the main reasons for using a project finance is the ability to limit risk. A project finance is always structured in such a way that the revenue of the project is enough to feed the OPEX and the debt service of the project. The project finance can stand alone based only on its own cash flow. Therefore, no financial support from outside is needed, which implies that outside parties do not have to take any risks from the project company. The investors participate with their equity share depending on the equity debt ratio. In the event of a project company's failure, the investor bears liability only with its equity share. The investor's risk of the project company is limited to this equity share, which means there are no impacts on other businesses the investor is running.

Another incentive for applying a project finance is also related to risk. Due to the varied organization possibilities of forming a project company, it is possible for different investors to join one single project company as a joint venture. Depending on the agreed arrangement between different investors, the investors spilt their equity and thereby they spread their risk.

A further reason why investors use project finance is the creditworthiness. The debt for the wind energy project is fixed within a project company as a closed circuit. The investor bears liability only with its contributed capital. The debts from the project company have no influence on the corporate credit lines from the investor, which leads to an increase of the creditworthiness from the investor. This frees up capacities the investor can use to launch other companies at the same time.

One of the most important reasons for using a project finance in the wind industry is the possibility, which every project finance has, to have an off-balance sheet financing. The off-balance-finance means that the loans for the construction of a wind park do not burden the balance of the investors. For the financing of a wind park a separate project company will be formed, which acts as the borrower. Thus, the project loans are only in the balance sheet of the respective project company. This is a very significant advantage for investors, as their own balance sheet will not be charged by the loan and the investor's credit or other debt capacity is not affected.

#### 4.3.3 Financial Advice and Consultancy in the Wind Industry

As explained in chapter 2.1.2 (p. 22), there is a certain governance in every GCC. Governance describes the control chain, defines the processes and the power relations of the different actors between themselves. This dissertation will now explore whether the financial sector has influence on governance in the wind industry and if so, how this influence can be measured. Furthermore, it must be analyzed whether governance structures are changing and why.
In order to clarify this question, the governance of the wind energy market has first to be analyzed. These new findings can then be used to draw conclusions on the influence of the financial sector. The whole market and the entire commodity chain is built around a finished product, which is at the end of every commodity chain. In the chain of the wind industry, the finished product is a wind park, which is ultimately purchased by an investor or operator and produces kWh. In this way, the total purchase price of the wind power project is passed from the end to the beginning of the entire commodity chain. This does not, of course, occur at the same time, but every actor in this chain is paid after a certain payment or certain payment steps.
The interface that exists at the end of this chain is the market. The market is where sellers of projects, usually projectors, meet with buyers, for example investors and future operators. At this interface, one can distinguish between a buyer's market and a seller's market. These two markets represent extreme market conditions and refer to which price and contract conditions are determined by the buyer and seller on the market.
As table 14 (p. 189) summarizes, a buyer's market is a market situation, in which the buyer is in a favorable negotiating position compared to the seller. Reasons for the strong position of the buyer may be that supply exceeds demand, leading to a supply surplus. The bottleneck in this mar-

ket situation is the sale of the products. This leads to price increases. In contrast to the buyer's market, the seller's market is a market situation, when the seller is in a more favorable negotiating position than the buyer. Reasons for the strong position of the seller could be that demand exceeds the supply, leading to a demand overhang. A bottleneck lies in the procurement of products which leads to a drop in prices.

**Table 14: Characteristics and comparison of buyer's market and seller's market (Own compilation)**

| Characteristic | Buyer's market | Seller's market |
|---|---|---|
| **Ratio supply and demand** | Supply exceeds demand | Demand exceeds supply |
| **Consequence** | There is excess supply | There is excess demand |
| **Bottleneck** | Sales of product | Procurement of product |
| **Pricing** | Prices are decreasing | Prices are increasing |

The market forms, mentioned before, are extreme and they rarely take such an extreme form in reality. Examples of a seller's market are public short-distance and long-distance transport, as well as the petrol market. Buyer's markets are almost all consumer goods, such as cars or all products, which one can purchase at the supermarket.

This can also change over time. In Germany, for example, the telephony market has developed from a pure seller's market to an almost pure buyer's market. A similar change has taken place in the German electricity market. Previously, utilities and local power suppliers had a monopoly. Today however, the electricity market is mainly a buyer's market. It is possible to cancel the existing electricity contract within a few minutes with just a few clicks, and to change the current electricity provider online.

Analysis of the market situation of wind energy projects has shown that a seller's market has prevailed so far. This analysis result was also being confirmed by the interview partners (INTVW 07 Project developer, 2016, para. 65; INTVW 12 Technical and Commercial Management, 2016, para. 13, 23; INTVW 13 Project developer, 2016, para. 6; INTVW 23 Financial Service Provider, 2016, para. 5, 21). In summary, the interview partners were able to make several statements about the market situation. On the one hand, projects are now selling faster than in the previous years. On the other hand, sellers always receive several offers for their offered projects. This variety of offers inevitably leads to a rise in project prices. Thus, the seller is not pressured to accept the first offer. These factors lead to the conclusion that the market for wind parks or project rights is a seller’s market.

The reason for a seller’s market in the wind industry lies in the fact that there are not enough wind energy projects that can meet demand and that more and more buyers are entering the market. This means that there are too few wind energy projects on the one and on the other hand, too much capital to be invested in these projects. Furthermore "in many countries the addition of new projects tends to be stagnating or reversing. [...] At the same time, the asset class is now more established and recognized for investors, especially for institutional investors. This means for the market that there are more investors than good projects in the existing market” (INTVW 23 Financial Service Provider, 2016, para. 5).

However, the wind energy market was not always a seller's market. Interviewees reported that the market for projects collapsed between 2003 and 2005. Due to the influence of new EEG regulations, the demand for wind energy projects fell. As a result, prices for wind energy projects also declined. Thus, in this time, the wind energy market evolved into a buyer's market (INTVW 12 Technical and Commercial Management, 2016, para 15, 16). But what kind of market type is expected in the future? Does the wind energy market remain a seller's market? A project developer concluded that "it will be possible, if there are too many projects on the market which cannot be implemented due to the tender model, that we will have a buyer's market again" (INTVW 07 Project developer, 2016, para. 65).

If a buyer and a seller find each other, usually a due diligence process of the project takes place. This means that in almost every transaction of wind energy projects the participants of the transaction make use of APS, which are provided by the financial sector. Since these transactions deal with highly complex projects, with different company structures and contracts, a certain level of human resources is needed to examine such due diligences. As a result, these assessments can usually only be carried out by major law firms (INTVW 18 Lawyer, 2016, para. 3). Pension funds and institutional actors such as Allianz and Munich Re for example, have their own investment managers. But to finance and invest capital, the investment managers are bound by certain regulations. Thus, these investment managers have to commission external service providers to audit projects (INTVW 26 Manufacturer, 2016, para. 65). Thereby area-specific knowledge is required. Different areas of expertise include dealing with land registers, commercial registers, corporate law, guarantee, administrative law and public law issues during a due diligence. This service is used by all actors, especially banks. Larger firms, such as Siemens for example, have the possibility to provide these services in-house (INTVW 18 Lawyer, 2016, para. 7).

Due to their financial advice and consultancy, financial services providers are fully positioned along the entire GCC and thus also have the possibility to determine decisions. In the case of corporate financing, this is regulated by means of co-right to speak or certain requirements. This is similar for project financing. Since the whole project is financed, the bank and its financial service providers are crucial to many aspects. Many decisions are always left to the bank, because the project checks are often left to the bank (INTVW 08 Manufacturer, 2016, para. 33; INTVW 07 Project developer, 2016, para. 25; INTVW 19 Financial Service Provider, 2016, para. 73; INTVW 16 Bank, 2016, para. 30; INTVW 26 Manufacturer, 2016, para. 17). Although the project developer is often more involved in the topic than the bank, sometimes project developers only perform cursory checks, because the bank again checks everything and every detail of the project. In other words, the evaluation and, above all, decision making power is increasingly moving from the technical side to the financial side, which means that the technical risk is valued on a monetary basis and then decided on the basis of the monetary default risk (INTVW 14 Bank, 2016, para. 21).

The fact that there is a seller’s market, which means it exists a greater demand than supply, opens a new field of activity in the GCC of the wind industry. In addition, the emergence of a seller’s market also has a meaning for the influence of the financial sector on the GCC of the wind industry. As a rule, wind parks are integrated into separate companies. The wind energy turbine as a technical good, and all related rights and obligations to operate and maintain these wind turbines for 20 years are also deposited in this company or SPV. This means that the wind parks can also be traded during operation by selling and buying this SPV. There are, of course, many personal reasons why operators or investors would like to sell their current wind park, but a major reason for the sale is that their expectations at the point of purchase have not been met. In most cases, this is due to excessive forecasted claims from assessors or sellers. But why would someone else buy such a project? Either the lower yield meets the investment requirements of the new buyer or the project is optimized. And here the financial sector again enters the field of activity. The financial sector makes good use of the fact that there is high demand and that there are not enough projects on the market, and creates new products or optimizes the existing wind park. By doing so, the financial service providers are able to resell the projects to saturate the demand of the buyers. As a fund manager summarizes, "in the end, it is our task to turn […] 4.8 % into 5.1 % or […] 5.8 %, with fine sanding paper and a tuning set. That is our task" (INTVW 05 Fund Manager, 2015, para. 55).

This demand is also growing steadily by an increasing number of different actors who want to buy wind energy projects on the wind energy market. Here public utilities are to be emphasized as such an actor. There are more and more utilities on the market that have to buy projects because the city council decided for example to improve the ecological balance of a city or municipality. "Public utilities play an interesting role, because they are entering completely uncoordinated into the market and unconsciously disturb the market prices. Because they have only one strategic requirement to procure supply security. And this of course greatly confuses the price structure" (INTVW 05 Fund Manager, 2015, para. 17). Wind parks that have been already realized are ideal investment projects for municipalities, who are risk-averse since most of them are owned by the public sector. Already built wind parks are less risky. The biggest risk among others is whether the wind report is correct or not. Only after a certain number of years of operation one can more accurately estimate whether or not the 20-year average specified in the expert opinion is attainable.

But what is the role of financial service providers in these resales, and why are financial resellers the driving force behind such transactions? Financial service providers take an advisory role in such transactions for buyers and can thus influence the purchasing processes (INTVW 18 Lawyer, 2016, para. 27). The most common reason why financial service providers are involved in the transaction process is the fact that during sales the finance will be also restructured (INTVW 11 Utility, 2016, para. 51; INTVW 13 Project developer, 2016, para. 43). In addition, other factors have changed in the project, which the financial service providers once again optimize to make the project more profitable

The best example is refinancing. In the case of refinancing, an existing finance is restructured. As a rule, interest rate commitments were set at the beginning of the project financing, which expire after a certain period, for example after 10 years. This means that the SPV needs a follow-up financing or refinancing after this time. At the moment, it is the case that interest rates are still very low compared to previous years. It is highly probable that current interest rates are significantly lower than when the interest rate was fixed. This situation opens up new opportunities for the financial service providers, and opportunities to further expand value creation by providing the financial services to the companies with a new financing or refinancing (INTVW 19 Financial Service Provider, 2016, para. 75).

The financing contract with the bank regulates whether a severance sum or a prepayment penalty[62] has to be paid when the credit is released. One possibility is that the borrower negotiates with the bank that this fee is waived, if one remains with the bank and signs another credit agreement.

Other factors which can be improved and optimized in a wind energy project in order to increase sales opportunities are OPEX. For example, contracts such as full maintenance, technical management, commercial management, insurance, direct marketing can be renegotiated after termination. In all of the aforementioned OPEX positions a price decline is observed so that an existing project can always be optimized, which increases the sales opportunities.

[62] The charge for the repayment of a loan during the interest-fixing period is referred to as early repayment indemnity.

It can therefore be said in general that, on the one hand, financial service providers sit completely along the commodity chain and on the other hand, they always have direct contact with investors and thus possible sources of money. This also applies to the general principle: who has the money is in a strong position and can determine where and how to invest. The decision making process for such investors is prepared and accompanied by APS firms. This applies to project financing as well as to corporate financing. Small, capital-weakened companies seek financial investors to finance and secure their operations. Thus, the number of financial products has risen.

The demand for projects is being pushed up by a growing number of actors who are looking for projects. The financial sector is greatly contributing to the fact that more projects are being traded and more projects are made tradable. In the meantime, financial service providers are now making decisions at positions of the commodity chain, where other actors in the chain previously made decisions. The focus shifts from project developing to trading projects.

#### **4.3.4** Wind Energy Finance as a New Circuit of Value

Financing is indispensable in the field of renewable energies, especially in the wind industry. However, in a detailed analysis, a distinction has to be made between project finance and corporate finance. Project financing includes wind parks or individual wind turbines which are financed by a project finance. Whereas corporate finance means the financing of different companies and actors of the entire GCC of the wind industry. Although corporate finance plays a role in the wind industry, the focus of banks in the wind industry lies on project finance (INTVW 14 Bank, 2016, para. 42).

In the beginning of the wind industry, no financial service provider and no financial services were needed. Originally, finance was not present as a part of value added and as an independent process in the commodity chain. Due to the novelty of the technology, wind energy was not eligible for financing. In the early 1990s, the financial sector then created new circuits of value and began to finance projects. The reasons for this were, that the technology was more mature and reliable, a fixed feed-in tariff from the policy was secured, and that financing renewable energy projects has become a prestige and a positive marketing effect for the bank. The demand for project financing then grew steadily over the years as the overall costs increased, mainly caused by the constantly increasing size of wind turbines. Thus, project financing was not feasible for private individuals and smaller project developers anymore.

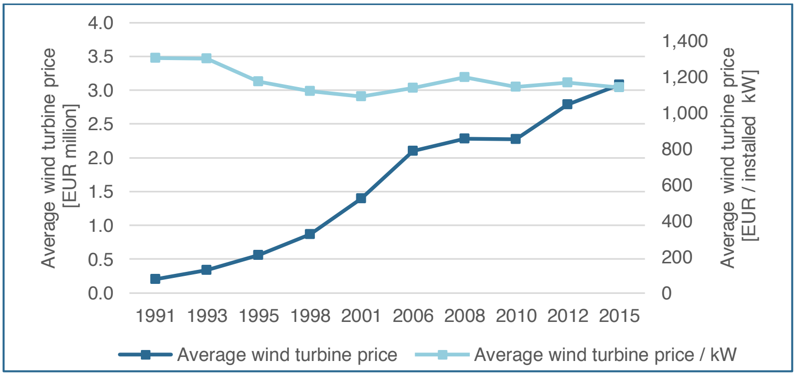


**Figure 28: Development of average wind turbine prices (Own calculation based on Deutsche WindGuard, 2015b, 2014, 2013, DEWI, 2016, 1999; IE Leipzig, 2014)**

Figure 28 shows this increase for wind turbine prices over the years. The prices are shown for the average price of a single wind turbine and the average price for each installed kW. As figure 28 shows, the average price per installed kW has declined slightly over the years. This average price per installed kW was multiplied by the average rated power of a wind turbine. Since the average rated output in the period from 1991 to 2015 rose from about 165 kW to about 2,700 kW per turbine, the total price per turbine obviously also increased strongly.
It should be noted that, in addition to the capacity of the generator, the height of the tower and the length of the rotor blades are decisive for the price. In the early days of the wind industry, projects were initially developed by private individuals and small developers. Figure 28 makes clear that it has become infeasible for smaller actors without a bank financing. In 1991, a turbine could be purchased for just over EUR 200,000. In 2016, an average wind turbine costs more than EUR 3 mil-

lion. Therefore, today wind energy projects are very large investment projects that require enormous capital requirements and cannot be implemented without bank financing even for very large companies and actors in the GCC.
The redistribution of risk is another driver for the need for the financing of wind energy projects. Wind energy projects are generally implemented through project financing[63]. In the case of project financing, the investor is only liable for the contribution of his capital invested. This is standard and is customary in the banking sector and is often used also outside the wind energy sector. Therefore, banks and other financial service providers could easily transfer the model of project finance from other sectors to the wind industry and thus they could create new circuits of value. The idea of project financing could be extracted from the area of telecommunications, infrastructure projects, oil and gas as well as real estate (Yescombe, 2013, p. 6). The fact that, contrary to a standard participation, an investor is only liable for project finance with his equity capital and not his private assets, is a crucial point for the importance of project financing in the wind industry and its development. Many of the risks associated with wind energy projects were not recognized by the project developers, investors or banks in the beginnings of the wind industry. The industry had to constantly learn from the mistakes of the past. As a result, the banks set various standards while structuring new project financing. The requirement of a full maintenance contract with a turbine manufacturer that is liable for repair, maintenance and replacement, can be mentioned as an example. In addition, many banks require from the investor to use an independent technical manager, who independently monitors the wind turbines, who is always informed of the technical condition of the wind turbine, and who also claims when requirements from the full maintenance contract have not been properly met. Thus, many of the risks that the operator originally had to bear, were transferred to the banks, and after a learning phase, banks have transferred these risks to third parties.
Another reason why such a high demand for financing exists is the tax effect, which is generated by the interest on a debt financing. The interest

[63] For an accurate and detailed description of project financing, see chapter 4.3.1 (p. 150).

paid for the provision of borrowed capital reduces the taxable profit since they represent tax-deductible operating expenses. This can be an enormous tax effect for an investor for several years.

This tax effect should not be underestimated and has an enormous impact on the return of a project. As a result, tax advisory firms play a special role in transactions. The tax consultants have an enormous influence on business decisions. As a fund manager of wind energy assets states, “the tax consultant helps in optimization, but in the end, it is not a decisive element. […] But if he would say no, it does not work. Then we would say, well then, we step back from the project” (INTVW 05 Fund Manager, 2015, para. 31). This influence is also described by a partner of a law firm. It “is always 100 % decisive what the economic or tax consultant says. Legally, one has always more design possibilities [...]. Therefore, [...] that, what is tax, must be approved by the tax consultant. And then one begins to make or complete the legal formation" (INTVW 18 Lawyer, 2016, para. 41).

The final main reason for the need for financing is strongly linked to the generally large capital requirements. If an investor is able to borrow loan capital at more favorable terms than the terms of the wind energy project, with regard to the overall return of capital, a leverage effect for the IRR arises. This effect is called leverage effect because the leverage effect of the financing costs increases the investor's equity capital and the amount of its investment.

As described at the beginning of this chapter, there are two areas in the wind industry where there is the need for finance. The first finance area is project finance, which is needed by the project companies or SPV, for whole wind parks and each individual wind energy turbine. The second area concerns corporate finance. Project financing is limited to one project and its duration. In corporate financing, the focus is on financing the business principle of each company. In essence, each company needs two things to operate its business and to achieve its economic objectives. The first factor is capital. Every company needs a foundation from which new enterprises can be targeted and from which capital can be invested. Capital includes all things that are also listed in a balance sheet. This includes for example investments, rights, and other financial resources. The second factor is liquidity. Liquidity means the availability of sufficient cash. This implies that liquidity is the ability to meet payment obligations on time. For the procurement of capital as well as the provision of liquidity, every company, including companies in the wind industry, must obtain cash. If a company can carry out the payment of funds on its own, this is called internal financing. If the funds come from outside, this is called an external financing.

The creation of new circuits of value in the wind industry is similar to those in any other industrial sector. There are different types of finance forms. These different financing schemes are shown in figure 29. Varieties of financing ranges from classic bank credit, mezzanine financing[64] to private equity financing or venture capital. The competition and the urge for higher returns in an environment of low interest rates are causing investors to take more and more risks. As a CEO of a financial service provider in the wind industry states "we are already on the way to initiating cash-flow-based mezzanine financing, which is certainly an innovative concept with clear opportunities for new market partners as well" (INTVW 25 Financial Service Provider, 2016, para. 7).

It has to be assumed that the financing forms move away from standardized bank loans to mezzanine financing and venture capital. Venture capital can then be provided through off-balance structures (INTVW 25 Financial Service Provider, 2016, para. 69, 71).

As can be seen in figure 29 (p. 199), different forms of financing also have different interest costs. The different interest costs are strongly related to the hedging of the borrowed capital since the borrower carries a different risk for each type of financing. The right mix of the various instruments in the form of structured corporate finance is crucial for optimal corporate financing. The leverage effect can also be used in the case of corporate finance as in the case of the project finance mentioned above.

[64] Mezzanine financing includes a mix of equity and debt capital functions. A company or a project company is provided with equity. The lenders, which prove the equity, do not receive voting or influence rights or residual claims such as the real shareholders.

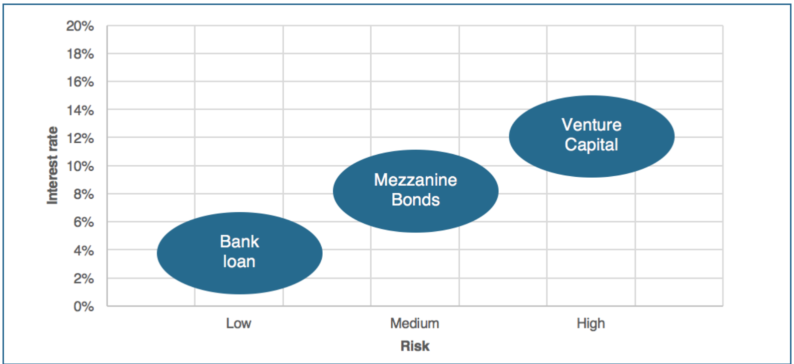


**Figure 29: Types of financing and their influences on interest costs and risk (Own illustration)**

If the ratio between equity and borrowed capital is chosen correctly and the interest on the borrowed money is lower than the return on the borrowed money, the leverage effect can be used to increase the return on equity, which also leads to an increase of the company value. This can be called, among other things, the most important need for finance in the wind industry. But nevertheless, there are many ways to finance wind energy projects and thus "wind energy will play a greater role in the capital market" (INTVW 25 Financial Service Provider, 2016, para. 33).

### 4.3.5 Capital Switching in an Institutional Framework

A further service of the financial sector is capital switching. According to Bassens and van Meeteren (2015), "[c]apital switching is a fee-based business we most directly associate with the activities of asset management services or the (hedge) fund industry (Holmes, 2009), but it can more generally refer to all legal, financial, accountancy, and other professional services catering to capital that is channeled through financial markets in search of the highest profit" (Bassens and van Meeteren, 2015, p. 13).

When speaking of switching capital, it is first necessary to elaborate and define which actors in the financial sector are active in the wind industry. The financial sector in the wind industry includes all companies providing financial services with regard to wind energy.

A distinction has to be drawn between firms whose main business is to work with financial services and firms whose main activity is not offering financial services but who nevertheless offer them. Actors whose main activity is to work with financial services include banks, financial service providers, consulting firms and tax consultancy firms. Companies that do not primarily work with financial services can be all other GCC players in the wind industry, such as project developers, turbine manufacturers or technical management companies.

As the financial services originally came from the financial sector, the question must be asked why financial service providers are entering the market of renewable energies and thus also the wind industry sector. Why is the wind energy market more interesting to financial investors and their service providers than before? In the following, factors which lead to the market entry of financial service providers and make capital switching available are listed.

The trigger for capital switching using wind energy assets by the financial sector is the expansion of a completely new industry, which within a few years has grown into an enormous independent branch. The enormous potential behind this growth rates is illustrated in figure 30 (p. 201). The figure shows the potential for external financing and loan capital for wind energy projects in Germany. For this purpose, the average turbine prices per kW for selected years were determined and calculated. These figures were multiplied by the annual installed capacity of new wind parks. From the interviews and the literature, it can be concluded that as a rule a debt ratio of around 80 % can be regarded as a standard. Thus, it was possible to calculate the estimated potential for loan capital between 1991 and 2015, which is needed for new projects in the wind industry. However, it should be made clear that these calculated figures can only be roughly estimated, since both the share of loan capital and the turbine price can fluctuate. However, it is worth mentioning that the price refers only to the installed turbine. Since the remaining costs such as infrastructure or connection to the grid are usually also financed. Thus, the real amount to be financed should be even higher. Figure 30 illustrates that this area is of enormous importance for banks, which has grown steadily in recent years and will continue to be an attractive market for borrowers in the future. It is interesting to note that the total loan capital of approximately EUR 130 million in 1991 has grown to almost EUR 36 billion in 2015. In the same period, however, the average price per installed kW of wind turbines has changed only very little.

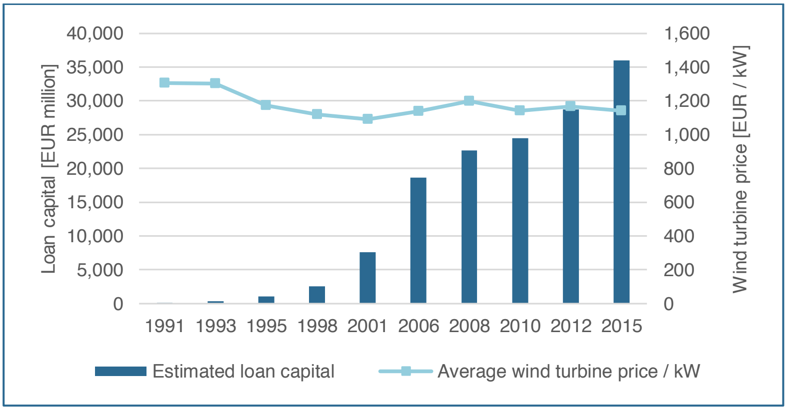


**Figure 30: Estimated potential of loan capital at wind energy projects in Germany (Own calculation based on BWE, 2002; Deutsche WindGuard, 2014, 2015a; Fraunhofer IWES, 2015b)**

The following factors, are about reasons why financial service providers are able to advise investors to switch capital from existing markets into the market of wind energy. The interviews showed that missing investment alternatives is a push factor. Financial service providers, investors and borrowers are always guided by the potential self-profitability of investment projects. It only makes sense for these financial service providers to position themselves long term and to be active in areas where attractive return on equity is possible, as higher margins are also possible for financial service providers with higher returns. The wind industry, which is located in the energy sector, is competing with infrastructure, real estate, agriculture, private company investments, ships and airplanes. Therefore, it is not surprising that an interviewed financial service provider states that the wind industry will have a “mix of market partners, which invest for purely strategic or opportunistic reasons, looking at opportunities and seeing investments in the wind industry as well as investing in real estate or other topics. […] So, what today is a state-subsidized cash cow is tomorrow just as much a market economy model as the real estate market (INTVW 25 Financial Service Provider, 2016, para. 23).

Furthermore, the institutional framework was excellent for seeding financial services in the wind industry. The low-interest environment is accompanied by ample liquidity. As shown in figure 31, since 2008, all major central banks of the Western industrialized countries have set the key interest rates to near zero.

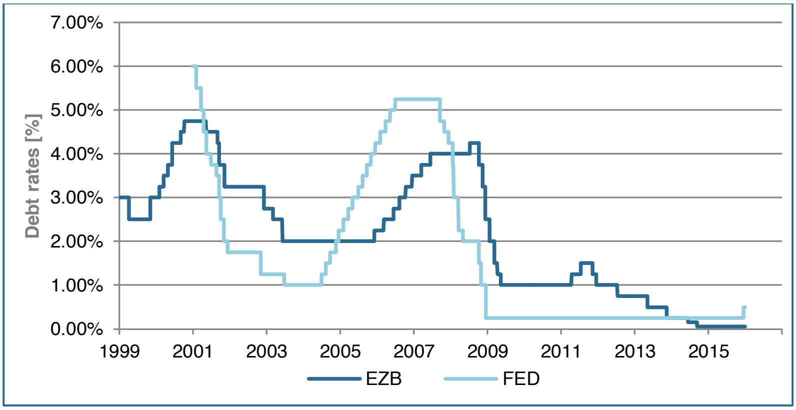


**Figure 31: Development of the base rates in Europe and USA (Own illustration based on EZB, 2016; FED, 2016)**

As figure 31 illustrates, the key interest rates have been lowered by the European Central Bank but also in the US by the Federal Reserve System. The last drastic reduction to around 1 % occurred in 2009. In addition, the interest rate for government bonds, bonds and corporates was also pushed to a historical low level, either through direct purchase programs of the central banks or via the allocation of short-term refinancing options.

This low-interest policy also has an enormous impact on the wind industry. On the one hand, it has an impact on the return of the projects. As all investments are based on the key interest rates, it should also be noted that the returns on wind energy projects have declined. On the other hand, the low interest rate policy pushed other investors into the wind industry. (INTVW 05 Fund Manager, 2015, para. 33; INTVW 14 Bank, 2016, para. 69; INTVW 16 Bank, 2016, para. 13, 19, 59, INTVW 18 Lawyer, 2016, para. 53). However, these low interest rates entail a tremendous risk. If the interest rates change, and the interest rates of the financed wind parks increase after the interest-fixing period, it may well mean that some projects encounter creditworthiness problems (INTVW 19 Financial Service Provider, 2016, para. 87).

In order to protect themselves against inflation, the money can no longer be deposited on current-accounts or government bonds. As a result, there is too much capital on the market that is looking for investment opportunities with attractive returns, which leads to an overaccumulation. However, this also means that financial service providers are pushing for securitization in other areas in order to present attractive alternatives to their customers. Thus, wind energy could be developed as a new area and further expanded (INTVW 06 Project developer, 2015, para. 37). In many conducted interviews, this investment pressure was a major issue for investors which indicates that it is one of the most important push factors for the wind industry (INTVW 23 Financial Service Provider, 2016, para. 21; INTVW 03 Project developer, 2015, para. 45, 48; INTVW 05 Fund Manager, 2015, para. 47; INTVW 04 Broker, 2015, para. 15, 49; INTVW 26 Manufacturer, 2016, para. 7, 26). As a financial service provider says, “money is not the bottleneck anymore” (INTVW 25 Financial Service Provider, 2016, para. 33). This leads to an investment pressure which increases the demand for wind energy projects. In one interview, a broker stated that the demand for wind energy projects is even higher than in the real estate market (INTVW 04 Broker, 2015, para. 9). According to a banker this demand “will further increase, as we have low interest rates. So, the big investors have hardly any alternative to invest” (INTVW 14 Bank, 2016, para. 77). The investment pressure and the low interest rates even lead investors to operate projects despite operational risks without earning money. This is because certain investors have to pay negative interest if they do not invest their money (INTVW 20 Consultant, 2016, para. 15). This means that in the case of another interest rate policy, investors would not buy such low performing wind energy projects (INTVW 20 Consultant, 2016, para. 29; INTVW 01 Investor, 2015, para. 19).

But there are further factors which make the market environment of renewable energies and especially the wind energy sector interesting for financial services providers in order to establish themselves in this market. These are incentives that the market itself creates and attracts financial service providers.

The most important pull factor, particularly the enormous capital requirements that have grown over the years, has already been explained in detail in the previous chapter. Individuals, small groups of investors and small and medium-sized enterprises depend on banks to finance investments in wind energy projects or finance their own business activities with the aim to grow further.

A further important pull factor is the total turnover or the amount of the income for the entire wind industry. As written in the previous chapter 4.2 (p. 146), the end of the commodity chain is the operating wind park, which sales the produced kWh. This income is calculated backwards along the commodity chain. Financial service providers are also positioned along this commodity chain, moving money along the chain and thus generating income for themselves. The larger the turnover the more money all stakeholders earn.

In figure 32 (p. 205), the average payment per kWh was calculated based on data from the Federal Network Agency. It becomes clear that this average price has declined between 2006 and 2014. But in contrast, the absolute revenues have risen by nearly 50 % in the same period. While in 2006 EUR 2.7 billion EEG remuneration for wind energy installations in Germany was paid, by 2014 it was already more than EUR 4 billion. This EUR 4 billion is a tremendous incentive for financial service providers to participate in this industry and benefit from this revenue.

Furthermore, the market environment in which wind energy is located can be defined as a friendly market environment with a very good image, which is a further pull factor. On the one hand, the energy policy has made a positive and long-term choice for the wind energy with its funding programs. The nuclear phase-out in Germany was decided in 2011 and is to be completed by 2022. In addition, the EEG offers fixed remuneration rates, which are now reduced quarterly, but nevertheless provide investment security to the investors.

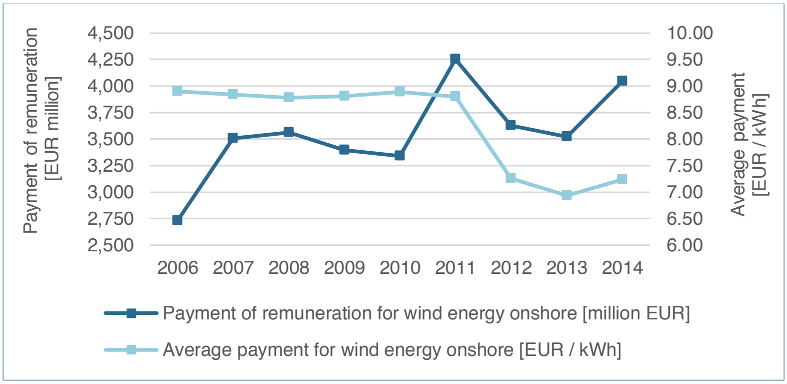


**Figure 32: Development of total payment remuneration for wind energy onshore (Own calculation based on Bundesnetzagentur, 2016)**

Wind energy can also be defined as a green and sustainable investment. Meanwhile there are green banks, which handle their money business in a fair, ethical and ecological way. In Germany, four banks which meet the mentioned criteria can be found: Umweltbank, GLS Bank, Ethikbank and Triodos Bank (Own survey). In times when certain banks have already switched to sustainable investment activities, the green and sustainable image of the wind energy sector is also seen as a pull factor that financial service providers are engaged in and which made wind energy excellent suitable for capital switching.

## 4.4 Commercial Profitability of Wind Energy Projects

### 4.4.1 Market Value Evaluation of Wind Energy Projects

Two questions form the basis for evaluating a wind energy project and from which assumptions for the commercial profitability can derived. On the one hand, the amount of kWh, which can be produced at the selected site, must be taken into account, on the other hand capital expenditures and the operational expenditures[65] of the project have to be calculated to operate the project over the entire term of 20 years. All these costs, which are necessary for the production of electrical energy are the electricity production costs. An investor has to invest these electricity production costs to produce a single kWh in a wind energy project in the entire period of 20 years. Since the selling price in Germany of a produced kWh is not determined by supply and demand, but rather by the legal framework EEG, this will facilitate the consideration of wind energy projects, since the risk of the sale price no longer exists. Therefore, with the help of these underlying assumptions a wind energy project can be easy evaluated: If the cost of producing a kWh is less than the remuneration[66] for producing it, a wind energy project is profitable from a macroeconomic point of view.

Therefore, one has to evaluate the profitability of projects. Is the specific wind park profitable for the investor of the project?

This question can be divided into different approaches of project evaluation. As described, there are different perspectives from which to pose this question. For example, a wind energy project can make sense to the economy, or even to a bank, but it is possible that the same project becomes a debt trap for a private investor.

Therefore, it is important to note that there are three assessments of profitability. On the one hand, there is an (1) overall economic approach, which includes the electricity generation costs. Here one has to analyze whether a wind energy project can be operated economically. The analysis of electricity generation costs makes it possible to compare the average costs of electricity generation using different renewable and conventional technologies. Electricity generation costs include all investment and operating costs over the entire operating life, as well as the costs of financing the respective generating plants, divided by the electricity revenues. Accordingly, electricity generation costs are usually stated in

[65] For a further explanation of capital and operational expenditures of wind energy projects see chapter 4.4.3 (p. 213) and chapter 4.4.4 (p. 218).

[66] It should be noted that from 2017 no fixed remuneration exists. The bidder must offer a price within a tender process. If the bidder receives a supplement by the auction, he receives the offered price for 20 years. It is to be expected that in the near future no fixed prices will be paid and the electricity has to be sold directly at the electricity exchange.

euros per megawatt hour (EUR / MWh) or in cents per kilowatt hour (ct / kWh). It is important to note that the project-specific site conditions of all technologies are decisive for the specific level of electricity production costs.

In the case of electricity generation from wind energy, the investment costs mainly comprise the costs for the wind turbines, foundations, cables, permit, installation and project rights, which are also referred to as CAPEX. The operating costs of wind turbines include, in addition to land leases and maintenance and repair costs, the expenses for insurance. The costs for the financing result from the interest on the debt and equity capital employed. These interest rates are significantly influenced by the assessment of the risks of the technology and the specific project as well as the general financing conditions. The development of electricity generation costs of onshore wind parks was calculated in different studies and are summarized in table 15.

**Table 15: Wind onshore electricity generation costs (Own compilation based on DECC, 2012; Deutsche WindGuard, 2013, 2015a, Fraunhofer ISE, 2012, 2013; Panos, 2009; Wissel et al., 2008)**

| | 2008 | 2009 | 2011 | 2012 | 2012 | 2012 | 2013 | 2015 |
|---|---|---|---|---|---|---|---|---|
| Ct/kWh | 9.6-14.4 | 9.3 | 5.0-13.0 | 6.5-8.1 | 6.35-11.1 | 11.6 | 4.5-10.7 | 5.3-9.6 |

The second valuation perspective regarding profitability is the (2) bank's view. Almost every wind park is financed by borrowed capital from a bank. The focus in the valuation analysis of a wind park is on the risk. Profitability plays a subordinate role in the bank's view. The bank just wants to be sure that the operator of the wind park can pay back the borrowed money and the interest. If there are too many uncertainties and too many risks, the bank reduces leverage and equity increases. If the risks and uncertainties are too high and the bank realizes that the project cannot run alone, the bank will not enter into the project. Thus, such a project would not be profitable for the bank.

The last consideration is the (3) view of an investor and operator of a wind park. The investor makes an initial investment in the wind park. All costs are summarized as the CAPEX. However, in order to be able to operate the wind park for 20 years, he has to maintain and repair the wind park. Other costs are also incurred during the operation of the turbine. These are the OPEX. However, these costs are offset by revenues from the EEG. The revenues depend on the applicable EEG feed-in tariff rate and the amount of electricity produced, which is derived from the AEP[67]. On the basis of CAPEX, OPEX and AEP, the expenses and the running costs can be offset against the energy pricing. The difference between these factors is crucial to the profitability of a project and thus also to the return on equity for the investor. Since the investor also bears the risk of wind damage, repairs or other events in a wind power project, the investor has the expectation that his capital employed generates return. As a rule, the Internal Rate of Return (IRR) is used to calculate the return on equity over the 20 years. This percentage is ultimately the most important decision making factor for an investor assessing profitability and taking into account risks.

The risks that can have a significant impact on the return include the absence of the average forecast wind rates at the site, a failing power curve of the wind turbines, excess of the projected CAPEX or OPEX, technical limits of the WTG or not enough created cash reserves for maintenance and repair.

However, financing is important when evaluating wind projects. A concrete calculation of the profitability of an investment project is not possible without the inclusion of the financing conditions. Even if a technologically oriented examination is primarily based on a rather abstract economic analysis of the technology, the topic of financing must be analyzed in particular. The calculation of the capital outflow and cash flows over the operating period of twenty years of operation, which is expected from the investment, is particularly important for investors, operators and the financing banks. It must be mentioned here that in the case of an investment, the return on equity is leveraged through the use of borrowed capital if the interest rate on borrowed capital is lower than the total capital profitability.

Ultimately, however, profitability is influenced by wind. In general, it can be said that for an operator, a profitable investment can be achieved

[67] AEP is explained in more detail in the following chapter 4.4.2 (p. 175).

from an average annual wind speed of just over 6 m / s in rotor hub height.

#### 4.4.2 Influence of the Annual Energy Production on the Profitability

The first and most important influence factor to evaluate wind energy projects is the energy production of the planned wind park. When determining the Annual Energy Production (AEP) of a wind turbine or a whole wind park the following quantities are important: the mean annual wind speed at the site, the power curve of the wind turbine and a sufficiently high technical availability (reliability) of the wind turbine.

When determining the AEP, one must distinguish between newly constructed projects and wind parks which are already in operation. For unbuilt projects, the project developer orders a wind assessment by independent external wind experts and consultants. Previously, there was a great risk because the quality of wind assessments was not as reliable as they are today (INTVW 22 Investor, 2016, para. 31). These wind assessments are generally required by each buyer or investor. To get a finance from a bank for the project, banks usually require two independent wind assessments. If the results of appraisals are too far apart, the bank may require a further report from the project developer. The financing banks create lists (Own survey), where all wind experts and wind consultant firms which are accepted by the bank are listed by name. As a banker makes this point clear: “We have the list with the experts we accept. And we accept only them. Otherwise, a new expert must first introduce himself to us, to our engineers and specialist and colleagues at the headquarter” (INTVW 14 Bank, 2016, para. 23).

The quality of wind reports has improved noticeably in recent years and is constantly developing. The promotional organization for wind energy and other renewable energies (German: Fördergesellschaft Windenergie und andere Erneuerbare Energien or FGW e.V.) periodically publishes technical guidelines[68] for wind turbines for the determination of wind potential and energy yields. These technical guidelines describe the process by which the wind potential and energy yields are determined at

[68] The current version (as of January 2016) is: Technical Guideline Part 6 (Revision 9).

sites and sets standards for the creation and development of wind assessments. Banks almost always refer to this guideline when accepting a wind assessment report for financing a wind park. For instance, the Deutsche Kreditbank only accepts only wind reports that are created with the latest revision of the Technical Guideline Part 6 from the promotional organization for wind energy and other renewable energies (Deutsche Kreditbank, 2015).
The basis for the calculation of the AEP are assumptions regarding the quantity and distribution of the wind at the site. In figure 33 an example of such an assumption is shown. The blue bars show the distribution of the wind speed distribution over a year. As mentioned above, another key figure for determining the AEP is the knowledge of a power curve of a wind turbine. The power curve of a wind turbine (red line), which is shown in figure 33 is a graph that indicates how large the electrical power is depending on wind speed. This figure makes clear how important it is to choose the right turbine for the right site with its specific wind conditions.

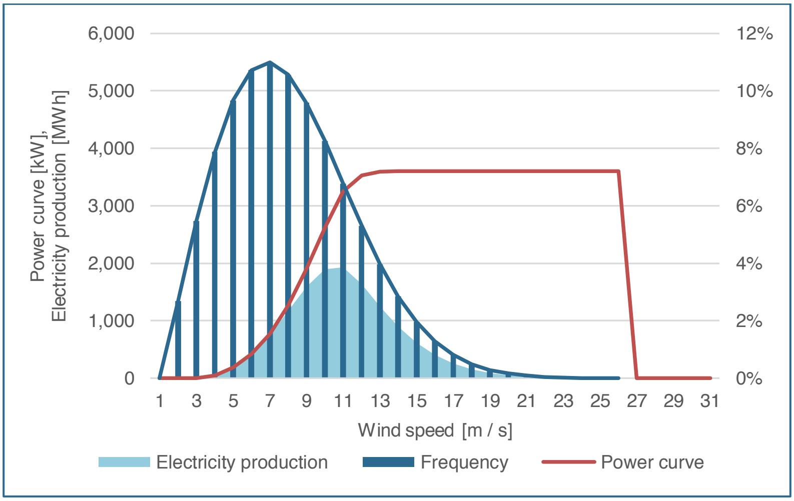


Figure 33: Wind speed distribution and power curve (Own illustration)

When the wind speed reaches the so-called cut-in speed, the yaw control starts the azimuth drive and rotates the wind turbine's nacelle into the wind. The cut-in speed depends on the type of turbine and is about 3 m / s. In figure 33 (p. 210), it can be seen that the peak of the power curve occurs at around 11 m / s. This is the wind speed at which the wind turbine reaches its rated electrical power. This point is called rated output power. Thereafter, the WTG is running at full capacity. If a certain wind speed is exceeded, the rotor blades are rotated out of the wind to avoid damaging the turbine. From this point, the system is no longer feeding into the grid. This point is called cut-out speed.
The calculation of the AEP in wind assessments is based on very complex models and assumptions adopted by the evaluators. Therefore, specific uncertainties have to be defined, which are also named in the report. The uncertainties are evaluated and weighted by a relative percentage. Uncertainties may for example consist of the data from the wind measurement met mast or station, operating data, long-term variability and correlation, wind index, site correction, applicability wind climatology, conversion to wind turbine sites, power curve, wind farm efficiency (Strack and Winkler, 2003, p. 54). An overall uncertainty in the energy yield can be defined based on the assessment and the weighting of the uncertainties, which is dependent on the specific site and generally is about around 10 % of the AEP (Own evaluation).
With the help of these uncertainties, probabilities can be defined of whether the calculated wind yield can be achieved or not. The results of the expert opinions are often expressed as a P50, P75 or P90 value. The so-called P-value indicates the probability (P = probability) of the occurrence of the wind production forecast. The higher the P-value, the higher the probability that the predicted yield is reached or even exceeded. A P50 value indicates that there is a 50 % probability of the projected yield being at least reached or even exceeded. Thus, a higher P-value contains a higher safety margin. In this respect at a higher P-value, a lower income from the investments is expected. When evaluating a wind energy project with the P75-value, the probability for entry exceeding of the wind park production increases to 75 %, whereby the projected income is lower compared to the P50-value (Klug, 2006, p. 38).

In figure 34, this exceedance probability, associated with the expected electricity production, is illustrated. It clearly shows that as the expected electricity production increases, the exceedance probability decreases.

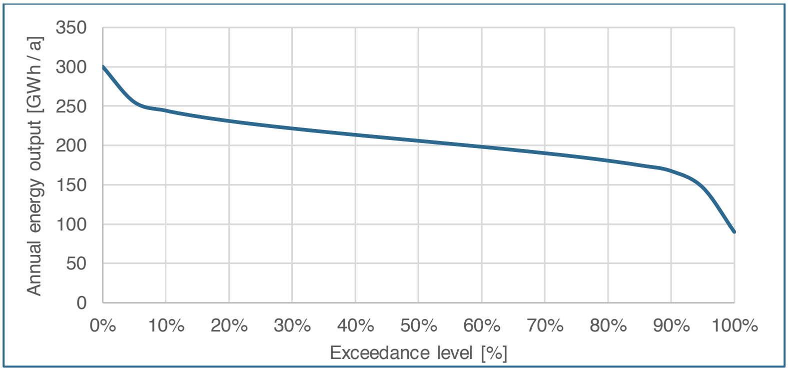


**Figure 34: Sample of a WTG's annual energy production and exceedance levels (Own illustration)**

The advantage of wind parks which have already been operating for a specific period of time, while evaluating the AEP, is that the real electricity production from the WTG for the operating years can be consulted for comparison, in addition to the wind reports. Depending on the length of operating time of the wind park, the actual real production number can be more meaningful than the production numbers from the wind reports.
Alternatively, a new wind report can be created which combines the actual real production with calculated forecasted wind data that represents a more accurate forecast for the coming operating years. In general, the wind report should be compared to the actual production data of the turbines in the assessment of the AEP. At the beginning, wind reports often predict too high production forecasts for wind parks (INTVW 07 Project developer, 2016, para. 19). However, the quality and forecast of wind reports have steadily improved. This is demonstrated in a DEWI survey from 2013: "The results are showing a quite high amount of assessments lying within a reasonable range of deviation, however also a high rate of overestimation of the corrected real production has been detected. [...] It can be seen that there are higher amounts of too optimis-

tic results in older EYA assessments but the hit-rate concerning the P50 is improved within the last years" (Schorer and Levée, 2013, p. 11). The improvement of the wind reports is one of the reasons why return expectations are decreasing (INTVW 01 Investor, 2015, para. 19).

#### 4.4.3 Wind Park Capital Expenditures as Cause Variable for Profitability

If the wind conditions are determined at the site, the investor can start with the further project and investment planning. The second important influence factor of evaluating wind energy projects is the capital expenditures or CAPEX of wind parks.

Based on the wind conditions the appropriate turbine can be built on each site. At low wind sites, low-wind turbines, which have longer rotor blades and are mounted on higher hub heights are perfect suitable. At sites with higher wind conditions, turbines can be built with smaller rotors blades and lower hub heights but generators with more capacity can be used. The choice of the right turbine has massive impacts on the CAPEX.

The CAPEX of wind turbines can be divided into major investment costs and incidental costs. The main investment costs include the WTG with its various components such as blades, hub, nacelle, tower and all needed electronic components. These components are usually delivered by the wind turbine manufacturer for a fixed total price. The choice of the WTG is crucial for the incidental investment costs, which are divided in the following areas: foundation, road construction and infrastructure, WTG construction and transport, grid connection, planning, finance and miscellaneous. In general, the CAPEX varies widely and are subject to site-based influences such as the size of the project, condition of the building ground and foundation soil, proximity to the grid connection point and number of turbines.

In the following, the major investment costs, in particular the wind turbine itself, are explained in detail. With the progress of wind turbines with ever increasing hub heights, generators and rotor blades, the purchase price of a wind turbine increases constantly. In principle, the following statement applies: The larger the wind turbine, the lower the cost of the wind turbine relative to one kilowatt of installed capacity. In general, a modern wind turbine contains up to 8,000 different components.

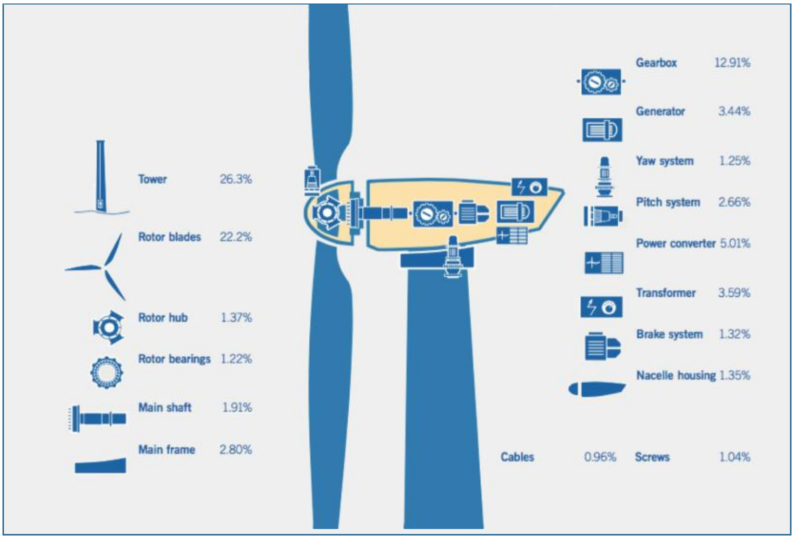


**Figure 35: The different components of a wind turbine and its cost share (Modified based on Wind Directions, 2007)**

As figure 35 makes clear, the biggest cost factors are the large components such as the tower (26.3 %), the rotor blades (22.2 %) and the gearbox (12.91 %). Together, these parts already constitute more than 61 % of the entire WTG. When evaluating wind energy projects, however, usually it does not matter how are the individual cost positions of the main components, because in general the investor pays a total price for tower, nacelle, hub and blades. Therefore, the decisive factor in the overall price of the wind turbine, combined with soft factors such as the deposit, delivery times, and scope of the extras such as modules for shadow control and ice sensors.

It is important to further discuss the incidental investment costs. As described, these costs are highly dependent on the choice of the turbine. The type and scope of the foundation is dependent on the hub height of the WTG. Wind turbine manufacturers typically require a standard flat foundation. With unfavorable soil conditions, special procedures must be

taken to improve the soil condition. To upgrade the subsoil and to ensure the high demands of the wind turbines additional mortar and gravel columns can be placed using vibro displacement densification. Another method to ensure the turbines stability is the use of a pile foundation. It may be necessary to design a completely new foundation design. This can greatly increase the costs compared to a flat foundation. The investor of the wind park project has to bear these additional costs. Regarding the foundation construction, manufacturers have different approaches to integrating themselves in the commodity chain. For example, Siemens and Vestas offer their products basically without foundations. Manufacturers such as Nordex and Enercon sell their WTG in Germany with foundations (Own survey).
A further part of the incidental investment costs is for the road construction and the infrastructure. Any wind park can be reached through a main road. These are usually public roads of the city or municipality. From this main road, different internal roads have to build to reach every wind turbine and to get access to the site. The cost of access roads, normally indicated as EUR / m, are also determined by the size of the wind turbine, since the roads have to meet the requirements of the establishing cranes. Every wind turbine needs its own crane pad. Larger tower segments or larger blades require larger and dismounted curve radii. Since the turbine has to be accessible for any repairs during the operation time of 20 years, a certain part of the access roads remains permanently. The crane pad must also not be removed after the construction of the turbine because to exchange of turbine parts and components a crane is needed. Given the local diversity and the different requirements of the turbines, a standard price per square meter, which is equal in all wind energy projects, cannot be defined.
Another possible share of the CAPEX are the investment costs of the WTG construction on the site and transport. The construction costs of the time depend on how long the construction teams are on site. Manufacturers will take over these construction costs in general, but there can be differences within the sale and purchase agreements with the manufacturer. It is a matter of negotiation and risk management if certain rules are integrated in the purchase agreement, which imply that the investor

has to bear the costs when the crane cannot operate for an entire day or a specific period of time due to strong wind and bad weather conditions. Accordingly, it can be assumed that these downtime costs are also more or less fixed costs for the manufacturer. The cost of a large crane, which erects the tower parts and connects the rotor blades with the hub, is around EUR 100,000 (Own survey). These costs include the transport of the crane to the site, the assembly of the crane and the removal of the crane. Labor costs for the crane per day are not included.

In general, the manufacturer bears the transport costs to the site, similar to how the investor bears the costs of construction downtime. But it can be agreed between the manufacturer and the investor that due to bad weather conditions the heavy transports cannot move and the investor has to accept these downtime costs.

The costs of the grid connection are also covered under CAPEX. The grid connection costs depend on the local conditions such as the distance to the nearest grid connection point and the local grid operator. The number of turbines is also decisive. The more turbines want to feed into the grid, the greater the cable cross-section must be in the external cable route. The costs for the cable can be calculated per m. As prices for cables are highly dependent on copper prices, the cost of cabling can vary greatly. The grid connection costs have to be paid by the operator and investor of the wind turbines. If the grid cannot absorb the total amount of electricity, the wind park produced, the investor is obliged under the EEG to pay for grid reinforcement. Otherwise the whole capacity cannot feed into the grid.

The planning costs include the cost for planning, approval, compensatory measures, establishment and organization of the operating company. Also, the payment for the project developer is included, as well as all costs which the project developer has spent on the project development. This can be costs for geological surveys, wind resource assessments, noise and shadow reports and for example one-time payments to landowners to get land lease contracts for the site where the WTG will be constructed. For example, the costs for the approval fee of a wind turbine which has to be paid to the approval authority, amounted to around EUR 70,000 in Brandenburg in 2016 (Own survey). The amount to be charged is set-out in the scale of fees and depends also on the amount of the total investment costs. Compensatory measures are highly dependent on the environmental conditions on the specific site. In the aforementioned example of the turbine in Brandenburg, the compensatory measures amount to approximately EUR 50,000. Overall, the planning costs are approximately 3 - 6 % of the total investment costs.

Additional costs arise with the establishment of finance that has to be added to the CAPEX. This does not include the interest and redemption payments, as they are incurred by the operational phase of a wind energy project and therefore must be counted among the OPEX. Since almost every wind park is operated through finance, costs that must be paid to the financing institution must be taken into account under the investment costs. Due to the ever-increasing size and complexity of projects (INTVW 16 Bank, 2016, para. 10, 11), the financing banks tend to request one-time financing costs, also-called banking fees. Wind parks as technical investment projects with their specific risks also require a high examination effort on the side of the lenders. This is the reason for such charges and fees (Hau, 2014, p. 891). This bank fee or commitment fee often varies and is a matter of negotiation. According to a banker the fee depends "on the level of the project. If we are active as a bank at the beginning of the projects and also take on a consultancy function, the price is certainly different from when someone comes to us with a complete project. These services must then also be reflected in the price" (INTVW 16 Bank, 2016, para. 47). Another component that is mentioned in the financing costs is the discount which can be agreed between the lender and investor. When issuing the loans, banks can offer a discount on the starting amount, which can vary between one bank to another[69]. Interest charges for the interim financing part during construction until the project achieves the first revenues due to the feed in tariffs also belong to the one-time financing costs. When constructing a wind park with several wind turbines, a period of some months can pass from the date on which first payments have to made until the commissioning date. In addition to that, the value added tax also has to be financed (Hau, 2014, p. 891).

[69] For a detailed explanation of structuring project finance see chapter 4.3.1 (p. 150).

The final category of CAPEX is the miscellaneous costs. This includes all costs that cannot be assigned to any of the above categories. These costs also vary greatly for each project. Costs resulting from the acceptance of the wind park fall under miscellaneous. It may be certain reports that must be submitted to the planning authority or the approval authority. Again, this can be costs for technical experts who, for example, review the whole WTG or only parts of the WTG. Here costs for such a technical status report of the WTG can vary greatly. For example, rotor blade inspection can be carried out on the ground, or after installation of the blades. The assessment of the blades on the ground is less expensive but of course no material errors, which could occur during the installation of the blades to the hub, can be declared and indicated to the manufacturer. Further miscellaneous costs can be an automatic bat detection system, which is installed after the erection of the wind turbine. In this detection system microphones are included that record bat activities. Other charges may apply caused by specifications for the data connection requirements for example the remote monitoring, remote control and the SCADA system.

### 4.4.4 Wind Energy Operational Expenditures and their Influence on Profitability

The operational expenditures or OPEX are a further important element in a project evaluation. The operating costs have a major impact on the rate of return of a project. A wind park generates every year certain income through the production and sale of electricity. Of these costs, the OPEX must be served as well as interest and repayments for the CAPEX.

The OPEX include maintenance and repair measures, land lease payments, insurance for machinery breakdown and interruption, costs of technical and commercial management, costs for direct marketing, tax consulting fees, costs for the own electricity consumption, maintenance or participation costs of a substation, and formation of reserve accounts or dismantling costs.

The maintenance and repair contracts, signed between manufacturer and investor, are usually mandatory and binding for a purchase contract for the wind turbine. The methodology of the cost calculation in this case differ from manufacturer to manufacturer. As a rule, a certain amount per generated kWh will be charged. Current prices tend to rage from 0.009 to 0.011 ct / kWh (Own survey). This can also be staggered and rise with ongoing operating time. Another payment system is a fixed fee for maintenance. Based on that, a minimum amount of produced kWh is defined. If the actual production yield exceeds that minimum payment level an extra payment is due. Also, a combination of different systems may be agreed upon. For older machines, a pure fixed rate with a certain availability can be negotiated. This compensation is independent of the actual produced kWh. The service provider who performs the full maintenance and the operator can agree, that if the agreed turbine's availability will be exceeded, the extra remuneration above this agreed level will be shared. Prices for a full maintenance contract in a typical park with 10 turbines from 2009 are around 42,000 EUR per year per WTG (Own survey).

The second major influence factor for the OPEX is the land lease payments. Again, the payment details are up to the outcome of negotiations between project developers and the land owners. Here a very rising trend can be seen, due to the fact that in recent years an enormous competitive pressure arose among the project developers for the rare potential sites where the use of wind energy is possible. Generally, it can be said that in regions with a high wind potential as in northern Germany, a higher proportion may be paid to lease the land than in regions with lower wind conditions as in the south of Germany.

The cost of insurance for machinery breakdown and interruption are rather low in comparison. Mostly, these insurances are provided with an indexing around 2 % annually.

Project developers usually perform the technical and commercial management. However, in recent years, independent companies have also been established that have specifically dedicated themselves only to the technical and commercial management of a wind energy project without any project developing goals. An example of this business strategy is the company Kaiserwetter Energy Asset Management GmbH. This company performs wind turbine services but has no engagement in project development, project finance, construction or investment (Kaiserwetter, 2014, p. 6). Currently a price drop on the market can be observed, as in recent years an enormous competitive pressure has arisen. Usually prices for both services amount to approximately 1 - 2 % of the income revenues but the prices are strongly dependent on the scope of services and the wind park. There are service contracts based on a fixed price. Hereby it is important to define the exact dividing lines between the service provider and the operator and investor.

Since 2014, the direct marketing[70] is mandatory for all new wind turbines in Germany. The direct marketer takes a service fee per kWh from the operator, which is generated by the wind turbines, and sells the produced kWh on the market. Since there are many direct marketers in the German wind energy market, also a strong competitive pressure is noticeable. Many interview sources say that there will be a market shakeout in the nearest time. It can be assumed that the market prices that are available at the moment are at a low point and will increase again in the nearest time. The size of the fee depends on the park size, production of the parks, geographic location, duration of the contract and how the park fits into the portfolio of the direct marketer. Normally there are contracts with a duration of 2 or 3 years. According to statements from some direct marketers, a price forecast beyond 2 years is currently not possible.

Based on the statements of the interviews an own survey of direct marketing prices has been carried out. Hereby a total of 16 market participants in the German direct marketing sector for wind energy were determined. All 16 direct marketers were asked to name their service fee for a previously determined wind park. As table 16 (p. 221) shows, the average of the prices requested was EUR 0.62 / MWh. The offers varied between EUR 1.09 / MWh and EUR 0.28 / MWh. With a feed-in tariff of EUR 8.9 / MWh, almost 7 % of the remuneration is thus paid to the direct marketer.

[70] For a detailed explanation and definition of direct marketing, as well as the impact on the economic operation of WTG see chapter 4.2.4 (p. 140).

Table 16: Price comparison of direct marketers (Own survey)

| Number | Direct marketer | Service fee [EUR / MWh] | Quote requested |
|---|---|---|---|
| 1 | DV 01 | 0.68 EUR / MWh | 02/11/15 |
| 2 | DV 02 | 0.34 EUR / MWh | 09/11/15 |
| 2 | DV 03 | 1.09 EUR / MWh | 09/11/15 |
| 4 | DV 04 | 0.28 EUR / MWh | 14/10/15 |
| 5 | DV 05 | 0.59 EUR / MWh | 10/11/15 |
| 6 | DV 06 | 0.65 EUR / MWh | 30/11/15 |
| 7 | DV 07 | 0.70 EUR / MWh | 19/11/15 |
| 8 | DV 08 | 1.00 EUR / MWh | 26/11/15 |
| 8 | DV 09 | 1.04 EUR / MWh | 22/10/15 |
| 10 | DV 10 | 0.97 EUR / MWh | 09/11/15 |
| 11 | DV 11 | 0.55 EUR / MWh | 02/11/15 |
| 12 | DV 12 | 0.30 EUR / MWh | 02/11/15 |
| 13 | DV 13 | 0.54 EUR / MWh | 14/10/15 |
| 14 | DV 14 | 0.36 EUR / MWh | 22/10/15 |
| 15 | DV 15 | 0.45 EUR / MWh | 14/10/15 |
| 16 | DV 16 | 0.45 EUR / MWh | 26/11/15 |
| **Average** | | **0.62 EUR** / MWh | |

Other costs are very project-specific and cannot be generalized or applied to other projects. For example, tax consulting costs depend on each investor and are also related to the specific tax situation of the investor. The establishment of financial reserves is dependent on what was agreed in the financing agreement with the bank, which conditions were laid down and which ratio of loan and equity was agreed at time of signing the credit agreement. Also, the cost of own energy consumption varies by the type of the turbine and the current contract with the energy supplier. If the wind park is not connected to a 20 kV cable line and the transfer station must be serviced, extra costs can occur for maintenance and instant attitude of a substation. Substations have to be serviced, repaired and inspected at regular intervals, which generates costs.

Table 17 (p. 222) shows the costs for the different cost categories and the respective share of the average operating costs for the years 1 - 10 and 11 - 20. As the table shows, the largest share of operating costs are service and maintenance, land leases and the technical and commercial management. Of these, the technical and commercial management decreases, but the land leases and the service and maintenance increase.

If the OPEX are higher over the years than it has been initially planned, the return on equity of the project decreases. It is the goal of every wind park operator to keep the OPEX as low as possible. Of course, the performance of the wind park should not suffer. It is a normal for the OPEX to not remain constant throughout the total life of the park of 20 years. Experience shows that, according to project developers and wind park operators, an increase of operating costs occurs from the first to the second decade of the wind turbine's lifetime.

**Table 17: OPEX costs break-down (Own table based on Deutsche WindGuard, 2013, p. 3)**

| Operating year | 1 - 10 | | 11 – 20 | |
|---|---|---|---|---|
| | Costs | Share | Costs | Share |
| **Service and maintenance** | 1.05 ct / kWh | 44 % | 1.47 ct / kWh | 55 % |
| **Land leases** | 0.53 ct / kWh | 22 % | 0.51 ct / kWh | 19 % |
| **Technical and commercial management** | 0.41 ct / kWh | 17 % | 0.36 ct / kWh | 13 % |
| **Insurance** | 0.12 ct / kWh | 5 % | 0.07 ct / kWh | 3 % |
| **Reserves** | 0.20 ct / kWh | 4 % | 0.14 ct / kWh | 5 % |
| **Miscellaneous** | 2.41 ct / kWh | 8 % | 0.13 ct / kWh | 5 % |
| **Total** | **2.41 ct / kWh** | **100 %** | **2.68 ct / kWh** | **100 %** |

According to the survey analysis, the OPEX will increase by about 20 % in the second half (11th to the 20th year of operation) of the operating time. This is due to the fact, that in the second half of the total operating time, the wear of the WTG increases with increasing age of the WTG, which causes higher service and maintenance costs. The second largest cost factor of the OPEX are the land lease payments. This cost position is also variable (Deutsche WindGuard, 2013, p. 3). Many land lease agreements are designed in a way that the percentage share of the electricity sales revenue for the land owners fluctuates with the operating time. The land owner receives, for example, by operating year 1 - 10 around 7 % of the electricity revenues and by year of operation 11 - 20 around 6 % of the electricity revenues from the investor.

### 4.4.5 Energy Pricing as Political as Determining Factor for Profitability

If the AEP and the cost estimates of CAPEX and OPEX are calculated, these numbers can be compared to the energy price per produced kWh that one gets from the network operator.

In Germany, there is an investor-friendly situation. Before the investment has to be placed, the price of the remunerated kWh is determined and thus the investor is able to calculate exactly the electricity sales price for all the next 20 years. In Germany, the feed-in tariff was regulated first at the beginning of 1991, with the so-called Stromeinspeisungsgesetz (StrEG). In 2000, the StrEG was replaced by the EEG. In the EEG, the remuneration for wind energy and other renewable energies is precisely defined. The EEG has been amended several times, as described in chapter 4.1.3 (p. 138), most recently by the EEG 2017.

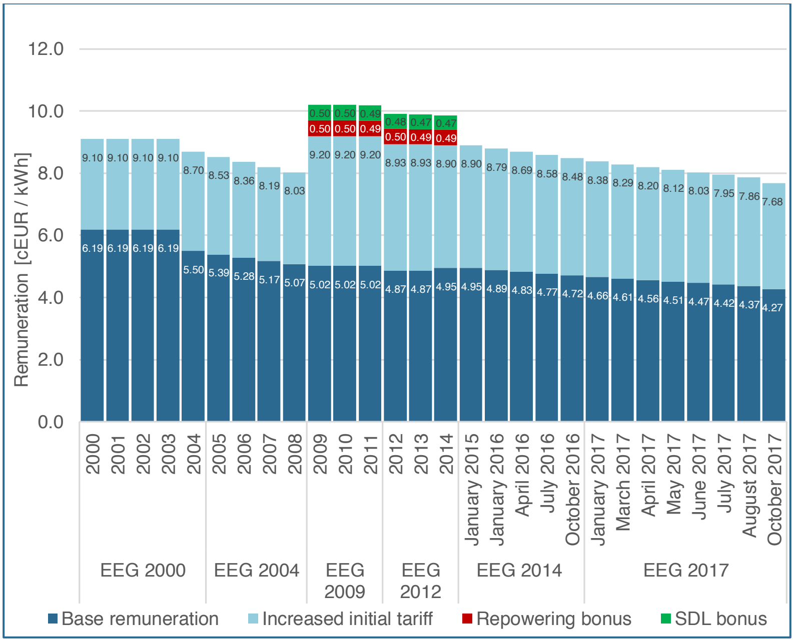


**Figure 36: The change in remuneration for wind parks in Germany according to EEG (Own illustration based on EEG 2000; EEG 2004; EEG 2009; EEG 2012; EEG 2014; EEG 2017)**

Figure 36 shows the development of remuneration for wind energy onshore in Germany. In the period from 2000 to 2017, there was a total of 6 amendments to the EEG in which the feed-in tariffs were adjusted. As can be seen, the remuneration was steadily reduced year by year. However, with the EEG 2009, the remuneration was raised again. The remuneration is made up of a basic remuneration and an increased feed-in tariff. The basic remuneration is granted for the entire operating period of 20 years. The duration for which the increased feed-in tariff is paid is the result of the location quality, which has already been described. This is to create a balance between good and bad sites with different wind conditions. Figure 36 makes clear that the commissioning date plays a significant role in remuneration. The later the wind park is connected to the grid, the lower the paid remuneration for the produced kWh of the wind park. In addition to the existing feed-in tariff, there were other incentives anchored by the policy in the EEG 2009 and 2012. A repowering bonus is obtained if the project is a repowering project, and it is also proven that a special number of old turbines with a special capacity has been dismantled. The so-called SDL bonus was available between 2009 and 2014 if one could prove that the built turbine met the requirements of the electrical network. This applies to the voltage maintenance, the output of active and reactive power as well as the conditions under which the wind turbine may shut down or must support the grid (Smolka et al., 2008, p. 4). The last incentive is the management premium. The management premium was maintained until 2014 when electricity has been sold and traded by a direct marketer. This premium should compensate the administrative burden and the resulting direct marketing costs.

As a result of the plannable remuneration, a very good basis for planning, financing and, above all, investment security for wind energy projects was created. When evaluating projects, AEP can be calculated as the investment basis with the applicable rate of compensation. This gives the investor a good overview of the expected revenue and can offset it against the CAPEX and the OPEX. From this calculation, the electricity production costs can be calculated.

## 4.5 Capital Market and Capital Employed

### 4.5.1 Development of Investment and Operating Costs

The size of each investment in wind energy projects as well as in investments in other energy technologies depends on various factors. As al-

ready stated, the largest cost factor in a wind energy project is the wind turbine itself. Based on this, the decisive factor for the amount of the investment is the capacity of the wind turbine.
As the costs have to be made comparable, the costs for the projects are stated at specific costs per installed kW. By this calculation, an investor can compare different projects on the same basis. Generally speaking, the lower the cost per kW installed, the more economical and better the investment costs. This calculation cannot be used to conclude the profitability of a project over the entire term. For project A, for example, the investment costs per kW are significantly lower than for project B. In return, however, project B has a considerably higher number of full load hours due to a better wind conditions than project A. Thus, project B is more economical than project A despite higher investment costs.

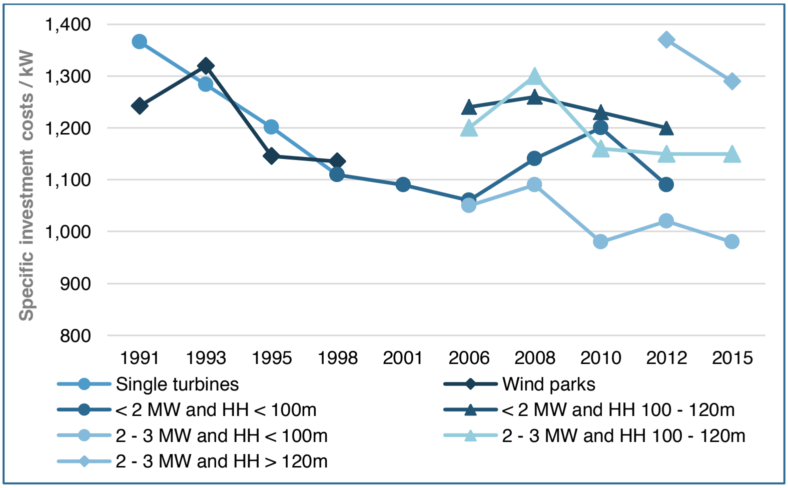


**Figure 37: Trend of specific investment costs / kW for wind energy (Own calculation based on Deutsche WindGuard 2013; Deutsche WindGuard 2015; DEWI 1999)**

In order to show a development of these specific investment costs per kW, different data sources and investigations were analyzed, partly converted and reassembled. The capacity of turbines has continued to grow. For example, the wind turbine manufacturer Enercon produces turbines with 800 kW up to 7,580 kW (as of March 2016). The hub height also differs significantly. There are Enercon turbines with 45 m hub height up to 159 m hub height (as of March 2016). Both the height of the capacity and the height of the hub height have an enormous impact on the specific investment costs per kW.

Therefore, in figure 37, different types of wind turbines with different specifications are shown. In the period from 1991 to 1998, the only distinction made was between a single installation and a whole wind park. The figure shows that the investment costs for wind turbines have declined steadily, with slight fluctuations, irrespective of the size of the capacity and the hub height.

In 1991, the price per installed kilowatt was around EUR 1,300. The price was initially higher for single turbines than for a whole wind park. The costs then declined further in the following years. The latest numbers from 2015 show that a wind turbine between 2 and 3 MW with a hub height below 100 m costs less than EUR 1,000 per installed kW. Compared with the costs of 1991, this means a reduction of costs by 25 %. This reduction in costs is due to the fact that in recent years the production costs for WTG and thus the prices for the electricity production have fallen sharply. This can be attributed to more efficient turbine techniques, optimized production processes and higher quantities of production.

In the years 2012 and 2015, one also clearly sees the cost differences which are generated by the different capacities and different hub heights. In principle, the cost per kW decreases the greater the capacity becomes. This has to do with the fact that the ratio of additional costs for a larger generator does not increase in the same proportion as the remaining costs of the turbine. Furthermore, it becomes clear that the hub height of a wind power installation has a higher influence on the price than the capacity. Thus, the cost per kw for the 2 - 3 MW turbine with a hub height of less than 100 m and the turbine with less than 2 MW with the same hub height is cheaper than a turbine with less capacity. The highest cost therefore is a wind turbine with an output of 2 - 3 MW and a hub height greater than 120 m. The investment would amount to more than EUR 3.2 million for a 2.5 MW turbine with 120 m hub height.

To get a better overview, all above mentioned cost positions are illustrated in table 18. The table shows the percentage cost distribution of CAPEX and how these shares have changed over time in constant time intervals. Data from the years 1996, 2006, 2009, 2012 and 2013 is available, thus covering the complete evolutionary cycle of the wind energy industry. The table shows that the largest cost factor during the whole period is the WTG. The WTG share slightly increases from 67.5 % to 75.0 % and 78.7 %.

**Table 18: Development of wind energy projects CAPEX (Own compilation based on Hoppe-Kilpper et al., 1997; EWEA, 2009; Blanco, 2009; Knopp, 2012, p. 15; IE Leipzig, 2014; Deutsche WindGuard, 2014)**

| | 1996 | 2006 | 2009 | 2012 | 2013 | 2013 |
|---|---|---|---|---|---|---|
| WTG | 67.5 % | 75.6 % | 71.0 % | 75.5 % | 78.7 % | 75.0 % |
| Grid connection | 8.7 % | 8.9 % | 12.0 % | | 5.2 % | 5.0 % |
| Foundation | 9.1 % | 6.5 % | | 4.2 % | 3.8 % | 4.0 % |
| Cabling | 5.3 % | | | 2.0 % | | |
| Planning | 1.5 % | | | 4.1 % | 2.9 % | 6.0 % |
| Approval | 3.4 % | | | | | |
| Land purchase | 2.7 % | | | | | |
| Other | 1.8 % | | 8.0 % | | 1.6 % | 7.0 % |
| Civil works | | 0.9 % | 9.0 % | 3.7 % | 4.1 % | 3.0 % |
| Electricity installation | | 1.5 % | | 1.4 % | 1.6 % | |
| Consultancy | | 1.2 % | | | | |
| Financial costs | | 1.2 % | | 6 % | | |
| Control systems | | 0.3 % | | | | |
| Compensation measures | | | | 2.9 % | 2.2 % | |

At this point, the CAPEX example from 2012 should be emphasized. This example describes a small wind park with three Vestas V90, each with a capacity of 2.0 MW and a hub height of 105 m. Furthermore, it can be seen that financing costs, which consist of financing costs (3.6 %) and debt discount (2.4 %) exceed all other CAPEX costs apart from the WTG, such as foundation, cabling, planning, civil works, electricity installation and compensation measures. This means that in this example, the largest share of value added, after the turbine manufacturer, remains in the financial sector.

A change has also developed in the in the OPEX as well as the CAPEX over time. In table 19 the OPEX from the years 1997 - 2001 are compared with the operating figures of 2013. The figures from 1997 - 2001 were determined by the German Wind Energy Institute and are averaged for this period. The figures for 2013 are from the German WindGuard. The figures clearly show on the one hand that the share of service and maintenance has almost doubled. Only 26 % of all costs for service and maintenance were paid to the service provider in the years 1997 – 2001 and in 2013 it was already 50 %. This is partly due to the increasingly complex technology, and, on the other hand, that the new service contracts are almost only full-service contracts. These contain a risk premium for the manufacturer or the service provider. This means that, even in case of damage to a main component, such as engine power, transmission or rotor blades, the operator has to carry no costs. For carrying the risk, the service provider gets paid.

**Table 19: Shift of operational costs of wind energy projects over time (Own compilation based on DEWI, 2002; Deutsche WindGuard, 2013)**

| | 1997 - 2001 | 2013[71] |
|---|---|---|
| Service and Maintenance | 26.0 % | 50.0 % |
| Operational Management | 21.0 % | 15.0 % |
| Land lease | 18.0 % | 21.0 % |
| Insurance | 13.0 % | 4.0 % |
| Reserves | | 5.0 % |
| Other | 17.0 % | 7.0 % |
| Power from the grid | 5.0 % | |

As shown in table 19, the costs for the operational management have decreased, unlike to the maintenance costs. Between 1997 and 2001, 21 % of all costs were spent on operational management. In 2013, however, it was only 15 %. This decline can be related to the fact that operational management was already carried out in 2013 by companies specializing only in the operation of wind parks, whereas in the years 1997 to 2001 the farmers or landowners themselves still managed their own WTGs themselves. Due to this professionalization, competitive pressure and probably also due to economies of scale, since the providers today manage a portfolio with often more than hundreds of MW, the proportion of this operational management costs have fallen.

[71] The figures are from a Deutsche WindGuard (2013) survey and are averaged from different years of operation.

The share of insurance costs also fell from 13 % to 4 % over the same period. The insurance policies have fallen steadily since the technical risk for WTG has declined over the years and has become more and more assessable. Many risks, such as the exchange of components, are now mostly covered by the manufacturers and therefore need not be covered by a separate insurance policy. Moreover, as the number of insured wind turbines increases, the contribution for a single wind turbine can be reduced as the risk is distributed to a larger, steadily growing number of wind turbines.

### 4.5.2 Commercial Bank Loan as a Success Factor for a Booming Industry

As already mentioned in chapter 4.3.1 (p. 179) the ratio of loan capital and equity capital depends on the risks of the projects and amounts approximately for 80 % loan capital and 20 % equity capital (Schaffarczyk, 2012, p. 74). The ratio is subject to fluctuations, however when investors add equity capital this gives the banks confidence and signals seriousness and feasibility of the project (Weber et al., 2006, p. 138). However, it can be assumed that "the equity ratio will increase in the future as the risks from the EEG are more difficult to calculate compared to old financing models" (INTVW 25 Financial Service Provider, 2016, para. 7).

Due to the high investment costs for wind energy projects and the favorable interest rate conditions, the raising of loan capital plays a central role within the development of wind energy projects. Table 20 shows a rough overview of the active commercial banks in the wind energy sector. The table depicts the period between January 2010 until the end of June 2015 and lists the mandated lead arrangers or MLA[72] for wind energy project finance in Germany. Hereby the numbers include onshore and offshore wind parks. It has to be mentioned that table 20 does not cover every single bank which finances wind energy projects in Germany,

[72] The term mandated lead arranger or MLA is used within syndicated loans, which "are typically set up for facilities exceeding EUR 50 million which a single bank does not want to take alone. The lead bank, [...] known as the mandated lead arranger, will arrange the line and commit to undertake the full amount of the credit" (Vernimmen et al., 2014, p. 374).

because the compilation shows only the syndicated loans transactions and not the bilateral finance transactions (Markus et al., 2011, p. 598).

**Table 20: Mandated lead arranger for wind energy project finance in Germany (Own survey based on IJGlobal, 2015)**

| Rank | Company | Total USD million | Transactions | Market Share (%) |
|---|---|---|---|---|
| | | | Analysis period: 01/2010 – 06/2015 | |
| 1 | KfW | 1,340.23 | 5 | 26.55 |
| 2 | HSH Nordbank | 512.46 | 13 | 10.15 |
| 3 | NordLB | 464.34 | 8 | 9.20 |
| 4 | Mitsubishi UFJ Financial Group | 298.32 | 2 | 5.91 |
| 5 | DekaBank Deutsche Girozentrale | 228.49 | 2 | 4.53 |
| 6 | Rabobank | 221.88 | 3 | 4.40 |
| 7 | Dexia Group | 187.66 | 3 | 3.72 |
| 8 | Skandinaviska Enskilda Banken | 183.54 | 3 | 3.64 |
| 9 | UniCredit | 143.22 | 2 | 2.84 |
| 10 | ING Group | 130.64 | 2 | 2.59 |
| 11 | Santander | 130.26 | 2 | 2.58 |
| 12 | Deutsche Bank | 117.10 | 2 | 2.32 |
| 13 | Commerzbank | 108.22 | 1 | 2.14 |
| 14 | NIBC Bank | 106.29 | 3 | 2.11 |
| 15 | LBBW | 96.42 | 4 | 1.91 |
| 16 | Helaba | 91.41 | 2 | 1.81 |
| 17 | ASN Bank | 88.43 | 2 | 1.75 |
| 18 | Societe Generale | 71.88 | 1 | 1.42 |
| 19 | BayernLB | 71.60 | 1 | 1.42 |
| = | Bremer Landesbank | 71.60 | 1 | 1.42 |
| 21 | Lloyds Banking Group | 71.22 | 1 | 1.41 |
| = | Siemens | 71.22 | 1 | 1.41 |
| 23 | NRW Bank | 66.12 | 1 | 1.31 |
| 24 | Banco Sabadell | 59.04 | 1 | 1.17 |
| = | DnB NOR Bank | 59.04 | 1 | 1.17 |
| | **TOTAL:** | **5,048.00** | **27** | **99 %** |

As table 20 shows, two wind turbine manufacturers are among the 25 largest financing banks for wind energy projects. Mitsubishi UFJ Financial Group is ranked fourth with a financing volume of almost USD 300 million. This bank is part of the Mitsubishi Group, which also manufactures onshore and offshore wind turbines with Mitsubishi Heavy Industries. In addition, Mitsubishi holds a 50 % share in a joint venture with the Danish wind turbine manufacturer Vestas. The MHI Vestas Offshore Wind joint venture, founded in 2014, develops and produces offshore wind power turbines. Another financing bank is Siemens Bank. Siemens is active both onshore and offshore worldwide and also in the German wind energy market. These two examples show that manufacturers already earn a portion of their revenue through financing, and that the financing business has become an independent business area within manufacturers.

There are indications of an increasing professionalization within the banking sector. According to the thematic background paper of the international conference for renewable energies in 2004, the professional handling of banks while financing renewable energies has been spotted as an obstacle to mobilizing finance of renewable energies. It seems that in 2004 the banks were not ready for a professional and sophisticated finance for wind energy projects. To improve the capacity in the banks, the following solutions have been proposed: "When building renewable energy investment capacity within a financing institution, the approach needs to be flexible, as different institutions follow different 'product development' paths. To enter a new sector, some finance institutions first focus on creating the right policies or strategies, while others focus on training personnel. [...] Pursuing change in a financial institution takes time and commitment at all levels. To be successful across the institution, changes in the incentive structure are often needed" (Sonntag-O'Brien and Usher, 2004, p. 14).

Meanwhile the professionalization of the bank regarding wind energy projects has advanced enormously. Today the commercial banks have their own departments that deal with renewable energies and especially wind energy.

In a classical loan finance, a fixed interest rate for a specific period as well as a repayment schedule are determined by the commercial bank. While determining these terms, the commercial bank is risk-averse, which means that the commercial bank always considers the worst-case scenario of wind energy projects. This worst-case consideration begins with the first and most important input variable. The financing banks calculate the business case with the annual energy production or AEP of P75 or P90[73]. That means that the bank calculates with a risk of not reaching the forecast AEP, which is 25 % or 10 %.

So far, commercial bank financing has been offered only by banks. In the meantime, however, there are wind turbine manufacturers in the German

[73] For a detailed explanation of calculation and evaluation of AEP and exceeding probabilities see chapter 4.4.2 (p. 175).

wind industry that offer commercial bank financing for wind energy projects (INTVW 09 Manufacturer, 2016, para. 51). Thus, a manufacturer expands its activities from the real economy with activities from the financial economy and develops has a further business field.

#### 4.5.3 Government-Owned Development Bank and the Liability Risk

Most of the wind energy projects in Germany are financed by loans given from the Kreditanstalt für Wiederaufbau (German for: Credit Institute for Reconstruction) or KfW, because these loans are subsidized and can be requested through commercial banks (Hau, 2014, p. 891).

The KfW was founded after the Second World War in 1948, with the aim of financing the reconstruction of the German economy. The initial funding came mainly from the European Recovery Program European Recovery Program funds[74]. The KfW banking group is one of the largest financiers worldwide and with a balance sheet total of EUR 465 billion, is the third largest bank in Germany after the Deutsche Bank AG and the Commerzbank AG (Bankenverband, 2014, p. 7).

The law for the credit institute for reconstruction imposes support measures, in particular financing projects for environmental and climate protection (KfW, 2013). In order to improve the economic, social and environmental living conditions around the world the KfW provided EUR 72.5 billion of funding in 2013. Of this amount, 38 % was allocated for climate and environmental protection, and thus also for wind energy projects (KfW, 2014).

KfW programs to promote renewable energies in 2013 had a commitment volume of around EUR 3.9 billion, which in turn mobilized a total investment volume of around EUR 6.6 billion in Germany. As illustrated in table 21 (p. 233), the volume of commitments in 2013 decreased significantly compared to 2012. The reason for this decrease can be explained by the changing conditions of the EEG.

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[74] The European Recovery Program, also commonly known as the Marshall Plan, was an extended economic reconstruction program by the United States to support Western Europe that was weakened by the consequences of the Second World War. The European Recovery Program consisted of loans, raw materials, food and merchandise.

**Table 21: Effects of the KfW "Renewable Energies" programs in Germany (Own survey based on KfW 2014)**

| | 2010 | 2011 | 2012 | 2013[75] |
|---|---|---|---|---|
| **Commitment volume** | EUR 8.9 billion | EUR 6.3 billion | EUR 7.1 billion | EUR 3.9 billion |
| **Mobilized investment** | EUR 11.0 billion | EUR 8.3 billion | EUR 10.0 billion | EUR 6.6 billion |

The lending of KfW credits are executed by the pass-through principle (INTVW 01 Investor, 2015, para. 89). This means that the investor of its wind energy project applies to its principal bank. Then the principal bank clarifies the credit arrangements directly with the investor, for example the form and extent of the amount, collateralization and term (BWE, 2012c, p. 30). Thereby the wind energy project undergoes a due diligence process by the bank to evaluate the risks and the collateralization. According to the results of the due diligence process, the bank systematically compiles specific measures to enhance the security of payment returns to the project itself and hence for the investors. During a due diligence process the bank is often advised by external attorneys. According to a lawyer specialized in wind energy, "as a rule, external attorneys from law firms are activated for due diligence. Because [...] when we are talking about financing, [...] they do not have the capacity to carry out their own due diligence process. [...] That costs a lot of money, if such a due diligence process is carried out. On the other hand, in view of the possible total financial volumes, this is no longer important" (INTVW 18 Lawyer, 2016, para. 5). If the finance details have been finalized, the principal banks apply the loans for the investment projects at the KfW. After application, these loans are available for the principal banks as refinancing funds and are passed through to the investor.

As KfW offers different programs for the specific investments. Loans for wind energy projects fall under the KfW's Standard (270) program, which is a program for renewable energies. Within this program, the grace period and the fixed interest rate are dependent on the loan terms. The details are illustrated in table 22 (p. 234).

[75] The data for 2013 are preliminary estimations by the KfW bank group.

**Table 22: KfW funding program for wind energy projects and characteristics (Own compilation based on KfW, 2015)**

| Term | Grace period | Fixed interest rate | Maximal interest rate[76] | Effective interest rate[76] |
|---|---|---|---|---|
| 1 - 5 years | Up to 1 year | Entire term | 1.60 % - 2.40 % | 1.61 % - 2.42 % |
| 6 - 10 years | Up to 2 years | Entire term | 2.10 % - 2.90 % | 2.12 % - 2.93 % |
| 11- 20 years | Up to 3 years | 10 or 20 years | 2.45 % - 4.00 % Risk categories B, C, D | 2.47 % - 4.06 % Risk categories B, C, D |

The most relevant factor for investors while financing a wind energy project is the effective interest rate, because these interest rates are a specific share of the total loan capital, which the investor has to pay back to the bank respectively to the KfW. The interest rates are also scheduled in the cash flow calculation and are part of the yearly accrued OPEX.

The interest rates are not determined by the bank or the KfW. The interest rate determination occurs through a fixed selection procedure. The relevant influence factors for the price calculation are the grace period, the term for fixed interest rate and the risk rating. Whereas the grace period and fixed interest rate can be elected by investor, who can base his decision on his elected business case, the risk rating is conducted by the KfW or the bank on base of a rating procedure. Thus, the financing bank has a large influence on the internal rate of return or IRR of the investor. The higher the interest rate of the investor, the higher the return of the bank.

Thus, it is in the interest of the investor to keep the interest rates as low as possible. Hereby the rating of the project and the risk management to keep the risks low are important. To evaluate the risk management of a project and to rate the risk, the KfW has nine different risk classes. These are ranked from A - I, where A represents the lowest risk class, and I represents the highest risk category.

According to a survey of the Deutsches Institut für Wirtschaftsforschung (German for: German Institute for Economic Research) or DIW, the most

[76] The maximum interest rate and the effective interest rate reflect the state of data as of 15.08.2015. The mentioned rates refer to the price categories B, C and D.

relevant risk categories for wind energy projects are category B, C and D. Due to these three risk categories the actual interest rate range lies between 1.61 % and 4.06 %, as illustrated in table 22 (Tisdale et al., 2014, p. 7).
The liability risk for a wind park can go beyond the total investment costs. This liability risk is largely carried by KfW. The standard bank carries only a smaller proportion of the liability risk due to their smaller share of the commercial bank loan. The share of the liability risk is dependent on the proportion of loan capital which has been made available either by the standard bank or KfW. Since most wind parks are financed by KfW, the liability risk lies on one single bank, for which ultimately the Federal Republic of Germany is liable with guarantees.
These guarantees are also the main reason why KfW can refinance itself favorably. The main source of funding for KfW is the capital market. KfW has a very high credit rating due to the KfW law and the associated guarantees by the Federal Republic of Germany, and is given an AAA rating by rating agencies.
Therefore KfW-based financing is highly standardized and therefore very simple. The implementation of tender model required by the policy makes KfW-based financing much more complicated and challenging. Here, again, a new business model is emerging for the financial sector. As a CEO of a financial service company states, "the more challenging […] the more market opportunities there are. And market chances are always better than political risks. Therefore, the importance of financing today is highly standardized, tomorrow the importance will rise even more because it is no longer standardized" (INTVW 25 Financial Service Provider, 2016, para. 5).

#### 4.5.4 Change of Investment Periods

The duration of the investment in a wind park normally depends on the investment form and the intentions of an investor. The length of time for which the capital has to be committed, is therefore very much dependent on the investment strategy of an investor. The investment is limited by the life of a wind park and the used technique of the turbine.

Originally, most wind turbines were designed for 20 years. Since the turbines cannot be operated without certifications, the turbines were only certified for 20 years. This corresponds to the standards defined by the IEC and the DIBt as the lower limit for the certification of wind turbines (Watter, 2011, p. 70). However, since there are still wind turbines that have been in operation since 1970, it can be assumed that a lifetime of 30 years is also realistic (Jacobson, 2009, p. 154). An extension of the certification would change a lot. So, the manufacturer Enercon has announced that "[w]hile several manufacturers now claim an extended 25-year design life for their turbines, the EP4 is thought to be the first wind turbine platform specifically developed to last for 30 years. […] [T]his is an essential step in changing project financing conditions, especially as it allows asset depreciation to be spread over ten more years, driving down the lifecycle-based cost of energy“ (Windpower Monthly, 2014).

This technical limitation also limits the investment periods. A further limitation of investment in wind parks is defined at the political level. According to the EEG, the turbine gets paid from the first time the turbine feeds into the grid. This fee is paid for the duration of 20 calendar years plus the year of commissioning (§ 21 EEG 2014).

Based on these limitations, there are various ways in which wind park operators, investors or financiers can participate in a wind park. These include participation rights, investment funds and direct shareholding. These different financial products are interesting for different investors with different capital sums. Therefore, different investment periods are also given for these different forms of participation. Due to various scandals, insolvency proceedings and poor publicity, there are almost no participation rights to acquire on the German market. Suppliers who issued participation rights were, for example, the project developer Prokon and Windwärts (Own survey). As a rule, these participation rights had a term of at least 5 years (Own survey). However, due to a missing meaningful whole statistical population of products for participation rights, no reliable statements can be made about changes in the investment period or frequency distributions of participation rights over time.

The analysis of investment periods for investment funds is different. The database of the company eFonds Solution was used to analyze the investment periods. The database administrates a total of 700,000 participations in 7,500 funds with EUR 21 billion in equity for suppliers and intermediaries. From this database, a total of 629 funds which were invested in wind parks were identified. Of these 629 funds, 355 funds were able to determine both the issuing year and the projected investment period. The oldest fund with a projected investment duration was issued in 1995 and the most recent in 2016.

The results of this analysis of the projected investment duration are shown in figure 38. According to the results, the minimum duration is 3 years and the longest duration was projected for 30 years. The figure shows that 118 funds, which corresponds to more than 33 % of all funds, projected an investment period of 20 years. This is corroborated by interviews, which indicate a general investment period of 20 years (INTVW 01 Investor, 2015, para. 9). 58 funds, which corresponds to a share of more than 15% of all funds analyzed, indicate a period of 25 years. These two periods stand out particularly.

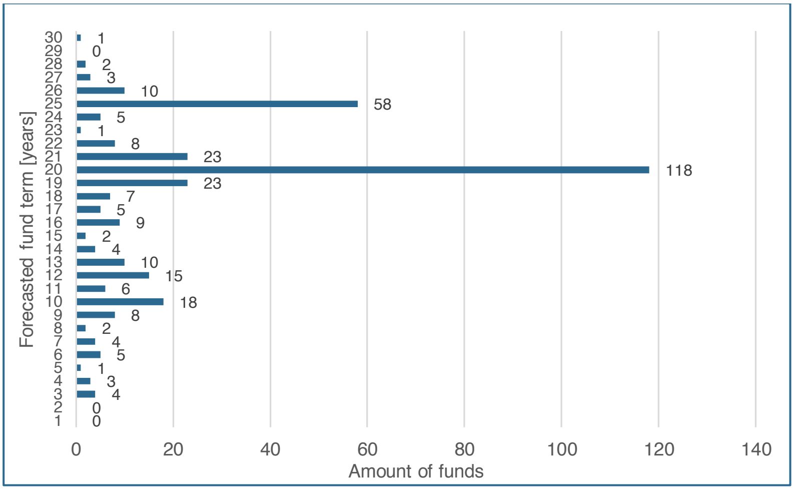


**Figure 38: Forecast fund term and frequency (Own calculation based on eFonds Solutions 2016)**

Since the relatively long investment period does not support the thesis of financialization, where short-term investments are made and speculation is carried out, a correlation must be made between date of fund emission and its forecast fund term, as illustrated in figure 39.

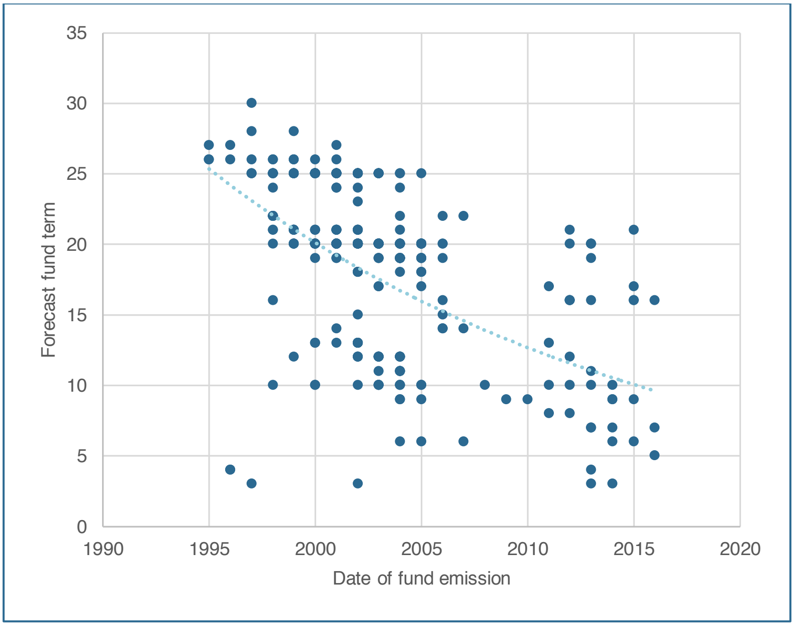


**Figure 39: Correlation between date of fund emission and its forecast fund term (Own calculation based on eFonds Solutions 2016)**

Other frequent periods are 10, 12, 13, 19, 21 and 26 years. As described above, the older wind turbines are only certified for 20 years and the feed-in tariff is only paid for 20 years. This is the reason why the most common projected investment period is 20 years. Interestingly, there is a relatively large proportion of funds that plan to operate the wind park over this period. If the period is extended to 21 years, which covers the 20-year operating period plus the year of commissioning which also remunerated, however, almost 28% remain with a longer investment period than 20 years. An operation of more than 20 years is accompanied by considerable expenditures, such as annual reports and renewals of electricity supply contracts. One reason for these longer prognoses may be that by extending the investment period, the economic viability of a park can be better represented. So, the longer one runs the investment, the higher the IRR. At the latest from the 20th year onwards, the investment is completely free from loan capital and thus is fully paid off. Thus, every subsequent year represents pure profit for investors, less the operating costs for the plant. This naturally increases the return on equity substantially.

On the basis of this different investment periods, a classification of the years in which the investment duration was projected provides a better understanding. Therefore, for each of the 355 funds, the date of the fund emission of each fund was correlated with its forecast fund duration. Figure 39 shows a data point for each year and investment duration. The frequency of how often this combination occurs is omitted in the figure in favor of clarity. As can be seen, a trend emerges. The earlier the funds were issued, the longer their fund duration was forecasted. The later the investment year, the shorter the investment period. This supports the hypothesis of intensified financialization processes, in which short-term investments are made. The year 1997 represents an extreme example, in which a term of 30 years was stated in a fund. The figure also shows that from 2005 no fund had predicted a term of 25 years. As of 2007, funds have only a maximum duration of 20 and 21 years.

Although there is a market to buy projects only to sell them again shortly thereafter, usually an investor is invested in a wind park for a longer period. According to a German fund manager "there are projects, which are held for a specific period of time, 7 to 10 years, to give them to the secondary market". Utilities would like to "basically hold the investment for the duration of 15 to 20 years" (INTVW 05 Fund Manager, 2015, para. 37). The reason for these long investment times is the fact that wind parks are seen as an addition to fixed-time investments. “Institutional investors, insurances, pension funds […] want to operate in the long term, basically like an interest real estate. Like 20 years and longer. […] Now there are some that may even operate even longer […]” (INTVW 23 Financial Service Provider, 2016, para. 11).

In figure 39 (p. 238) it is also clear that, from 2010, the large part of funds has a duration of 15 or less years. It can therefore be said in summary that there is a trend for the duration of wind energy fund to shorten over time. The wind parks are not reduced after these periods, but the investors and investors are paid out and the wind park is liquidated by a sale to another investor or operator.

The final form of participation is the direct participation in a wind park. This can happen as an investor or as a participation in a citizen wind park. Both forms of participation are basically designed for the entire operating period of a wind turbine, more precisely for 20 years. The shares of the wind parks can also be sold and thus the investment horizon can be shortened. With a few shareholders, however, a sale is simpler than a citizen wind park with more than 100 shareholders.

### 4.5.5 Expected Return on Investment

In the previous chapter 4.4 (p. 205) it was explained how wind energy projects are evaluated. It was shown which CAPEX and which OPEX are required by an investor who wishes to invest in a wind energy project. This assessment is very important for an investor's return and risk assessment. In order to estimate the relationship between risk and return, the return on a project must be calculated. This is done by calculating the Internal Rate of Return (IRR). For this calculation, however, investment totals must be counted against distributions that are paid out over 20 years. The calculation of the IRR is a complicated procedure, since an investment in wind energy projects results in irregular and fluctuating returns. The income fluctuates on the one hand due to unsteady wind conditions, but on the other hand also due to tax depreciation of the turbine and interest and repayment. Therefore, a theoretical average annual return must be calculated.

Figure 40 (p. 241) shows a payout for a wind park built in 2015. The bars in the diagram show the planned annual distributions at the wind park over a period of 20 years, based on the 20-year payment according to the EEG. The line is the accumulated dividend resulting from the annual distributions and thus increases every year. The initial investment costs of the wind park are made by the investor. The total equity is then tied up in the wind park. This corresponds to 100 % of its capital employed in year 0 of figure 40.

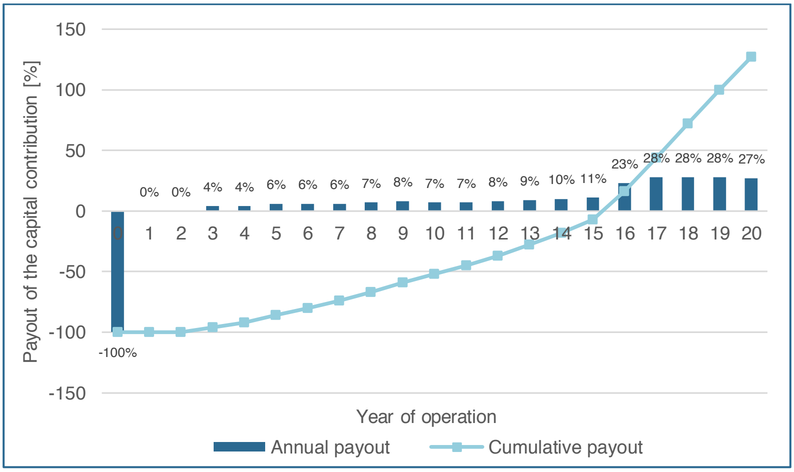


**Figure 40: Trend in percentage of a wind park's capital contribution (Own calculation)**

In the first two years of operation, the reserve is established for the bank. The debt service paid to the bank consists of repayment and interest. In addition, the credit is already being repaid in the first few years. Therefore, no distributions are made to the investor in the first two years. It is clear that the distributions in the first 15 years grow slowly and steadily. This is due to the fact that each year the debts become less and thus the interest rate of the loan decreases over the years. During the repayment period of approximately 15 years, annual distributions from year 3 onwards are between 4 % and 11 % of the paid-in capital. From the 16th year of operation, the credit is fully repaid. It can be seen that from this point onwards, the distributions are significantly higher. Over the period of operation, a projected equity distribution of 227 % including repayment of the capital employed can be achieved in this example. This is cumulated in the line which is illustrated in figure 40.

As a result of this projected equity distribution, an initial indication of an investor's return is already given. In order to be able to compare different projects, the IRR calculates the income and distributions calculated above. The advantage is that this method of calculation offers the investor a very good comparison, which can also be used in other investment sectors besides the wind industry. This method can be used to compare

the return on equity of wind parks with investments in other energy supply projects, real estate, ship bonds or interest on the capital market.
This comparability is achieved by setting the Net Present Value (NPV) of an investment or financing equal to zero[77] in the calculation of the IRR. Thus, the interest rate at which the payout cash value and the cash value of an investment or financing are equal. The payment flows are discounted. It thus expresses the average interest on the capital committed in an investment object. The calculation is then usually carried out by means of an interpolation method. It should be noted, however, that this method assumes that all capital returns can be reinvested with the internal interest rate. Whether this is a realistic situation in reality cannot be verified. However, this seems very unrealistic, because it needs a second investment project with the same IRR which can be used to invest the surplus payments from the first project.
In the investment calculation of the wind park calculated above, due to the IRR calculation the project has a return on equity of 6.01 %. This return is a realistic value for a medium-sized wind park with average wind conditions in Germany.
The return on equity required by investors is dependent on the project-specific risk. If the default risk is higher, the investor also requests a higher IRR. In order to keep the cost of capital low, because the costs also affect the IRR, the highest possible proportion of beneficial debt is an advantage. This share, however, is also limited by the aforementioned risk. The higher the bank considers the default risk, the less loan the bank makes available to the investor.
Since the electricity has to be bought at a known price, the risks associated with wind energy projects are manageable. Compared to other investment opportunities, this leads to relatively high investment security in wind energy projects. As a result, investors are satisfied with relatively lower interest rates between 6 - 8 % per year. These are clearly below the conventional IRR requirement of 10 - 15 % per year. Thus capital costs

[77] The interest rate r is searched, where the net present value (NPV) is equal to 0. The investment I is compared with the sum of all discounted cash flows (payments) $C_n$ at points in time N. In order to solve the equation and to determine the rate of interest r, one usually uses an interpolation method: $NPV = -I + \sum_{n=1}^{N} \frac{C_n}{(1+r)^n} = 0$.

can be kept relatively low despite the high investment (DLR, IWES, und IFNE 2012, p. 262).
In Germany, expectations on the return are around 6 - 8 % on the investor's equity. In this case, however, a KfW bank financing of approximately 2 % is generally still required. The total return on capital of the whole project is thus more or less 3 - 4 % (INTVW 01 Investor, 2015, para. 17). These figures also show the enormous effect that financing can have on an investor's return.
In contrast to private investors, investment funds have slightly lower return expectations. Funds are created and have an expectation of around 4 % on the capital invested (INTVW 05 Fund Manager, 2015, para. 45). It has to be mentioned that funds projects are also leveraged by a loan financing. It can thus be assumed that the total return on capital of the projects is below the above figures.
The situation is different in the case of public utilities or electric utilities. Electric utilities often have a return on investment of 8, 10 or 12 % (INTVW 26 Manufacturer, 2016, para. 13). Often there is a minimum return on investment of 10 % for public utilities. Nevertheless, public utilities follow the general trend and also distance themselves from these investment requirements (INTVW 11 Utility, 2016, para. 23).
The interviews show that in general, the expectation of a return in the German wind energy market onshore has been steadily declining by all parties involved (INTVW 04 Broker, 2015, para. 19, INTVW 18 Lawyer, 2016, para. 57, INTVW 22 Investor, 2016, para. 27). As a result, many windy projects are also offered and bought at the wind energy market, which generate a lower return through lower wind conditions. These projects not only have a lower return but also contain considerably more risks due to their lower wind conditions. As a result of falling yields, financial service providers have the possibility to create more risky products and bonds, which would support financialization processes. The declining expectations of return are caused "by the current investment pressure, by low interest rates, up to negative interest rates. Some insurers are in a situation where capital is released which would normally have flowed into other forms of investment. At the moment, however, the market is so difficult that it is often more about maintaining the capi-

tal than about increasing it" (INTVW 19 Financial Service Provider, 2016, para. 29). This implies that the ratio of risk to return becomes less favorable (INTVW 05 Fund Manager, 2015, para. 14).

## 4.6 Structural Change of the Wind Industry

### 4.6.1 Professionalization and Change of Commodity Chain Actors

Commodity chains are not a constant construct that remains unchanged, they can change over time. This can be determined by two features. On the one hand, the actors in the commodity chain can change, and on the other hand, the share of the actor's added value of a product can change. These two aspects of the change are to be analyzed in the following on the commodity chain of the wind industry in Germany.

Figure 41 (p. 245) shows an example of possible stakeholders involved in a wind energy project in in different phases of the German wind industry. The table clearly shows that the number of players has increased significantly over the years. In the pioneering phase, the landowner himself submitted an application for the installation of a wind turbine on his land to the authority. Bank financing was already possible at this time, but the number of banks that financed wind energy projects was rare. With the financing of the banks, the land owner was able to order the turbine from the wind turbine manufacturer and to build it on his land. Usually, the land owner also operated the WTG himself after commissioning and also often maintained it himself. The table makes it clear that the value added share was distributed to very few stakeholders. The manufacturer had the largest value added share. The second largest share of the value added belonged to the landowner, since he held many positions that are now owned by different actors. If a bank financing was also part of a project, the bank would have the small value added share, if at all. The governance in this chain was divided between the manufacturer and the landowner because they were the only significant actors in the commodity chain. In this case, the landowner was responsible for the management of the project, which was, however, limited by the knowledge of the landowner. The landowner was free to decide which manufacturer he used. Depending on the knowledge about wind energy, technology and planning, however, the landowner was dependent on the manufacturer's work. Already in these early years of the wind industry, for example, the manufacturer Enercon provided the landowner with all planning documents and documents for the submission of a permit. This full-service package from Enercon was at this time the greatest success driver.

However, the manufacturer also had a massive power position since he was able to decide on the economic viability of a project, as the turbine price played a decisive role and the competition between the manufacturers was not yet very strong.

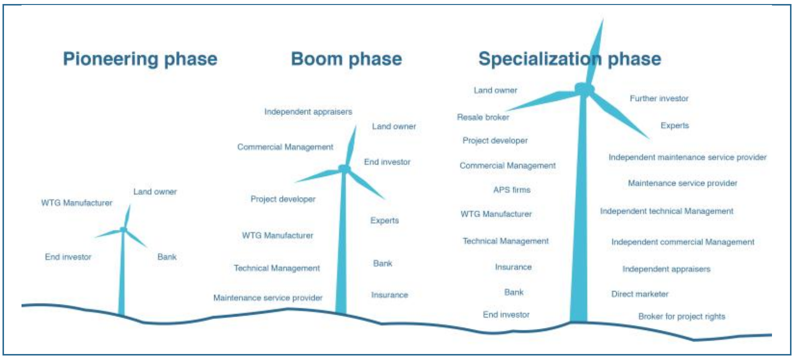


**Figure 41: Change of actors in the wind energy commodity chain (Own illustration)**

Figure 41 shows a metaphorical increase of commodity chain actors. In the boom phase, there were more and more project developers who specialized exclusively in the planning and approval of wind energy projects. This was driven by the continuous professionalization of the industry (INTVW 05 Fund Manager, 2015, para. 55; INTVW 04 Broker, 2015, para. 15) and the more complex turbine approval processes (INTVW 05 Fund Manager, 2015, para. 39). The manufacturers focused less on the approval and planning of the plants, but more on the further development and sale and distribution of their products. The landowner could no longer meet the complex requirements of the approval authorities. This new vacuum was filled by the project developers. In addition, an increasing number of experts had to be commissioned, for example, for wind surveys, nature conservation or stability assessments, which were also required by the authorities, but above all were required by the banks. Wind surveys in particular, have always been given a more important position by banks, as this has been the focus of economic and risk assessment. The maintenance of the facilities has also been professionalized. The turbines had already achieved such technical complexity during these years that maintenance could only be carried out by specialists and technicians. This maintenance was usually offered directly by the manufacturer and became a significant secondary service for the wind turbine manufacturer. As a result of these complexities, a completely new branch of independent consultants has emerged. Investors and banks also increasingly demanded expert opinions to submit claims to the manufacturers. The governance structure had also changed during the project. Due to rising complexity of the projects and an increasing capital demand, the landowner was pushed further aside by the project developers in the governance order. The landowner was less and less entitled to a co-ordination role and was ultimately only responsible for providing the necessary land. The wind turbine manufacturer also had a leading position during this time and was able to benefit from the bank's requirements that these maintenance contracts prescribed. The wind turbine manufacturers were thus able to bind the maintenance contracts to the delivery contract. Technical and commercial management as well as the conclusion of various insurance policies were also the responsibility of the bank. Here, the project developers were able to occupy controlling functions, since the technical and commercial management remained mostly in the hands of the project developers due to their specialization, experience and deep project knowledge in this area. The end-investors also experienced structural shifts. The circle of investors who were interested in wind energy projects changed extremely. These changes[78] in the investor circle changed fundamentally over the years.

As shown in figure 41 (p. 245), in the specialization phase further actors were added to the already complex commodity chain. This increase was

[78] This change and its consequences is explained further in chapter 4.6.2 (p. 210). The wind park owner structure in Germany is analyzed and it is shown how this has shifted over the years.

a result of the progressive professionalization of the wind energy sector, changes in the political framework and the desire to transform wind energy into a free market economy (INTVW 15 Maintenance Service Provider, 2016, para. 25). One such change was the introduction of direct marketing for the electricity produced by wind parks. Direct marketing was introduced on a free-wave basis in the EEG 2009 (§ 17 EEG 2009). Since the EEG 2014, an obligatory direct marketing was introduced for all new WTG. This led to an increasing number of direct marketers entering the German electricity market from 2009 to market the electricity produced by the WTG at the electricity exchange. A part of the value added therefore went to the direct marketers, who are remunerated for each produced kWh.

In addition, there was an increase in the number of service providers, both in maintenance service and in technical and commercial management, which led to competitive pressure. On the one hand, this competitive pressure resulted in a drop in prices for these services. This has reduced the value added by the service providers. On the other hand, the emergence of the independent service providers has weakened the governance position of the project developers and the WTG manufacturers. This weakening will lead to a consolidation in the market (INTVW 20 Consultant, 2016, para. 25). The first signs have already been seen in the takeover of Availon (INTVW 21 Service Provider Direct Marketer, 2016, para. 5), an independent service provider of Vestas WTG, by the wind turbine manufacturer Vestas in 2016. According to a former CEO of a manufacturer, the consolidation of manufacturers can be explained by the fact, "that the industry has become more mature, that the demands of the investors have grown, and that, on the other hand, there is the emergence of the strong Chinese, Korean manufacturers and then a completely different global competitive pressure, which did not exist before like this" (INTVW 24 Manufacturer, 2016, para. 38).

The trade of project rights, turnkey projects and existing projects has also gained tremendous importance in recent years. The demand for projects has risen sharply due to an overaccumulation of capital in the wind energy sector. Due to the increasingly difficult and increasingly long-term permit processes of wind energy projects, this demand can no longer be met. In this context, brokers have become increasingly important. Trading projects has become a separate business. The brokers can sit in the commodity chain in various positions when the project is in different phases. On the one hand, a broker can have secured areas or permits or entire turnkey projects, at the front of the commodity chain. On the other hand, the broker can trade and sale projects which are already running, and is therefore at the end of the commodity chain.

As a result of this increasing trading, the value added is increasingly distributed among the actors who are directly connected with trading and sales of projects. The broker is the first to be mentioned here. But with every purchase and sale, a wind energy project is usually also examined. This demands APS (INTVW 04 Broker, 2015, para. 15). Subjective perceptions determine that there are more and more APS firms offering their services in the wind industry. “These are often made up of industry experts and people from the financial sector who have found their gap in the area in order to offer consulting services that are increasingly needed” (INTVW 19 Financial Service Provider, 2016, para. 80).

During the process of selling a wind park, a due diligence has to be carried out both on the legal side and on the technical side. APS firms examine whether the project company has all the rights and contracts to operate independently the WTG or the whole wind park and can supply the produced electricity into the grid. Contracts with the landowners, service contracts with the service providers and grid connection contracts, for example, must be examined by attorneys and law firms. “As a rule, large-scale law firms are more likely be involved in such transactions. This is because the expertise and a certain manpower to perform such due diligence is there” (INTVW 18 Lawyer, 2016, para. 3).

On-site technical inspection is also important to check the condition of the installation. Independent consultancy firms are commissioned to assess the technical condition of the turbine with all its components. This is dependent on which service contracts conditions the wind turbine is operated. If a full maintenance contract is available, visible defects can be flagged up by the service provider and must be remedied by the OEM. If the wind turbine is only under a partial maintenance contract, the buyer and the seller of the WTG must agree on the price. Either the seller remedies the visual defects before the sale at their own expense, or the purchase price of the WTG is adjusted. Further consultants will evaluate and examine the project for additional factors. For example, they conduct assessments of a possible expansion of the wind park, the impact of possible shutdowns on load utilization or ice-shutdown control, and they provide information on the expected yields.

Of course, this change also affects governance. Because ultimately, the investor does not make his purchasing decision, but relies on his advanced producer service providers, such as law firms, corporate consultants, consultancy firms or financial institutions.

### 4.6.2 Conversion of Operator Structures

If the change in the proportions of the value chain is considered, the focus must also be directed to the operators of wind farms. After all, the value does not end at the sale of a wind park to an operator or investor, but the operator usually obtains an annual return of the wind park in general for more than 20 years. This chapter will therefore analyze who owns the wind parks, which actors operate the wind parks and whether there have been changes in the operational structure.

In 2011, the Klaus Novy Institute published a study which was based on numbers from the Institute for Trend and Market Research (trend:research). The study is an analysis of the market actors in the German renewable energy sector. The result shows which owners were present in the wind energy sector at the end of 2010 and the percentage of wind energy capacity they own (KNi, 2011, p. 2). The data was created using a trend:research database, completed with field research and reviewed through discussions on plausibility. This database was further developed by trend:research and a current status of the ownership structure of 2012 was published in 2014.

Figure 42 (p. 250) shows this ownership structure for the latest available data at the time of 2012. The units do not refer to individual wind turbines, but to each installed MW. In an analysis based on the number of wind parks or individual wind turbines, the structure would differ slightly since newly constructed WTG have greater capacity than before. Today a single WTG can have a capacity of 3, 5 or even 7 MW, whereas most WTG had less than 1 MW in the 1990s.

Figure 42 shows clearly that 48.1 % – almost half – of already existing wind parks are operated by private individuals. The low investment costs at the beginning of the growth of the wind industry and also the single WTG or small wind parks particularly led to an increase of the number of these private persons. Also, the possibility to participate in a so-called Bürgerwindpark[79] (German for: citizens' wind park), which became very common and are accepted as a popular model in Northern Germany, plays an important role for increasing the share of private individuals. A Bürgerwindpark can comprise between 200 and 300 limited partners (INTVW 12 Technical and Commercial Management, 2016, para. 9).

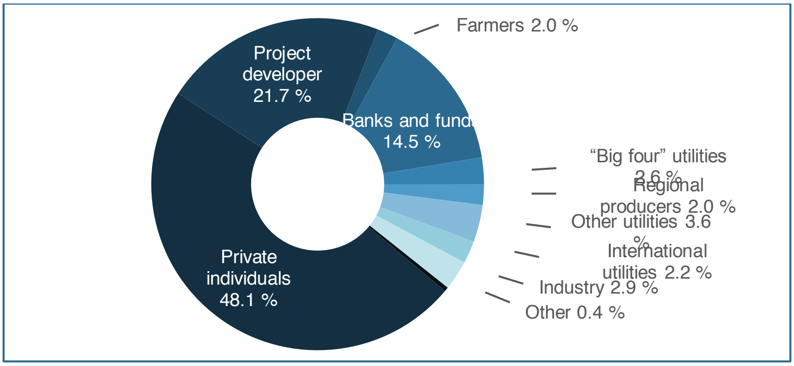


**Figure 42: Owner structure of onshore wind energy projects in Germany 2012 (Own illustration based on neue energie, 2014)**

For example, more than 90 % of the wind parks in North Friesland are realized as a so-called Bürgerwindpark, where citizens are directly financially and organizationally involved. In this way, the citizens benefit as residents and also from the profits. This participation increases the acceptance of the wind turbines. Furthermore, since the energy coopera-

[79] The term Bürgerwindpark refers to wind farm projects in which the local population will be offered a stake in the project. One goal is to help people who live near the wind farms to offer an attractive investment. The wind farm is financed by the citizens and is also operated by them.

tives are also locally embedded, they provide value added in the region because they pay taxes to the municipality, generate jobs for local construction and building and they work with regional banks and local savings banks. In this respect, the principle of cooperative energy contributes to a decentralized energy system, but also provides impulses for a community-based regional economic development (AEE, 2014, p. 4).

This evidence supports the idea that the turnaround in energy policy, especially in onshore wind energy, is promoted and supported by private individuals. The second largest share of wind parks is operated by project developers, with 21.7 %. This is not surprising since it is the core business of project developers to plan and to develop wind parks and operate them.

The third largest share of wind parks is operated by banks and funds, so these actors can be attributed to the financial sector. In 2012 14.5 % of wind parks were operated by banks and funds. This high percentage is initially surprising, since it is actually not a core business of a bank or a fund to participate in wind parks and to operate them. This high level of 14.5 % supports the hypothesis that the actors from the financial economy play an important role in the structures of owners and investors of wind parks.

Together, the three major groups of actors have a total share of 84.3 %. Other groups of actors are energy supply companies with 3.6 %, commercial trade and industry with 2.9 %, the big four energy suppliers in Germany (EnBW, E.ON, RWE and Vattenfall) have a share of 2.6 %, international energy supply companies hold 2.2 %, farmers have 2.0 %, operated regional producers represent 2.0 % and 0.4 % of all German wind parks are operated by others. It should be noted that many interviewees see the four energy suppliers as the losers of the energy revolutions, having somewhat missed the boat of wind energy (INTVW 25 Financial Service Provider, 2016, para. 39; INTVW 16 Bank, 2016, para. 41; INTVW 15 Maintenance Service Provider, 2016, para. 19; INTVW 26 Manufacturer, 2016, para. 11; INTVW 01 Investor, 2015, para. 125).

After this inventory survey from 2012, it is now necessary to understand the development process of the owner structure of German wind parks.

To get a better and more detailed comprehension of this development the data from trend:research was also considered, as shown in figure 43.

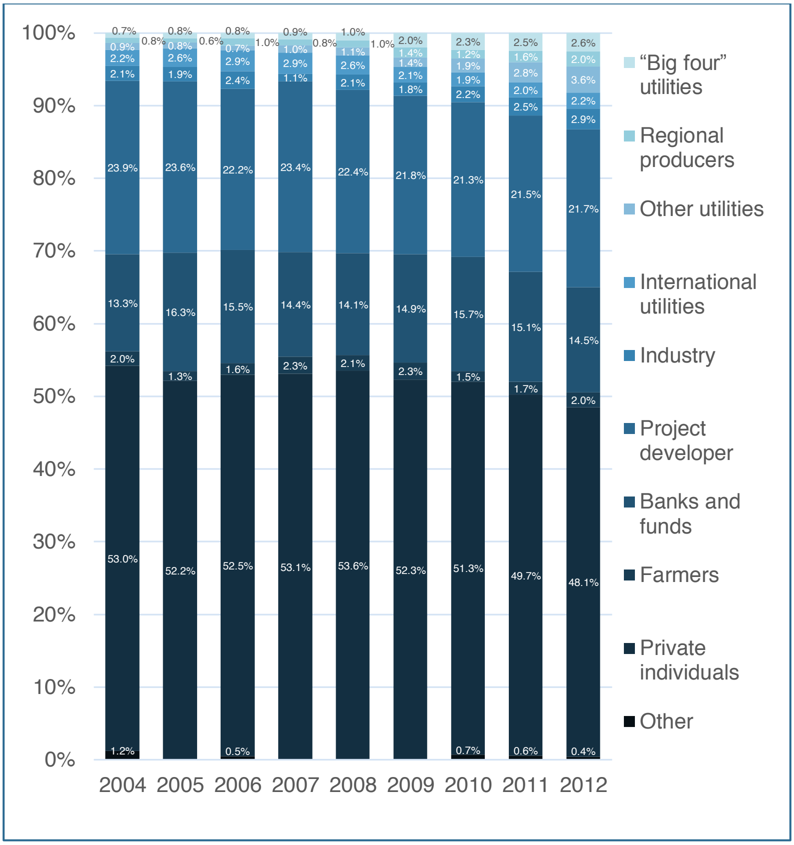


**Figure 43: Trend of wind energy owner structure 2004 – 2012 (Own calculation based on KNi 2011; wind:research, 2014)**

The development and change of the owner structure can be tracked on the basis of data from 2004 to 2012. In this time period, the cumulative construction of installed power capacity rose from about 16,000 MW in 2004 to about 30,000 MW in 2012. For a better analysis of the change and shift of the individual groups of actors, the absolute values have been converted. So, in the whole-time period between 2004 and 2012, each year represents 100 % of the total cumulative installed capacity of wind energy. Thus, the change of the share of the wind park owners may be expressed as a percentage based on the total amount.

As figure 43 (p. 252) shows, the largest share of the German onshore wind parks is owned by private individuals. The proportion has fluctuated slightly in the period from 2004 to 2012[80]. Nevertheless, the share has slightly decreased from around 53 % to 48.1 % in the period from 2004 until 2012. The share of project developers has also slightly fluctuated during the same period and was 21.7 % at the end of 2012, which corresponds to a loss of slightly more than two percentage points since 2004. As already mentioned, the third largest share of wind park owners is the financial sector, which consists of funds and banks. In contrast to the private individuals and project developers, whose share declined between 2004 and 2012, bank and fund ownership of German onshore wind farms has risen.

The share of banks and funds only increased very slightly in the period from 2004 - 2012 by about one percentage point to 14.5 %. Furthermore, it can be stated that the four large German utilities held a relatively insignificant proportion of 2.6 % of wind parks until the end of the 2000s. This is because for a long time, renewable energies and especially wind energy did not play a large or particularly crucial role in the strategic direction of the major energy utilities. Hence, the potential of wind energy in the German market was perhaps underestimated or was not recognized.

The slight increase of the financial sector in the actor structure of German wind parks cannot be cited as evidence of a financialization of the wind industry in the ownership structure. Therefore, it requires a highly selective approach. The numbers shown in the previous figure 43 (p. 252) are related to the total portfolio for each year. Because wind parks are operated over a long period, generally of 20 years, a statement on the development trend can be taken only conditionally. Therefore, a comparison is necessary, which compares the shares of the different groups of

[80] For 2011 no precise data is available. It is assumed that there are no major deviations from the previous and subsequent years. Therefore, the data for 2011 was averaged for a better overview of the years 2010 and 2012.

actors of the total portfolio of a year with the share of the different groups of actors of the newly installed capacity of the same year.

The comparison of this shift is shown in figure 44 (p. 254). For this, the data from trend:research from 2010[81] was used. In the comparison, the different shares of actors of the entire capacity which had been installed by 2010 are listed. The total installed capacity was about 27,214 MW. The owner structure of the new installed capacity in 2010 was compared to this. The total capacity of the new installed wind parks accounted for 1,443 MW.

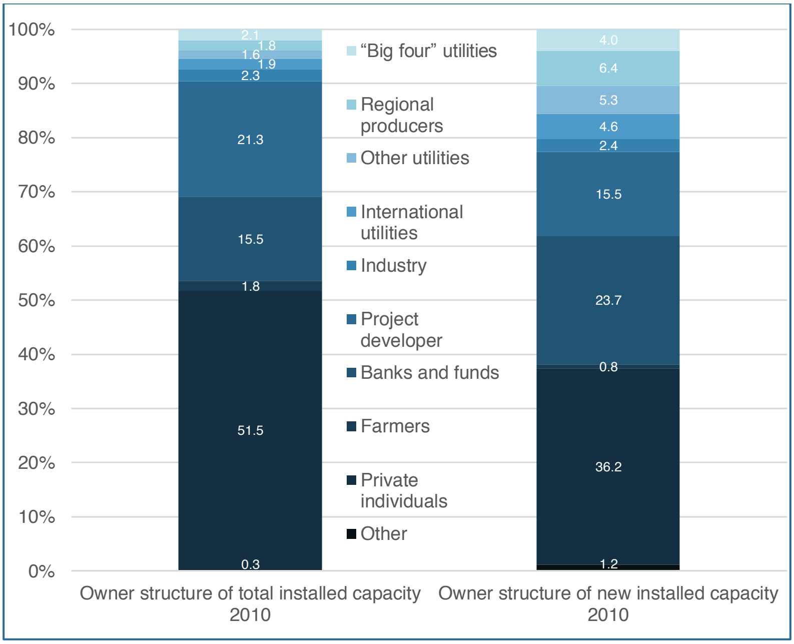


**Figure 44: Development of wind park owner structure in Germany in 2010 (Own compilation based on KNi, 2011, cf. Klagge and Anz, 2014)**

The figure 44 shows a different picture of the ownership and gives an indication of the direction in which the actor structures are evolving. It

[81] More recent data on the ownership of the new installed capacity of wind parks was not available.

can be seen that there are significant differences among the largest groups; the private individuals, the project developers and the funds and banks. The share of private ownership for the new installed capacity is much lower in relation to the total amount of installed capacity. Only 36.2 % newly installed wind parks in 2010 were owned by private individuals. A similar condition can be seen in the share of the project developers. Their share of new installed capacity in 2010 was only 15.5 %, although the share of total capacity accounts for 21.3 %. In contrast to these lower values, the share of the financial sector behaves differently. In the total capacity, banks and funds had a share of 15.5 %, but their share of new installed capacity accounted for 23.7 %. This increase in 2010 made the funds and banks the second largest group of wind park owners, surpassing project developers.

The financial sector's steadily growing share of German wind parks as well as the comparison of actual state of capacity and the new installed capacity, where the difference represents more than 8 percentage points, make clear that the financial sector does not play a subordinate role within the group of wind park operators. This argument reinforces further the hypothesis that the structure of owners and investors of wind parks is shifting from the real economy towards the financial economy. If this trend continuous in the following years, that the new installed capacity will have more or less the same ratio as the new installed capacity in 2010, this would change the ratio of the total installed capacity in the long term.

Ultimately, it must be noted that the ownership situation is constantly changing. Although the wind parks are designed for 20 years, the interviews show that the ownership structures change very frequently during the operating period of 20 years. A statement from a project manager of a utility describes the fact that a wind park's owner structure changes up to 10 times during the operating phase, particularly in the north of Germany (INTVW 11 Utility, 2016, para. 17). This would mean that every 2 years the wind park is sold and bought by a new investor. A bank has confirmed that the frequency of switching has increased compared to the beginnings of the wind industry (INTVW 16 Bank, 2016, para. 11, 15; INTVW 20 Consultant, 2016, para. 31). The operators change not only in

Germany but also across the whole of Europe (INTVW 16 Bank, 2016, para. 17). This means that there must be a network through which these projects are traded. When one considers that each transaction has to be structured and adjusted, financing must be optimized and a due diligence has to be carried out, it becomes clear that this offers significant business potential for the financial sector and its APS in the wind industry.

#### **4.6.3** Increase of Participation and Products

This chapter aims to analyze investment opportunities and financial products that are available in the context of the wind industry. It seeks to determine whether the number of financial products has increased over time and how these financial products are used. If such an increase in financial products can be proved, the hypothesis that a financialization of the wind energy commodity chain takes place can be strengthened, because an increase of financial products in a commodity chains has been defined as an indicator for financialization processes.

With regard to financial products and investment opportunities, there are two different target groups. Firstly, there are private individuals whose main business activities are not anchored in the wind industry. These private individuals see financial products as an investment with the possibility to diversify risks. For private individuals, investment opportunities in wind parks compete with other investment options such as real estate, ship investments or media funds (Stiftung Warentest, 2015, p. 43). The other target group consists of professionalized stakeholders in the wind energy commodity chain, whose core business is to work with wind energy. This group uses financial products for everyday business, for hedging or to improve their business. The focus in this section will be on financial products for private individuals.

As described above, the number of different forms of participation and thus financial products available for private investors for wind energy has increased. This shows that there is a clear interest among private individuals to participate financially in wind parks. This opened new opportunities and distribution options for financial service providers that offer such products and investments. The most common forms of participation in a wind park are through (1) profit participation rights, (2) in-

vestment funds and (3) direct investments. These different participation forms are further discussed in the following.
A (1) profit participation right is a profit-sharing paper, which guarantees the investor certain property rights. This right is certified in the form of registered securities or bearer instruments. If an investor is participating in a wind park by a profit participation right, the investor receives a fixed or variable interest rate on the net income of the company. But with participation rights the investor has no say in any of the decisions nor voting rights. Usually, the term is at least 5 years (Own survey). An investor summarizes in this context, "one builds up securities from which one takes debt financing to refinance wind parks. And that could then again be sold to other insurance companies, pension funds or family offices" (INTVW 01 Investor, 2015, para. 105).
The second form of participation is (2) investment funds. Within investment funds, one can distinguish between open-end and closed-end funds. Open-end funds are traded on the stock market and the investors can buy or sell their shares. Closed-end funds are subject to other regulations. The fund issuers collect a predetermined sum from the investors. Often there is a minimum contribution. The funds pool the money of many investors and, in this way, finance a planned or already existing wind turbine or a total wind park. Once a particular investment is achieved, the fund will be closed. In the event of the company going bankrupt, the investors may lose everything. In addition, the investor may withdraw from his shareholding during the term of its shares only with high losses through secondary markets. Depending on the provider, the duration of a wind fund varies, but usually the investment periods are between 5 and 10 years. As a CEO of financial service provider states, "today, we see in the wind industry, for example, that there are companies that offer shares for citizens outside a bank-dominated placement market. This is a one-to-one relationship between companies and subscribers of a stock without a bank […]. We will surely see such forms more frequently" (INTVW 25 Financial Service Provider, 2016, para. 33).
The third possibility of participation is a (3) direct investment in wind turbines. In this form, the investor provides capital and receives shares in the project company. Within this form, the investor becomes a co-owner

of the wind park. Thus, the investor benefits from rights and obligations which are specified in the articles of association. The investors who invest directly in a wind turbine or a wind park, usually invest a higher amount of capital and mostly commit for a period of at least 10 years. This form of participation is still very common. Nevertheless, the investor structure has changed significantly in this participation model. As a banker summarizes, “15 years or 10 years ago there were still these limited partnerships, where private individuals took part in a KG. This model was then canceled for tax reasons. And yes, now many parks already go to an investor just after the construction” (INTVW 16 Bank, 2016, para. 11).

After many investment scandals, including the collapse of the wind park developer and financer Prokon[82], a new law was passed by the federal government in Germany. The new German Capital Investment Act[83] (English for: Kapitalanlagegesetzbuch or KAGB) requires funds to register with the Federal Financial Supervisory Authority (English for: Bundesanstalt für Finanzdiensleistungsaufsicht or BaFin) (Möllers and Kloyer, 2013, p. 141). Since 2013, advertising such participation can only take place if the BaFin has approved the prospectus. Thus, the BaFin receives a wider supervisory mandate and is explicitly responsible for the protection of consumers' interests. This means that the BaFin can, if necessary, restrict the advertising of certain products or can even stop the distribution if a provider neglects legal rules or violates the Consumer Protection Act (Geurts and Schubert, 2014, p. 227).

The presence and volume of investments made in the energy sector, and specifically in wind energy, will be analyzed based on the example of the closed-end funds. From this analysis, conclusions can be drawn if processes of financialization take place.

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[82] The company Prokon collected approximately EUR 1.4 billion from investors by issuing profit participation rights and promised investment returns of more than 6 %. As too many investors wanted to withdraw their invested capital, Prokon got into financial difficulties because part of future expected profits had already been distributed in advance to the investors.

[83] The German Investment Act was passed by the German Bundestag on 16 May 2013, and came into force mainly on 22 July 2013. It replaces the Investment Act, whose regulations were incorporated into the KAGB and adds a number of new product rules and specifications.

The attractiveness of investment in wind energy and in renewable energies in general is shown in figure 45 (p. 259). According to the Federal Ministry of Economics, EUR 18.9 billion were invested in renewable energies in 2014. The largest investment of EUR 12.3 billion is assigned to wind energy. This amount corresponds to 65.1 % of the total investment volume in renewable energies, which reflects the huge investment interest in wind energy.
This shows that wind energy is the undisputed first choice of investment opportunities among renewable energies. It should be noted here that wind energy also stands in competition with other forms of electricity production. At the same time, policies have steadily withdrawn. As a result, the market for renewable energies must increasingly regulate itself through the market (INTVW 23 Financial Service Provider, 2016, para. 29).

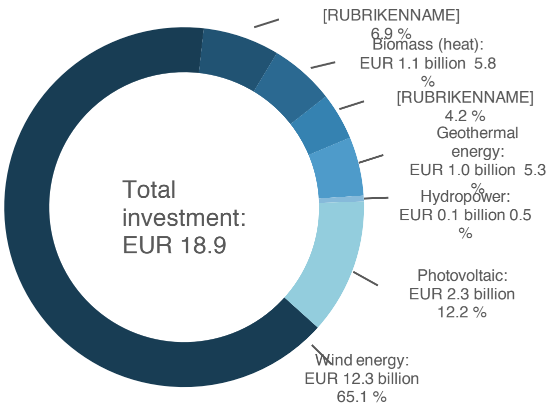


**Figure 45: Investments in renewable energies in 2014 by energy sources (Own illustration based on BMWi, 2015)**

Based on this finding, market and industry figures from the Association of closed-end funds have been collected and analyzed. The Association of Non-Tradable Closed-End Funds (English for: Verband Geschlossene Fonds e.V or VGF) became the Bundesverband Sachwerte und Investmentvermögen e.V in the year 2013. This includes, amongst others, real asset managers, depositaries, accountants, lawyers, tax consultants and evaluators. The asset managers organized within the association gather capital of private or professional investors mostly through alternative investment funds[84]. Investment targets are material assets such as real estate, airplanes, vessels and plants for renewable energies. The collated industry figures thus offer a very good basis for the analysis of changes in closed-end funds in the energy sector.

For the analysis, market and industry data for the period from 1999 to 2013 from various sources, published by the Association of Non-Tradable Closed-End Funds, was collected (bsi, 2014; VGF, 2013, 2012, 2011, 2010, 2009). Figure 46 (p. 261) shows the development of equity placements of funds in the energy sector as well as the loan capital. The time series clearly shows that energy funds experienced a rise in the early 2000s. In this first period energy funds reached a climax in 2001 with a total volume of EUR 1.4 billion. The ratio between equity and debt at this time was at 31:69. In this period energy funds had a share of around 8 % of the total investment volume which was placed by all funds within the Association of Non-Tradable Closed-End Funds.

Energy funds compete here with infrastructure funds, life insurance, aircraft funds, ship funds, real estate funds and leasing funds. In the second period from 2001 to 2007, fund volume decreased continuously. The lowest point of the volume of energy funds was achieved in 2007, which is due to the global economic crisis that emerged from 2007 onwards. In 2007, the energy funds had a volume of just EUR 411 million. The ratio between equity and debt at this time was 11:89, which is the lowest equity capital ratio within the period from 1999 to 2013. The ratio of energy funds to the total funds' investment volume in 2007 was also at the lowest point, representing 2.1 % of the total volume. This means that during the course of the financial crisis there were also relatively few energy funds in relation to the total fund volume. The decline can be explained by the deduction of capital from the financial sector during the financial crisis.

[84] Alternative investment funds or AIF are closed-end funds and are a form of long-term collective investment in material assets. Since July 22 2013, the regulations of the Investment Code (KAGB) also apply to these funds.

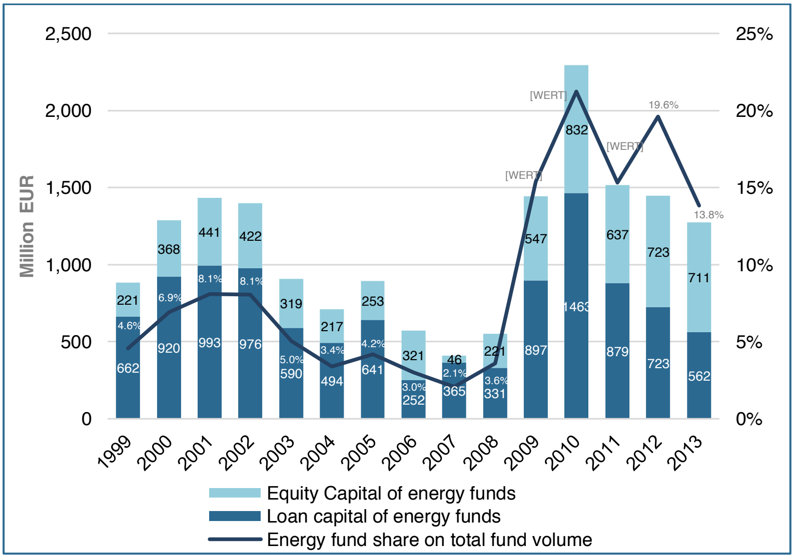


**Figure 46: Volume development of total investment funds and energy funds (Own calculation based on VGF, 2009, 2010, 2011, 2012, 2013; bsi, 2014)**

In the final period between 2007 and 2010, a sharp increase can be seen. The highlight was in 2010 with a total volume of nearly EUR 2.3 billion. The sharp rise after 2008 could be explained by the fact that the financial crisis of 2007 and 2008 caused many investors to take money out of the stock market and look for new investment opportunities (INTVW 11 Utility, 2016, para. 20). These new investment opportunities included renewable energies and financial service providers created new opportunities by, among other things, offering capital switching to their customers. At the same time, the share of energy funds rose sharply and reached a share of 21.3 % in 2010. The ratio between equity and debt in 2010 was 36:64. After 2010, the investment volume of energy funds fell again. In 2013, with less than EUR 1.3 billion, levels were below those of 2001. Nevertheless, two points have clearly been emphasized. On the one hand, the extremely low equity ratio has again increased and was 56 % higher than the loan capital in 2013. The second important factor is that although the volume of investment declined again, the share of energy funds' total investment volume with 13.8 % still plays a very important role. Thus, in 2013 energy funds take the second place of asset classes after real estate funds.

However, to make a precise estimate of the frequency, the interest and the actual participation of investment funds in wind parks, further research is needed. Therefore, the database of eFonds Solution was used for the analysis. The database administered a total of 700,000 participations in 7,500 funds with EUR 21 billion for providers and intermediaries.

From this database, 629 funds were identified which offer investments in wind energy. For 471 of these 629 financial products, the year of issue could be determined, which corresponds to nearly 75 %. The results of this research and analysis are shown in figure 47 and clearly show that since 1997 an enormous increase has occurred.

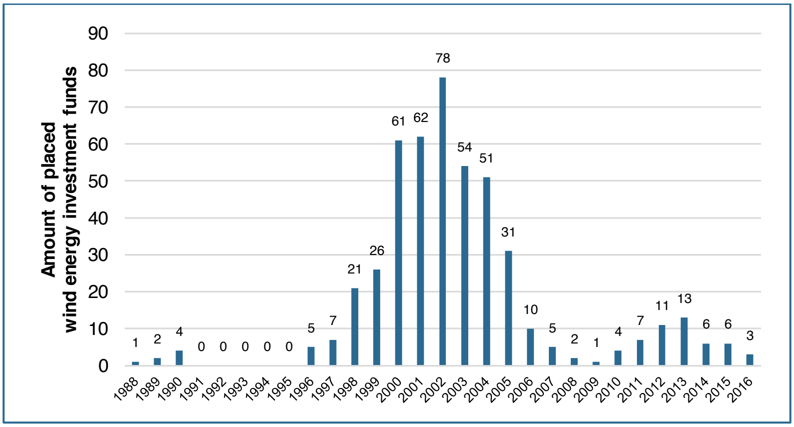


**Figure 47: Development of placed wind energy investment funds (Own calculation based on eFonds Solutions, 2016)**

In the years 1988 to 1995, only a total of seven wind energy funds was structured and offered. The peak of the wind energy funds took place a few years later in 2002. In 2002, a total of 78 wind energy funds was established. The boom in the number of wind energy funds was followed by a rapid decline in the period of the financial crisis. For example, only one single wind energy fund was placed in the market in 2009. There

was again a very slight increase in 2012 and 2013. However, in the following years from 2014 to 2016[85], a slight decrease can be determined.
A reason for the declining volume of energy funds since 2002 is that the expectations of returns and performance have not been met. This could be proven in a study focusing on 2015. In the study, a total of 1,139 funds was examined with a volume of around EUR 37 billion as of June 2015. Among them there were also green funds, which mainly operate wind parks. These results are shown in table 23.
All 49 investigated green funds failed to meet their forecasted expectations in this study. Of the 35 funds, which are still running and not liquidated, 43.6 % of the invested capital by the investors are in profit and 56.4 % are recording a loss.

**Table 23: Evaluation of green funds (Stiftung Warentest, 2015)**

| | Funds with forecasting and complete figures | | Share of the invested capital | | Fulfillment share of return forecast | | Total Result | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Private equity [EUR mill.] | Profit | Loss | Forecast met | Forecast not fulfilled | Prospected profit [EUR mill.] | Capital loss [EUR mill.] |
| **Green fund already liquidated** | 14 | 168 | 5.0 % | 95.0 % | 0.0 % | 100.0 % | 215 | -77 |
| **Green fund still running** | 35 | 1,066 | 43.6 % | 56,4 % | 0.0 % | 100.0 % | 1,444 | -217 |
| **Sum** | 49 | 1,234 | | | | | 1,659 | -294 |

The situation in the already liquidated 14 green funds is quite different. Here only 5.0 % of the capital invested recorded a profit and 95.0 % made a loss. Thus, green funds' predictions and expectations were not met at 100 %. The promised profit of EUR 1,669 million are faced with EUR 294 million losses. This means that for the private investors who operate wind parks, in most cases the return on equity expectations has not been reached with funds.
Despite underperformance, or even losses or bankruptcies of wind park funds, the financial service providers could benefit from placing the green funds. This is because usually private investors have to pay a processing fee or participation fee to the financial services providers for

[85] Data was collected until February 2016. Further possible placements of wind energy funds in 2016 were not considered.

structuring, managing and maintaining the funds. The fee for wind energy funds is approximately 5 % of the capital employed (Stiftung Warentest, 2015).
The numbers showed that in the commodity chain of the wind industry, it exists interest in financial products. This influence was favored by two factors. On the one hand, the confidence in German wind parks was very high. The secure policy framework provided investors with a secure investment with high returns. On the other hand, the investors had no confidence in stock markets due to the financial crisis and were looking for other investment opportunities. Thus, financial service providers have developed a whole new market field with products such as wind energy funds (INTVW 14 Bank, 2016, para. 61).
However, three aspects remain to be noted. (1) The peak period in which wind energy funds were placed by financial service providers was in the early 2000s and ended with the financial crisis. A financialization in this sector has therefore already taken place and had a brief revival from 2010 to 2013. However, the share of wind energy funds in the total volume of investment funds (2) has risen steadily and is now, after the real estate sector, the second largest asset class in this area. The (3) decrease of placed wind energy funds can be fed back in part to the underperformance of structured funds.
Another product which has been established by the financial sector in the wind industry, is similar to the multi-layered structured credit products described in chapter 2.2.3 (p. 57). Similar to the real estate products, different wind parks are linked by corporate structures in such a way that the different wind parks form a uniform product. Each wind park performs differently and is exposed to different risks. The reason for establishing such a product is to spread risks and probably make resale of poorly operating wind parks possible. Interview partners have confirmed that this model is also implemented in reality (INTVW 23 Financial Service Provider, 2016, para. 29).
The bundling of different wind parks in a single company can also be carried out, as so-called YieldCo. YieldCos are established companies with the purpose of generating a steady cash flow. These YieldCos work similarly to Real Estate Investment Trusts (REIT). In the wind industry,

YieldCos purchase wind parks in a turnkey state. This means that the YieldCos do not carry any development risks but only the operational risk of the wind parks. These companies are financed by issuing shares. These are freely tradable on the stock market. Large YieldCos in the wind industry are, for example, ABO Invest AG, with a market capitalization of EUR 76.04 million and Captial Stage AG[86], with a market capitalization of EUR 808.53 million (as of February 2017). According to a former CEO from this market segment, the business model of YieldCos in the wind business is rather difficult. Therefore, there have also been several failures of YieldCos in the German market (INTVW 23 Financial Service Provider, 2016, para. 45). In general, it can be said that the above-mentioned products also increase the tolerance to take more risks (INTVW 14 Bank, 2016, para. 75). Thus, the increasing risk tolerance and the professionalization in the segment of financial products are indicators for financialization processes.

### 4.6.4 Shift of Production and Trade

As described in the previous chapter, the financial sector has created financial products for professional actors in the commodity chain of wind energy and also for private individuals. Professional commodity chain stakeholders of wind energy are defined as stakeholders whose main task is to work with wind and who are located very closely to the production-, buying-, selling- and trading processes of wind energy. This group uses financial products for hedging or improving everyday business. The financial products which have been designed for professional use by the financial sector will be analyzed below.

In Germany, electricity is traded on the European Energy Exchange or EEX in Leipzig. An energy exchange is an organized market where electricity can be traded. The operation of EEX is similar to stock exchanges. This means that supply and demand of electricity are brought together. By standardized products, trading can be easily controlled, whereby the transaction costs decrease. The EEX is a stock exchange under public law and therefore subject to the German Stock Exchange Act. At the

[86] Capital Stage AG will be described in more detail in chapter 4.7.1 (p. 231)

EEX electricity, natural gas, coal and oil are traded as well as environmental products, cargo rates, metals and agricultural products. In 2015 at the EEX there were 424 trading partners from 33 different countries (EEX, 2015a).
Since the liberalization of the electricity market, electricity producers are exposed to volume and price risks. At the EEX, the producer may attempt to hedge these risks. In Germany, direct marketing has been obligatory for all wind park operators since 2014 (§ 19 EEG 2014). This means that the operator of a wind park has to sell the produced electricity, either directly to a bulk purchaser or on the power exchange. Usually a direct marketer assumes this sales process. At the EEX electricity from wind energy and other renewable sources is traded as an equal to conventional electricity and is sold for the same market price.
A distinction must be made between two differently functioning markets on the electricity exchange. There is the spot market and the futures market. On the futures market, the electricity is traded for the coming years, which means that an electricity producer can sell electricity at a known price today, but which the producer will produce only in the future. Therefore, the transaction is fulfilled physically and financially at a later time. Thus, trading partners can hedge against price risks up to six years in advance on the EEX. The advantage for electricity producers to sell electricity on the futures market is that the electricity producer can secure the sale of an already known quantity of electricity at a known rate, which implies planning security. For buyers such as large electric utilities, the advantage is that they can buy certain quantities at a fixed price and can pass on this price plus its margin to their end customer with a margin for the electric utility (Borchert et al., 2006). Regarding the futures market, as an electricity trader summarized, “the big money is earned by derivatives, all with a delivery period of at least one month or longer” (INTVW 10 Electricity Trader, 2016, para. 25).
In addition to the futures market, there is also the spot market at the EEX. On the spot market, trades are closed for a shorter time than in the futures market. The physical delivery of the electricity takes place at latest at a maximum of two days after the conclusion of the transaction. The spot market allows participants to optimize the procurement and sale

of electricity on the market in the short term. In the EEX spot market, the electricity of Germany, France, Austria and Switzerland is traded. In this case electricity products can be traded which are carried on the same day (intra-day market) or the next day (day-ahead market) (EEX, 2015a). This has the advantage that if a power generator has not yet sold its production output in the futures market to a specific date, the power generator can offer this electricity on the spot market at the intra-day market or the day-ahead market. For buyers the spot market is interesting to buy short term capacity at the intra-day market or to buy end of the day-ahead market for responding to variations of the load and the forecast or to failures of electricity plants (Schumacher and Würfel, 2015). In a comparison of the intra-day market and day-ahead market, the largest margins are expected in the day-ahead market. This is due to the fact that the volatility in the day-ahead market is higher than in the intra-day market (INTVW 10 Electricity Trader, 2016, para. 70).

Regarding the question of who the traders are, financial companies such as the British bank Barclays, the US American investment bank Goldmann-Sachs, Merrill Lynch, Bank of America and Deutsche Bank all trade or have traded electricity. The reason for a trader to trade is to earn money with the volatility of the courses (INTVW 10 Electricity Trader, 2016, para. 20). Therefore "banks need volatility to make money no matter what direction" (INTVW 10 Electricity Trader, 2016, para. 19).

In Germany, the energy exchange electricity from wind energy is primarily traded and sold on the day-ahead market. There are two reasons for this. Firstly, the transmission system operators have to provide the electricity, which is produced with fixed feed-in tariff, unlimited to the market. This is determined by the priority to feed-in electricity from renewable energy sources. The second reason why the electricity is traded on the day-ahead market results from the market premium of direct marketing, which refers to the price level of the day-ahead market (Rinck and Richter, 2015, p. 34).

Particularly in the case of wind energy, it is very difficult for traders to sell electricity from wind parks one and a half days in advance. The uncertainties of created or purchased wind and weather forecasts, sudden downturns or unpredictable weather phenomena all contribute to this.

These risks can be balanced by the traders in the intra-day market. In the intra-day market, the seller of wind energy is in an unfavorable negotiating position, because the trader cannot store the generated electricity and thus has to sell it to be able to balance its balancing group. The trader must accept the current offered market price. The fluctuation of prices and the occurrence of price spikes tends to increase in this market segment (Rinck and Richter, 2015, p. 35).

If this fluctuation and the price spikes increase steadily, the risk also increases while trading in this market. This was a good starting point for the EEX to create a new financial product and thus to securitize these risks. Earlier there were also a few non-standardized financial products for protecting against price risks, but these were only traded over the counter. The first official financial product, the so-called Cap Future was developed by the financial sector in 2015 to prevent price risks.

To explain the speculation product, the so-called Cap Future, in more detail, in figure 48 (p. 269) the development of electricity price index, the so-called $ID_3$-Price, is shown. "The index is called $ID_3$-Price and is based on the weighted average price of the hourly and 15-minute products of the last three hours prior to delivery. To provide an example: the $ID_3$-Price for hour 21 is calculated by using all hourly and quarterly transactions from hours 18, 19 and 20" (Vogel, 2015, p. 1).

To hedge these risks, each market participant and therefore also a direct marketer for wind energy is able to acquire this Cap Future. The need for this financial product is derived from the demand for wind energy by direct marketers and the offering of capacities. If direct marketers are trading their wind energy and, due to weather changes or inaccurate forecasts, the direct marketers have to make compensatory measures, it means that they have to purchase electricity at the intra-day market. Thus, with these Cap Futures the direct marketers can back up certain prices. The limit for the maximum price for the protection is set at EUR 60 / MWh by financial service providers, which offer this product. If the average market price of the $ID_3$-Price exceeds this limit of EUR 60 / MWh, the wind energy marketer will be paid the difference. The amount of the cap is shown as the blue area in figure 48. If wind is available as expected and the intra-day price of EUR 60 / MWh is not exceeded, the direct marketers can keep the cash price of the Cap Futures. For sellers, this Cap Future is attractive because the sellers can offer their very flexible but usually very expensive capacity in these peak times. The price at which this Cap Futures are traded is not fixed and is regulated by supply and demand alone.

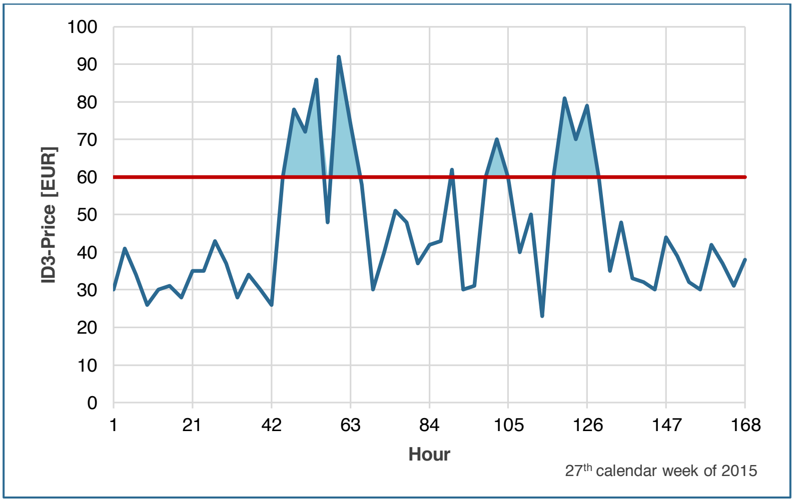


**Figure 48: Example of the $ID_3$-Price development and payment profile (Own illustration based on Rinck und Richter, 2015)**

Another financial product that was introduced to the German market in 2016 is the so-called Wind Power Future. As shown in chapter 4.1 (p. 132), the installed capacity of renewable energies is growing continuously. Thus, the share of wind energy in the electricity mix is constantly increasing. The risk of instability caused by wind, remains and increases even as there are more and more market participants that trade wind energy and the increasing amount of wind energy in their portfolio is put at a volume risk. By introducing Wind Power Futures, the financial services providers have created another financial product on the electricity market, which enables market participants to hedge these risks and which made these risks become tradable.

The Wind Power Future is a weather derivative and has been developed by the EEX. A derivative is a financial product whose price and development depends on the price of another financial product, for example a so-called underlying value. With a derivative, a trader speculates on whether the price of such an underlying value will rise or fall in the future. The underlying value of the Wind Power Future is not based purely on meteorological indicators, but it is calculated by the average kWh produced by wind turbines. The underlying value is a so-called Wind Power Index. This index is calculated based on current meteorological data, a validated meteorological model for determining the wind speed at the exact location of the wind turbine and a load curve of the currently installed wind turbines. The index is quoted in MWh of produced electricity per MW of installed wind power capacity per hour of the delivery period of the futures (EEX, 2016a, p. 2).

The advantage for traders who trade wind energy, is to hedge against wind downturns and thus against revenue losses. Therefore, the trader buys Wind Power Futures and agrees on an exercise price and a minimum for the respective wind park. The seller of this Wind Power Future receives an option premium, since the financial service provider assumes the risk of the wind loss. If the above-mentioned index value falls below the exercise price, the Wind Power Future begins to gain value. Below this exercise price, there is a break-even point for the buyer of the Wind Power Future. Under this break-even, it is a winning business for the trader because he gets paid the option from the Future.

The purchase of Wind Power Futures works like an insurance for the wind energy suppliers. If there is a lack of wind in the insured period, the financial service provider refunds the supplier's revenue losses. If the period is relatively wind strong, although the wind energy seller gets no payment from the option, he sets off a larger amount of electricity. Therefore, through the use of Wind Power Futures, the electricity supplier reduces the fluctuation of its sales and is not so negatively affected by extreme wind developments. However, he participates from positive wind developments. Only the option premium will be payable irrespective of the occurring wind development in each case to the financial services provider who sold the Wind Power Futures.

**Table 24: Financial and traded wind energy products at the electricity exchange (Own survey)**

| Market type | Futures market | Spot market |
|---|---|---|
| Financial products | Power Futures<br>Power Options | Power Spot Intra-day<br>Power Spot Day-ahead |
| Wind energy products | Wind Cap<br>Wind Power Futures | |

As shown in table 24, there are various products to trade electricity. Particularly in recent years, new products have been developed to trade wind energy. The Managing Director of the Exchange EEX summarizes the importance of these financial products: "The energy revolution poses new risks, and requires new instruments to hedge these. EEX is shaping the power markets of the future with new and innovative products like the Wind Power Future" (EEX, 2016a, p. 3). Due to such products, financial service providers may not only be able to expand their value added per each produced kWh, but they can also generate more sales by the same single kWh. This implies that the revenue from trading gains importance. The ratio between net electricity consumption in Germany and the trading volume of electricity is shown in figure 49 (p. 272).
In the whole period from 2002 to 2014[87] the net electricity consumption[88] always remained constant and was about 500 TWh. In 2014, the net electricity consumption in Germany amounted to 521 TWh. Furthermore, figure 49 (p. 272) shows the traded volume divided between the spot market and the futures market. In the years 2002 to 2004, the quantity of electricity traded was below the net power consumption. From 2005, the volume of the annually traded electricity was higher than the annual electricity needs and increases continually. In 2015, a total of 3,061 TWh were traded. The largest share of 2537 TWh, representing 82.9 % of total traded electricity, was traded in the futures market. A total of 524 TWh were traded on the spot market in 2015, which represents a share of 17.1 %. If the net power consumption in 2015 remains at the level of previous years, the volume of traded electricity is almost six times higher than the consumed electricity.

[87] At the present time there was no recent data for 2015 available from BDEW.
[88] The net power consumption refers to the used electrical work by the consumer after deducting own consumption of power plants and transmission or net losses.

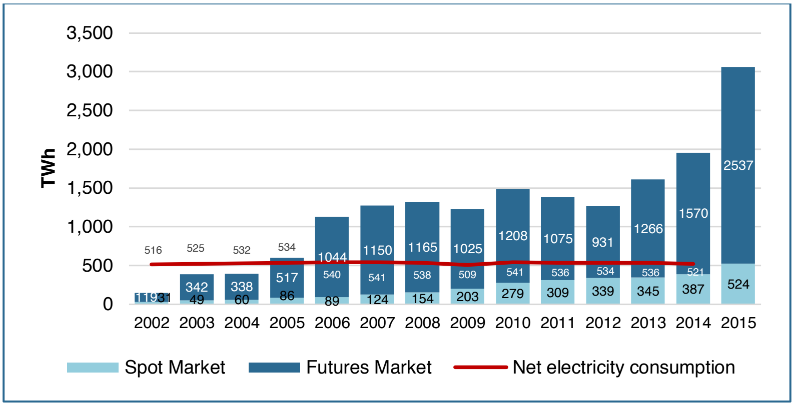


**Figure 49: Traded electricity and net electricity consumption in Germany (Own illustration based on BDEW, 2015; EEX, 2008, 2015b, 2016b)**

For comparison, in 2014 the volume of energy traded was around four times higher than electricity consumption, at 1,570 TWh. These numbers show that the trading of electricity, which also implies the trade of wind energy, is increasingly significant. When asked why more and more electricity is being traded, an electricity trader replied that banks want to participate more and more from the trade (INTVW 10 Electricity Trader, 2016, para. 32). Trading has no negative influence on the market per se. If there was no trading, there would be no liquidity in the market. Without trade, the market would collapse or prices would rise (INTVW 10 Electricity Trader, 2016, para. 42). Trade is used to protect producers and consumers (INTVW 10 Electricity Trader, 2016, para. 38). But if trade is no longer a hedge, but only speculation, this implies the market has become financialized.

Both the rising trading volume and the newly developed financial products for wind energy are indicator for increasing financialization processes in the wind industry. The shift takes place away from the production to sales and trading. The added value shifts from the production and consumption of wind energy to the purchase, sale and trade of wind energy and the tradability of risk hedging.

## 4.7 The Importance of Wind Energy on the Stock Exchange

### 4.7.1 Stock-Listed Wind Energy Companies

As already stated, the wind energy is a fast growing and fast moving industry. Therefore, the companies that operate in the commodity chain constantly need new capital to be able to grow further and thus not fall behind the competition. This growth can be financed either from equity or from borrowed capital. If the company wants to grow from equity, the profits generated by the company are reinvested into the company. Another possibility is that the owners of a company transfer additional capital from the owner to the company. If a company decides to finance the growth of debt, this usually means that the company gets into debt. Possible lenders for this financing are banks. The reason banks lend capital to the company is the interest which is to be paid by the company to the bank. The disadvantage of such a financing is that the company repays these interests to the bank in a repayment period agreed with the bank, regardless of whether the company generates profit at this time or not. The bank does not, however, enjoy the right to participate in the company or the success of the company.

Another way to generate additional capital is by an initial public offering, abbreviated to IPO. For this purpose, the company must be converted into a stock corporation. This is followed by a company valuation in which the equity of the company is determined. Equity is divided into equal shares. The nominal value of a share is determined by dividing the amount of determined equity by the number of shares. Only a portion of all shares are issued and offered for sale during the stock exchanges. The unissued portion remains with the company and the original owners of the company. Investors who now acquire shares of the company during a stock exchange are now co-owners and are called shareholders. The capital paid by the investors for the shares is granted to the companies and can be used for further investments. The proceeds generated from the IPO must not be repaid to the shareholders. All investors are now directly involved in the profit and loss of the company. The shares of the company can now be freely traded on the stock exchanges. The prices and the exchange price of these shares are determined by supply and demand. To trade on the stock exchange, the company must also pay a certain amount to the exchange.

In the German wind industry, various companies have also opted for financing through a stock exchange. Through an own survey, various companies were identified which are traded on German stock exchanges and are also active in the wind industry in Germany. As a basis for the analysis the German stock index (DAX)[89], the German mid cap stock index (MDAX)[90], the German small cap market index (SDAX)[91], the German stock index for technology sector (TecDAX)[92] and the Renewable Energy Industrial Index (RENIXX)[93] have been used. Thus, different actors which are traded on the exchange in the commodity chain were identified. These are shown in table 25[94].

**Table 25: Stock-listed wind energy companies with business activities in Germany (Own research based on business reports and stock market reports)**

| Company | Function | Founded | IPO | Revenue 2016 |
|---|---|---|---|---|
| Energiekontor | Project developer | 1990 | 2000 | EUR 210,137,000 |
| PNE Wind | Project developer | 1995 | 1998 | EUR 248,578,000 |
| Nordex | Manufacturer | 1985 | 2001 | EUR 3,395,033,000 |
| Gamesa | Manufacturer | 1976 | 2000 | EUR 4,611,983,000 |
| Vestas | Manufacturer | 1945 | 1998 | EUR 10,237,000,000 |
| Capital Stage | Investment company / Operator | 2001 | 2001 | EUR 141,783,000 |

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[89] The DAX tracks the 30 biggest companies and therefore it is the most important German stock exchange. The company size for the rank is based on terms of order book volume and market capitalization.

[90] MDAX tracks the 50 largest companies' shares from sectors excluding technology that rank immediately below the DAX. The abbreviation refers to medium-sized companies also so-called mid-caps.

[91] The SDAX is a German stock market index composed of 50 small companies in Germany, also so-called small caps.

[92] The TecDAX stock index includes the 30 largest German companies from the technology sector.

[93] The RENIXX was developed by the IWR and is a worldwide industry share index that represents the performance and development of companies in the renewable energy sector.

[94] The order of the listed companies is based on the order of the commodity chain.

The results of the analysis include the two project developers Energiekontor and PNE Wind. Both are German wind energy project developers who are also active in other markets outside Germany. In addition to the project developers, the German wind turbine manufacturer Nordex, the Spanish manufacturer Gamesa and the Danish wind turbine manufacturer Vestas were identified. In addition to these manufacturers, Siemens and GE are also players on the German wind energy market.

For a further investigation, however, these two companies were ignored, since these companies are mixed conglomerates and wind energy is only a small part of their total business activities. Another German manufacturer which has been listed on the stock exchange since 2002 is REpower. REpower was bought in 2007 after a bidding campaign by the Indian manufacturer Suzlon. By a squeeze-out, however, the minority shareholders were forced to resign and the trading of the shares on the stock exchange was stopped (REpower, 2011). In 2014, the company renamed REpower to Senvion. In January 2015 Suzlon sold Senvion to the US fund Centerbridge. Centerbridge is a hedge fund focused on leveraged buyouts and distressed securities. In June 2015, Centerbridge sold a stake to the Indian associated company Arpwood Capital. In February 2016, Senvion announced by a press release that the company intends to return to the stock exchange in the first half of 2016 (Senvion, 2016). The stock exchanges of Senvion took place on 23.03.2016[95]. The last actor to be listed on the stock exchange at the time of the investigation is the investment company Capital Stage, which also operates wind parks and solar parks, and assumes technical management tasks. Industry experts say that companies like Senvion are only bought for short-term investing. The hedge fund has optimized the company structure until indicators like EBIT look good thus the hedge fund can bring it back to the stock exchange. “When the earnings rise, one get the highest price for it and thus one get the most cash” (INTVW 26 Manufacturer, 2016, para. 56).

Table 25 (p. 274) clearly shows that, while the founding years of the companies varies greatly from 1945 to 2001, all companies were listed on the stock exchange by the turn of the century. The period of the IPO

[95] Because of the short time on the stock market (23.03.2016), Senvion is therefore not considered in the analysis of this dissertation.

was between 1998 and 2001. It should be noted that this falls within the same period in which most wind energy funds were also placed (see chapter 4.5.4, p. 235).

### 4.7.2 Shareholders and their Importance in Operational Business

After analyzing which players in the commodity chain wind energy are listed on the stock exchange in Germany and how the trading volume has changed, a more detailed analysis must now take place. The following will present the investor structures of these listed companies, which investors and donors stand behind these players and how these structures have changed.

First, it is necessary to clarify the advantages of investing in a share of a company. First, the shareholders receive an annual stake in the company's profit in the form of a dividend. However, it may also be decided that no dividend will be paid and the capital will be used for other investments. Shareholders also have voting rights at the annual general meeting. There, for example, votes on the board of directors or the supervisory board can be made. Probably the most important reason for shareholders to participate in a company is the supervision of the value of their shares. The value of the share is based, among other things, on the company value. The more successful a company is, the higher the market share, the more profit is gained, the better the outlook for a company is, the higher the share price. The future of the stock exchange has a very great influence on the purchase and sales behavior of a shareholder. The shareholder hopes that the value of the share will increase, and that he will be able to sell shares in the future with a profit.

In the following, the investor structures of the companies already described in chapter 4.7.1 (p. 273) will be analyzed. In order to generate a detailed data base, all the annual financial statements and annual reports of the mentioned companies were analyzed for the years 2010 to 2016. For each year, the exact number of available shares was determined and the corresponding investor groups added. In addition, press releases and compulsory notifications were added to the data analysis. If individual investors exceed certain voting rights thresholds, this must be publicly displayed. Thus, the change in investor structure could be analyzed for every company traded on the exchange.

As shown in figure 50, the project developer Energiekontor is characterized by a constant investor structure over the period between 2010 and 2016. Over the entire period, about 29 % of the shares were in free float. The rest were shared relatively equally between the founders of the company, Günter Lammers and Dr. Bodo Wilkens. In 2016, both major shareholders reduced their shares. For the entire period under review, there were no mandatory notifications that other major shareholders had exceeded or fallen below certain thresholds of voting rights. The influence of the financial sector is therefore not apparent.

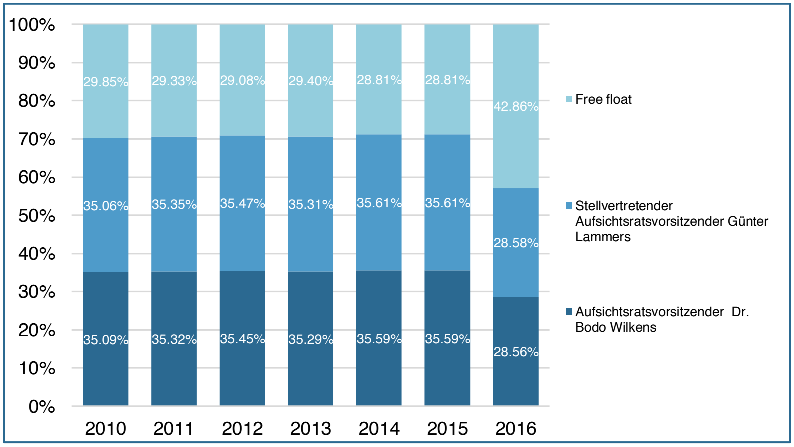


**Figure 50: Investor structure of Energiekontor between 2010 and 2016 (EnergieKontor, 2016, 2015, 2014, 2013, 2012, 2011, 2010)**

The project developer PNE Wind has undergone minor changes over the last 5 years. As can be seen in figure 51 (p. 278), the number of shares has steadily increased. As a result of these capital increases, the number of shares rose during this period to over 55 %. In 2010 and 2011, 100 % of all shares were in free float. In 2012, LBBW Asset Management Investmentgesellschaft mbH owned more than 3 % of the project developer, which is a wholly-owned subsidiary of Landesbank Baden-Württemberg. As early as 2013, the investment company either had no notifiable share of the company or was completely excluded from the company. In the year 2013, the wind energy project developer PNE Wind took over the majority of the Husum project developer WKN AG from Volker Friedrichsen Beteiligungs-GmbH. This is why Volker Friedrichsen Beteiligungs-GmbH holds a large part of PNE. In March 2017[96] three new shareholders appeared. The Internationale Kapitalanlagegesellschaft mbh is a financial institute part of the HSBC bank. The Axxion S.A. and the LRI Invest S.A. are both international investment companies, based in Luxemburg. Together the companies from the financial sector have a share of 15.8 %, which indicates that there exists a potential influence of the financial sector on the project developer PNE Wind.

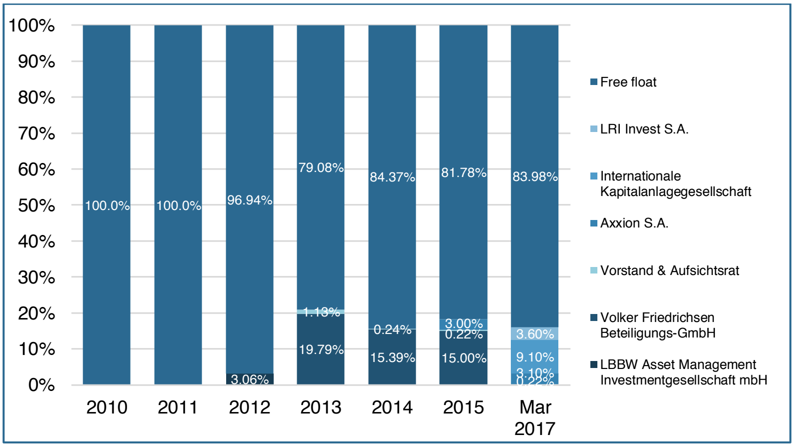


**Figure 51: Investor structures of PNE Wind between 2010 and 2016 (PNE Wind, 2010, 2011, 2012a, 2013a, 2014, 2015, 2016)**

In contrast to project developers, the company structure of the Spanish wind turbine manufacturer Gamesa differs strongly, as shown in figure 52 (p. 279). The majority of all shares are in free float, like in the previous examples of project developers. This majority was more than 70 % over the entire period. Over the entire observation period, the Spanish power generation and distribution company Iberdrola had more than

[96] PNE Wind's Annual Report 2016 explicitly mentions the shares of the shareholders of March 2017. Therefore, these data were taken into account.

19 % of all shares of Gamesa. In addition, in 2010, 2013 and 2014 Norges Bank, the central bank of Norway, accounted for more than 3 % of shares.

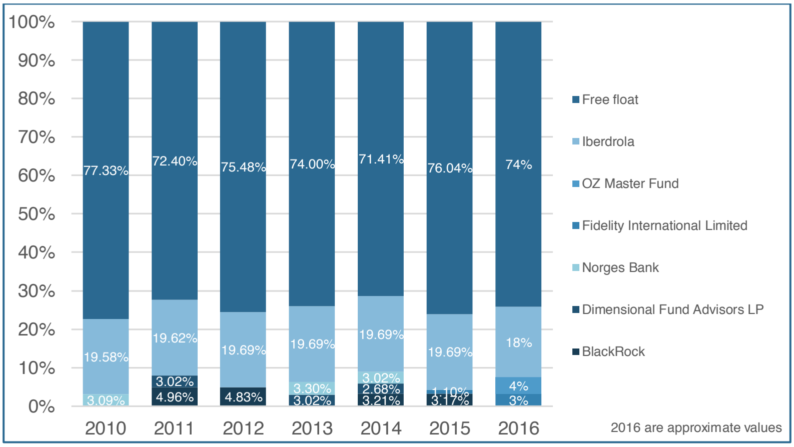


**Figure 52: Investor structures of Gamesa between 2010 and 2016 (Gamesa, 2016, 2015, 2014, 2013, 2012, 2011, 2010)**

As of 2011, a proportion of approximately 3 % can be allocated to the investment firm Dimensional Fund Advisors. A large proportion of this investment firm was also registered in 2013 and 2014. Dimensional Fund Advisors manages assets worth USD 372 billion worldwide (Dimensional, 2016, p. 2). According to its own statement the investment firm "add value by building portfolios that target higher expected returns in a cost-effective manner. By integrating a dynamic, market-driven process with a flexible trading strategy […]", the firm manages "the tradeoffs that matter for performance – balancing competing premiums, diversification, and costs" (Dimensional, 2016, p. 1).

The American global investment management corporation BlackRock has invested in the wind turbine manufacturer Gamesa since 2011.

At the beginning, BlackRock still held nearly 5 % of all company shares. BlackRock has reduced this share to 3.21 % in 2014. BlackRock is one of the largest asset management companies in the world. In 2015, BlackRock managed assets worth USD 4.72 trillion. Assets under management include mandates for the administration of money market instruments, bonds, equities and alternative and multi-asset investments. Also included are USD 13 billion of advisory mandates, including long-term portfolio liquidation mandates (BlackRock, 2015, p. 1).

According to a former managing director of a wind energy company on the stock exchange, “it is up to the amount of the position that Black Rock holds if they make an appointment with the company’s board or call them. That would never make public, but they will not say now, you have to do this or that […] but with a certain percentage, you look more closely then” (INTVW 23 Financial Service Provider, 2016, para. 43). This statement indicates that financial companies with a certain proportion of shares also intervene in the operative business of a company and try to influence it. When the combined shares of these three players are taken into account, the financial sector held 8.91 % of Gamesa shares in 2014. Also in 2016, the investment company Fidelity International Limited and the hedge fund OZ Master Fund held around 8 % of Gamesa shares. In comparison, in 2010 the only financial actor was Norgesbank, with a share of 3.09 %.

As figure 53 (p. 281) shows, the majority of Vestas’ shares[97] are also in free float. The Danish company Vestas distinguishes between Danish and international shareholders as well as shareholders who are not registered by name. Both groups increased in the period from 2010 to 2014. The total free float rose from 85 % to over 95 %. In 2010, Norges Bank, the Central Bank of Norway, was involved in Vestas. The investment company BlackRock and Capital Research and Management Company were also investing. This investment company is a subsidiary of the US-American Investment Company of the Capital Group Companies Inc. In 2013 neither the Bank of Norway, the Capital Group Companies nor BlackRock were mentioned in the annual report.

[97] Due to non-exact numbers, some shares were manually calculated, rounded or estimated.

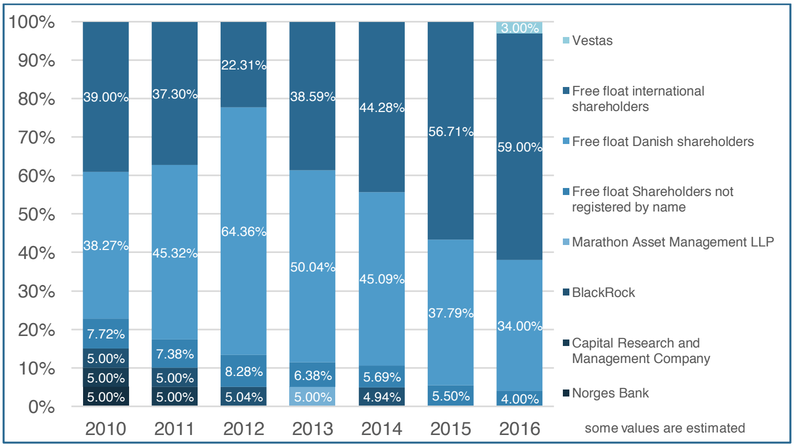


**Figure 53: Investor structures of Vestas between 2010 and 2016 (Vestas, 2016, 2015, 2014, 2013, 2012, 2011, 2010)**

Either these players have completely separated themselves from shares in Vestas or the amount of their shares has fallen below the prescribed reporting level. In contrast, the investment company Marathon Asset Management LP exceeded the reporting requirement of 5 % in the same year 2013. In summary, one may say that the share of the financial sector in the investor structure at Vestas has decreased from around 15 % to around 5 % in 2014. In the years 2015 and 2016, shares of financial companies have not been announced in the annual reports. However, this may also be due to the fact that certain reporting thresholds have not been exceeded.

Figure 54 (p. 282) shows the investor structure of the German wind turbine manufacturer Nordex. Here again, the free float of the company shares is clearly dominant. However, this share has declined slightly from 2010 to 2014. In 2010, more than 75 % of the shares were free float; in 2014 this has shrunk to just over 68 %. Between 2010 and 2012, the remaining shares were held by Skion / momentum capital, accounting for 24.99 %. This is a holding company of Susanne Klatten, the daughter of industrialist Herbert Quandt. Thus, no change can be seen in the period from 2010 to 2012.

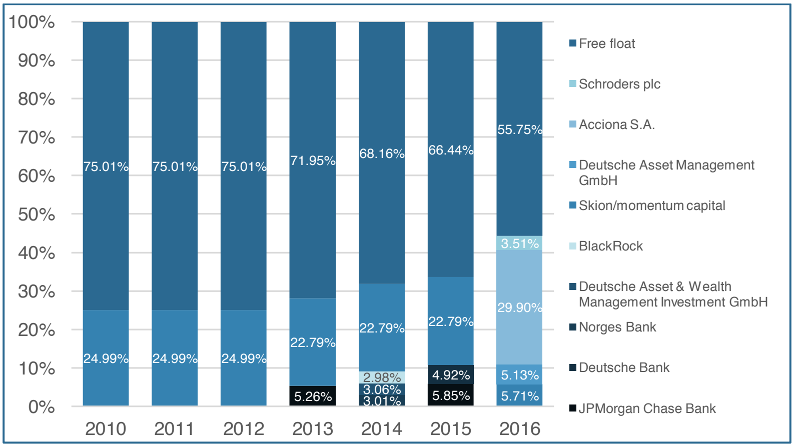


**Figure 54: Investor structures of Nordex between 2010 and 2016 (Nordex, 2016, 2015b, 2014, 2013, 2012, 2011, 2010)**

In 2013, the annual report disclosed that the US bank JPMorgan Chase & Co. held 5.26 % of the shares of Nordex. No reportable amount of share held by JPMorgan Chase Bank was recorded in 2014. The investment company BlackRock, Deutsche Asset & Wealth Management Investment GmbH, and the central bank of Norway, Norges Bank, participated in each of these investments, each of which was approximately 3 %. Deutsche Asset & Wealth Management is a German fund company and belongs to the Deutsche Bank Group. If the share of all four stakeholders were grouped together, financial actors accounted for 31.84 % of the German wind turbine manufacturer Nordex in 2014. In 2015 the share of the financial sector increased to 33.56%, due to the shareholder of Deutsche Bank.

This share has increased in relation to 2010. According to an interview partner, it can be assumed that there is some influence[98] of holding company of Susanne Klatten on the operational business. Through experience in the automotive sector, it will ensure that wind energy can learn from industries such as automotive engineering or plant engineering through appropriate consultants or initiatives. This would correspond to inter-

[98] It has to mention that this influence does not necessarily confirm financialization processes.

chain upgrading, which is initiated by a shareholder (INTVW 24 Manufacturer, 2016, para. 20, 40). As a result of the merger between Nordex and the Spanish wind turbine manufacturer Acciona, the shareholder structure has changed in 2016. For example, the Spanish manufacturer held 29.9% of Nordex shares in 2016. Financial actors in 2016 as the Deutsche Asset Management GmbH and Schroders plc, which is also an asset management company, held together 8.64 % of Nordex shares.
The change in the investor structure of the investment company Capital Stage is shown in figure 55. The investor structure was still relatively homogenous in 2010 and since then has changed in favor of the free float. In 2010, only 21 % of the shares were in free float, while this has risen to 56% by 2014.

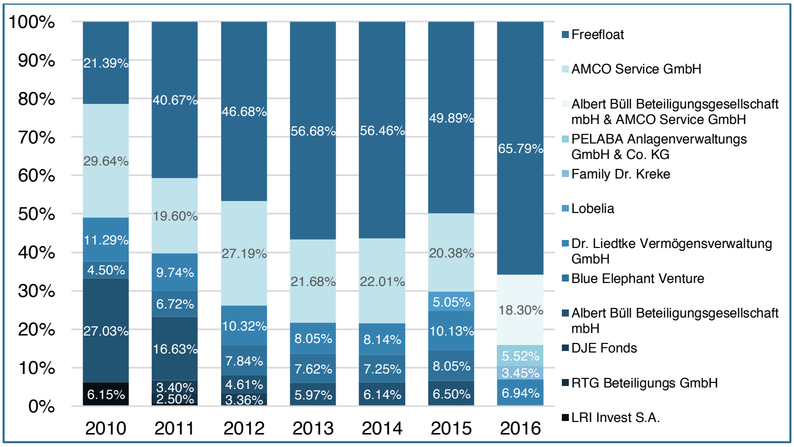


**Figure 55: Investor structures of Capital Stage between 2010 and 2016 (Capital Stage, 2016, 2015, 2014, 2013, 2012, 2011, 2010)**

All other players are persons on the Board of Directors or affiliates. Thus, the second largest share of the company Capital Stage is the company AMCO Service GmbH, which is controlled by the Büll family. This share can therefore be added to Albert Büll Beteligungsgesellschaft mbH. In addition, Dr. Liedtke Vermögensverwaltung GmbH also holds a share of Capital Stage. Albert Büll and Dr. Cornelius Liedtke sit on the Supervisory Board of Capital Stage. In addition, Liedtke and Büll are the founders of the B & L Group, which is mainly involved in the real estate business. Blue Elephant Venture GmbH can be assigned to Peter-Alexander Wacker, who can be assigned to Wacker Chemie AG. Blue Elephant Venture GmbH has steadily increased their share from 4.5 % to 8.05 % in 2015. The DJE Fond, LRI Invest from Luxembourg, RTG Beteiligungs GmbH and PELABA Anlagenverwaltungs GmbH & Co. KG are other players from the financial sector, which in the years 2010 - 2012 had different shares of participations. This analysis makes it clear that at Capital Stage, except for the free float, mainly financial actors are involved. This means that Capital Stage can also be described as a fund, the core business of which is wind parks and solar parks to operate and manage. As a provider of shares, Capital Stage is also a financial service provider in the commodity chain of wind energy. The share of the free float increased in 2014 until 2016 from 21.39 % to 65.79 %. In the same period, the number of shares has also risen. This means that interest in the purchase of shares of the financial service provider has also risen disproportionately.

### **4.7.3** Total Revenue and Traded Stock Volume of Wind Energy Companies

The previous chapter showed and explained how the ownership structures of wind energy companies traded on the stock exchange have changed and shifted. This shift was possible by buying and selling shares. These buying and selling processes are combined on the stock exchange. Each individual share can be bought and sold at the current exchange rate. Thus, a single share may change owner more than once in one trading year. This creates a daily trading volume. In the following, the relationship between the volume traded on the exchange and the revenue of this company will be analyzed.

For this analysis, the number of shares traded was determined for each trading day for each trading company operating in Germany that is traded on the exchange. The period of the analyzed trading days was from the beginning of 2001 to the end of 2015. The data for these figures came from the database of S&P Capital, which is a US financial information provider and a division of the financial service provider McGraw Hill Financial. Thus, the number of shares traded could be determined. This number of days was multiplied by the daily rate of the respective share. As a result, the traded daily volume of the share could be determined in Euros. Then the daily volumes of each year were added up to calculate the annual traded volume. As a result, the development of the trading volume on the exchange for these companies can be shown for the period between 2001 and 2015.

The analyzed stock companies used for the investigation are shown in table 26. Since shares can be traded in different trading venues, the trading data and volumes from the primary exchange were used for the analysis. The German companies Energiekontor, PNE Wind, Nordex and Capital Stage are primary listed at Xetra. Xetra is a trading center of the Frankfurt stock exchange. The Spanish wind turbine manufacturer Gamesa is listed on the electronic Spanish stock exchange interconnection system (SIBE) in Madrid. The Danish manufacturer Vestas is listed on the Danish stock exchange, which is part of the OMX and is operated by the NASDAQ OMX Group. The OMX is a Scandinavian stock exchange.

**Table 26: Analyzed stock-listed companies based on their primary listing (Own compilation based on S&P Capital IQ, 2017)**

| Company | Function | Primary exchange | IPO | WKN |
|---|---|---|---|---|
| Energiekontor | Project developer | Xetra | 2000 | 531350 |
| PNE Wind | Project developer | Xetra | 1998 | A0JBPG |
| Nordex | Manufacturer | Xetra | 2001 | A0D655 |
| Gamesa | Manufacturer | Madrid SIBE | 2000 | A0B5Z8 |
| Vestas | Manufacturer | Nasdaq OMX Copenhagen | 1998 | 913769 |
| Capital Stage | Investment company / Operator | Xetra | 2001 | 609500 |

In order to obtain a better understanding of the ratio of the volume of the respective company, the total revenue of the respective company was added. Revenue was chosen as an indicator because there is no business relationship between the trading volume and the revenue of the company. Nevertheless, the relationship between the traded volume of a company in relation to the generated revenue in the same year can be determined by the respective ratio.

This ratio is used as a further indicator of financialization processes in the wind industry. If the traded volume of the shares exceeds the annual revenue by a significant degree, it can be assumed that processes of financialization take place at the analyzed company. In this case, this would strengthen the thesis of a financialization of the wind industry.

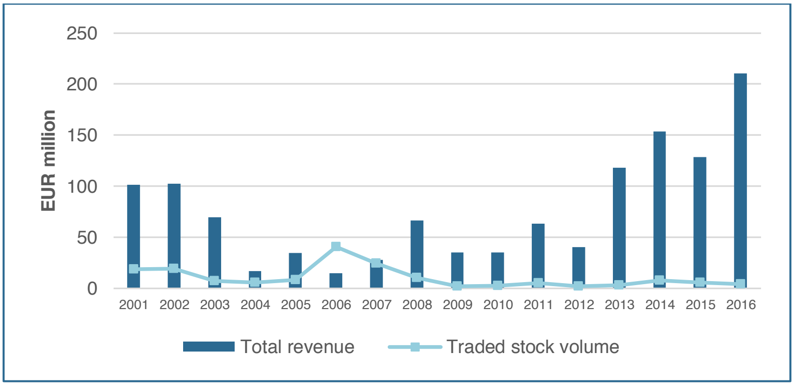


**Figure 56: Total revenue and traded stock volume of Energiekontor (Own calculation based on S&P Capital IQ, 2017)**

Figure 56 shows the development of the trading volume of the German project developer Energiekontor. It can be seen that the traded volume of shares dropped from almost EUR 19 million in 2001 to EUR 4 million in 2016. In 2006, this volume jumped sharply to more than EUR 40 million and in 2007 was EUR 24 million, well above the average of EUR 10.4 million. Furthermore, the figure shows the revenue of Energiekontor over the same period from 2001 to 2016. It is clear that the revenue of the company is above the traded volume until the year 2006. Since the company's revenue is more than six times the volume traded, it is assumed that the influence of the financial market on the real economy of energy control is low or non-existent.

The volume of trade in relation to revenue is more pronounced with the German project engineer PNE Wind than in the case of Energiekontor as shown in figure 57 (p. 287). The average volume of traded shares in the period from 2001 to 2016 was around EUR 91.6 million and thus only slightly below the average revenue of EUR 118.8 million during the same period. As in the case of Energiekontor, an above-average volume of trading is recorded in 2006 and 2007.

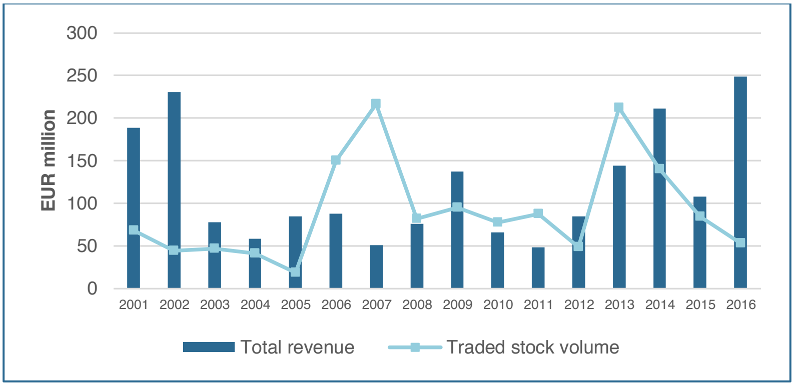


**Figure 57: Total revenue and traded stock volume of PNE Wind (Own calculation based on S&P Capital IQ, 2017)**

A very high trading volume is also apparent in 2013. The sale of the offshore projects Gode Wind I to III to the Danish energy group DONG Energy (PNE Wind, 2012b) can be mentioned as reasons for this sharp increase. After the announcement of this sale, the price per share doubled. Furthermore, PNE Wind held 54 % of the competitor WKN (PNE Wind, 2013b). Based on this data, it can be assumed that the financial market has a certain influence on the project developer.

The situation is different for the German wind turbine manufacturer Nordex. Figure 58 (p. 288) shows that the trading volume in the years 2007 - 2009 and 2012 were clearly above the company's revenue. Across the entire observation period from 2001 to 2016, the average annual trading volume of EUR 1.697 billion was well above the annual revenue of EUR 1.065 billion, which began to rise only from 2006 onwards. The above-average trading volume in 2007 and 2008 can certainly be explained by the financial crisis. In 2007, more than five times Nordex's annual revenue was traded on the stock exchange. The tremendous increase from 2012 is also interesting.

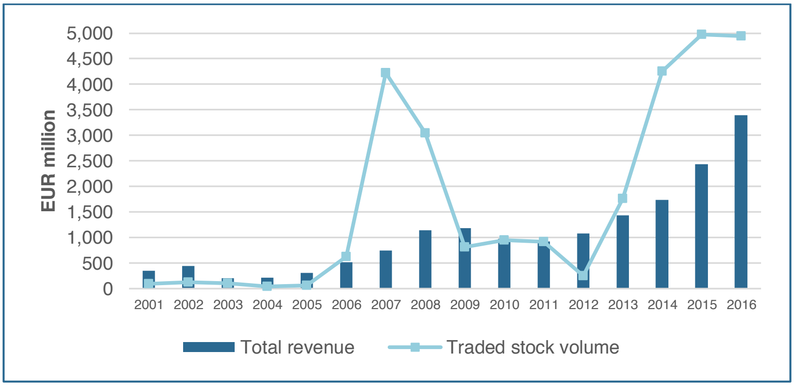


**Figure 58: Total revenue and traded stock volume of Nordex (Own calculation based on S&P Capital IQ, 2017)**

The year 2015 marks a high point in the traded stock volume, with almost EUR 5 billion. The highest revenue of the entire company, with over EUR 3.4 billion was in 2016. These figures show that market capitalization already plays an important role at Nordex.

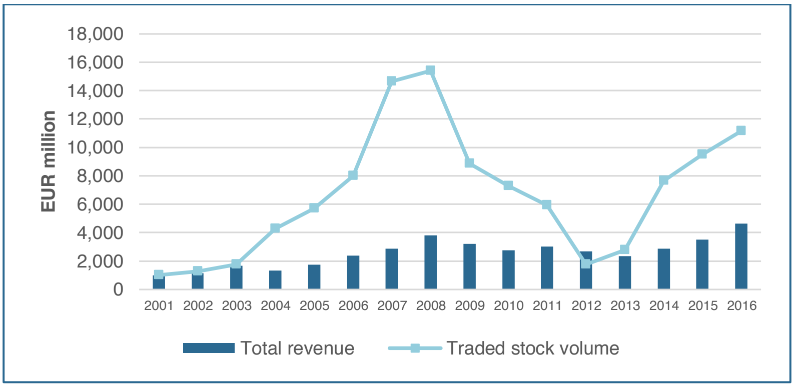


**Figure 59: Total revenue and traded stock volume of Gamesa (Own calculation based on S&P Capital IQ, 2017)**

As figure 59 shows, the development of trading volumes on the stock exchange and the ratio to the annual revenue of the Spanish manufacturer Gamesa is similar to that of Nordex. However, the period during which the trading volume was above the revenue is longer at Gamesa than at Nordex. At Gamesa, the volume of trading in all years, except for 2012, was higher than the revenue. The highlight of the trading volume was in 2008 and fell to a low point in 2012, which is the turning point in the development. This decline in trading volume can also be explained by the financial crisis. From 2001 to 2016, on average the volume of traded shares was around EUR 6.7 billion and the average annual revenue was almost EUR 2.6 billion over the same period. In this case as well, financialization processes can be mentioned. The ratio of traded stock volume is still higher at Gamesa than at Nordex.

Figure 60 shows the development of the annual revenue of the Danish manufacturer Vestas and the volumes traded on the Copenhagen Stock Exchange. Just as with Gamesa, the trading volume was above the yearly revenue every year until 2012.

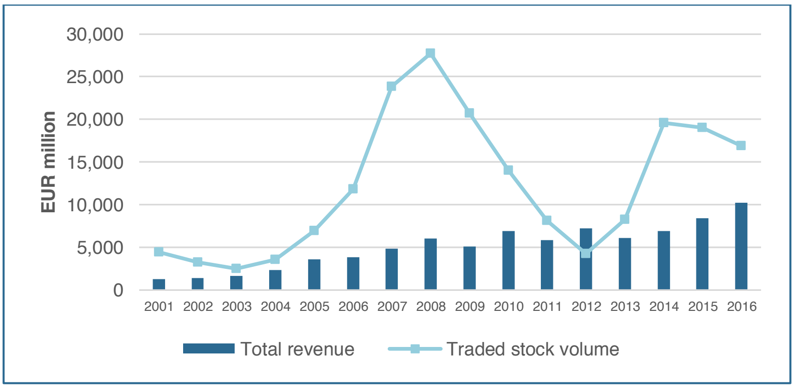


**Figure 60: Total revenue and traded stock volume of Vestas (Own calculation based on S&P Capital IQ, 2017)**

The peak was 2012, like Gamesa, with over EUR 27 billion of traded shares. This volume fell to EUR 5 billion by 2012. Another peak occurred in 2014. The volume of 2016 was already below the traded volume of 2014. This may indicate a further turnaround.

Over the period from 2001 to 2016 the average annual trading volume was EUR 12.2 billion, which is higher than the average annual revenue of EUR 5.1 billion. As a result, Vestas has the highest annual revenue as well as the largest traded share volume of all companies analyzed. As in the case of the manufacturers Nordex and Gamesa, the figures presented here show a significant influence of the financial market. This means that all manufacturers who are active in Germany and are traded on stock exchanges are subject to financialization processes.

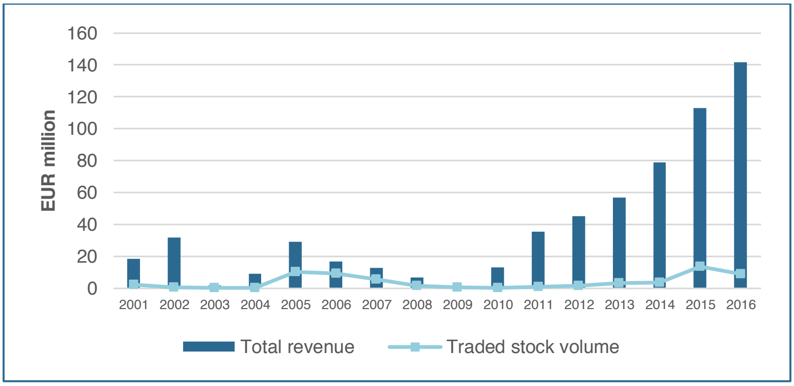


**Figure 61: Total revenue and traded stock volume of Capital Stage (Own calculation based on S&P Capital IQ, 2017)**

The last company in this analysis is the German investment company Capital Stage, which also operates wind parks and is shown in figure 61. In contrast to the above-mentioned companies, the annual revenue of Capital Stage in the entire observation period from 2001 to 2016 was always above the volume traded. The volume of the traded shares was below EUR 2 million in most years. There is a slight increase in 2005 and 2006 in which the trading volume rose to over EUR 10 million. In 2005, this represented roughly one-third of the annual revenue. The low point in revenue of Capital Stage was in 2009 with slightly more than EUR 1 million. The low point of the volume of traded shares followed a year later in 2010. From this point onwards, both have steadily risen until 2015. However, the annual revenue has risen significantly more than the trading volume. The annual revenue was more than eight times higher than the volume of shares traded on Xetra. Based on these calculations it can be assumed that the financial market plays a subordinate role in the business process of Capital Stage.

In general, it must be said that each wind energy company has to act in exactly the same way and is bound by the same rules as other stock listed companies. At the end of each year, the general manager of a stock company must reveal to the shareholders what he has done (INTVW 03 Project developer, 2015, para. 69). The reason to bring a company to the stock market is the extended access to further capital for financing. But this approach also offers risks (INTVW 26 Manufacturer, 2016, para. 53). In the case of the stock companies, such as the aforementioned companies Energiekontor and Capital Stage, the shareholders are directly involved in this company. The company keeps and operates wind parks. The consequence of this is that the shareholder has absolutely no insight how the wind parks are run. According to a financial service provider, "this is basically totally blurred. As a shareholder, you cannot see which IRRs they are buying. […] Because most do not even understand it, they want profit per share. [...] Shareholders do not understand that one has to evaluate this asset on a 20 - 25 year assessment. They look only quarter, quarter, quarter" (INTVW 23 Financial Service Provider, 2016, para. 33). In contrast to trading banks that are dependent on volatility in exchange rates[99], it is important for listed companies to have as little volatility as possible. According to a general manager of a wind energy manufacturer, "you have to pay attention to what you say and when you say it. Because there are very specific rules from the stock market supervision, which look carefully, that one does not say wrong things, or gives timely information, which is important for the share price" (INTVW 26 Manufacturer, 2016, para. 45).

In summary, it can be said that the analysis of the traded share volume of the wind energy companies traded on the stock market has produced different results. The project developers Energiekontor and PNE Wind as well as the investment company Capital Stage can be seen to have a small trading volume of shares in relation to the generated revenue. This low ratio is taken as an indicator that there are little or no financialization processes in these companies. The case of the three global wind turbine manufacturers Nordex, Gamesa and Vestas is different. For all three manufacturers, the volume of trade generally exceeds the annual revenue

[99] See chapter 4.6.4 (p. 265).

of these companies by a large margin. This is taken as an indicator of financialization and reinforces the thesis that the financial market has a certain influence on these actors.

# 5 Conclusion

## 5.1 Review and Findings

As the empirical commodity chain analysis has shown, there are financialization processes in the German onshore wind industry. In carrying out the empirical case study, financialization processes could be proved with the help of the Global Commodity Chains approach. Thus, the whole commodity chain and each individual chain area could be analyzed separately. The GCC's investigation as well as current research courses of APS and the research discourse of integrating financialization into production networks or commodity chains provided good assistance in the approach to answer the research questions. However, it should be pointed out once again that the core research interest was an empirical interest. The empirical interest was to examine financialization processes in the German wind industry. The synthesis of financialization and the commodity chains approach was here the means to the ends. Furthermore, the GCC approach was the analysis instrument. Nevertheless, an empirical contribution to the current research discourse could be provided through this dissertation regarding governance, APS, financialization and commodity chains.

Due to the questioning and the current nature of the research interest, it was necessary to generate primary data through semi-structured interviews and expert surveys. Due to the senior positions of the interviewees and their many years of industry experience, these were very informative and qualitatively helpful. After a certain number of semi-structured interviews, information saturation was observed. It is therefore assumed that further interviews would not have contributed to further findings for this dissertation. Through the transcription and coding, the collected knowledge was thoroughly verified and documented, and probably still provides material for further research and further research questions. Through the qualitative and explorative approach, the hypotheses about governance could be dealt with in a deeper way than it would have been possible with a quantitative approach. Nevertheless, certain statements from the interviews could be confirmed with secondary data which supported the argumentation in this dissertation. However, there were also arguments which were only to be supported with secondary data. For example, the shareholder structure of wind energy companies or the volume of shares traded on the stock exchange can be mentioned here.

As the analysis showed, there was almost no economic usage for wind energy in the pioneering phase. Wind energy was driven by research and support for environmentally friendly energy forms, which could be proved with statements from the interviews. Due to changes in the institutional context through the introduction of the electricity feed-in law in 1991 and the implementation of the EEG in 2000, an industry steadily developed. Since then it has been possible to operate wind energy economically. The interviews have confirmed that the introduction of EEG has been the most important influence factor for the wind industry to develop a safe business case. However, to grow into a mature industry, it also required the division of labor to continue its course. The analysis of the whole commodity chain showed that the actors of the commodity chain became increasingly specialized. The analysis of company structures showed that, apart from a few exceptions, such as for example the manufacturer Enercon, which represent many areas of the commodity chain, most companies have focused and specialized on one single segment of the commodity chain. It could be found out, that already in this time period there were also the first financial service providers who created fund products to offer new investment products. This is the beginning of a steadily growing financialization process in the German wind industry.

From a global perspective, wind energy continues to show tremendous growth. Looking at the development of wind energy in Europe, one can see the influence of the European Union. This influence of the European Union contributed to a tender model being introduced in Germany with the EEG 2017. It is to be expected that the electricity market in Europe will be further liberalized and that the market is likely to develop into a completely EU-liberalized common electricity market. This institutional framework would then take the financialization of wind energy to a whole new level. It is to be assumed that, in the case of a Europe-wide liberalization and merger, increasing and more rapid financialization processes will occur in other European countries which are not yet or only slightly financialized.

Outside Europe, countries such as China and India are growing rapidly. China has developed into the country with the greatest wind energy capacity in only a few years. Although Germany is growing even further, the growth rates are limited by the volume of tendering.

Regarding other countries and other wind industries, it can be assumed that a transferability of the findings from this dissertation to these countries is given. When transferring to other countries, however, three different factors must be considered. The (1) ownership structure in Germany is different from that in other countries where wind energy has developed. As has been shown in Germany there are still small limited partnership structures, private investors or even small public utilities. As shown in this dissertation, these ownership structures are shifting in favor of large and financially strong actors, yet the ownership structure in other countries, even direct neighbors of Germany, is quite different. In France, Spain and the UK, there are large energy suppliers which are the dominant market players in these countries. In contrast, it was shown that in Germany the so-called big four utilities play only a subordinate role in the onshore wind energy market.

When transferring the findings, attention must also be paid to the (2) developmental status of the wind industry in other countries. A distinction must be made between an emerging market, a mature market or a saturated market. As has been shown, private owners such as farmers and landowners themselves have developed and built their own wind turbines. However, the technology is now so advanced that a private individual can no longer provide the ever-increasing investment sums. In an emerging wind energy market, however, the farmers would not begin to develop wind turbines, as occurred in Germany, but rather wind parks would be built by professionalized wind park developers from the beginning in a large scale. However, depending on the development of the market, different actors are also involved, since the different actors also have different risk profiles. Thus, it is to be assumed that actors with a risk-averse profile would tend to avoid emerging markets, while actors more tolerant to risk would be more likely to participate in these markets.

The last factor that must be taken into account when transferring results is (3) geography. In Germany, the size and number of wind parks are quite different from other countries with a lower population density and other spatial structures, due to the high population density and spatial structures in Germany. In Germany, a wind park with five WTG is characterized as large wind park. In other countries, large wind parks begin with 50 WTG. Thus, the geographical situation of a country as well as the wind conditions on the ground play a further important role.

These three factors, however, lead to an important finding. Financial service providers and their APS can only emerge in a market that has already been developed in some way. A certain degree of competition is also helpful for the further growth of financial services, as due to competition and decreasing margins, the financial services sector can exert their strength to optimize projects financially.

As has been shown, the commodity chain has resulted in a division of labor with various processes of value added. This subdivision has resulted from the advancement of technology, further development, professionalization and specialization. As already mentioned, finance has a special function within the commodity chain of wind energy projects. But where can finance be integrated within the commodity? As has been shown, financing for a wind park has become a business that is more than a service that a customer needs to finance a wind park. The financing area covers the whole chain and has a different influence on every part of the chain. As illustrated in figure 62 (p. 297) finance is not part of only a single process of the commodity chain, but finance can, depending on the specific project, encompass all phases of the commodity chain and life cycle of a wind energy project from the first idea of planning a wind energy turbine until the dismantling or repowering of the turbine.

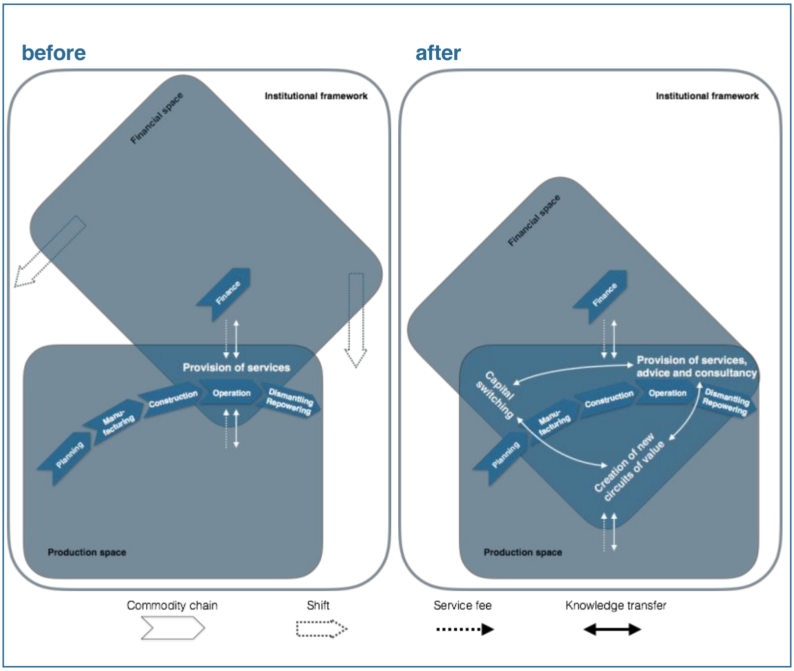


**Figure 62: Shift of the financial space within the wind energy commodity chain (Own illustration based on Bassens and van Meeteren, 2015, p. 10)**

Already in the planning phase, banks and companies from the financial sector engage in decision making processes. Investment decisions on how projects will be developed are influenced by financial investors in the background, banks decide which experts are accepted and financial service providers examine projects and prepare recommendations for the purchase or sale process. The influence of service providers from the financial sector is also significant in the manufacturing phase. The decision making power of whether a turbine is financed is held by the bank. The influence of the banks goes so far that the bank can dictate to turbine manufacturers which countries the suppliers can come from. There are also financialization processes during the operation of a wind park. The analysis has shown that projects are now being traded more often than in the past, and that the investment periods are simultaneously reduced. Wind parks must also be refinanced after the fixed interest period. In these processes, the interviews and the quantitative analyses have shown that financial service providers influence investment decisions in this way and thus change fundamentally the wind industry.

In the commodity chain, the financial sector offers various services as figure 62 (p. 297) shows. The financial sector structures financing for customers. This is achieved by project financing for wind parks as well as corporate financing for the companies which offer planning, manufacturing, construction or operation.

In addition, the interviews have proven that the financial sector has the knowledge and competence to optimize projects. It has been found that optimizing wind parks through leveraging the finance is very efficient. Depending on the refinancing interest rate, it makes sense to reduce equity and increase leverage to increase the IRR. This increases the added value for the customer and investor, which has been calculated in this dissertation. Through the constantly growing trade of projects, the financial sector has been able to build up impressive knowledge and competence. The projects must be examined for each transaction or structuring. Thus, the service providers gain deep knowledge about contracts, delivery times, guarantees, prices, actors and customers. An accumulation of market knowledge arises. Through the knowledge gathered, advice and consultancy services can be offered. The analysis showed that the market environment and the institutional context are very useful to the financial sector. The wind energy market is a seller's market which leads to a rapid turnover of projects, and through the low interest rate policy and the investment pressure new investors are entering the market. As the interviewees have confirmed, the political environment also makes wind energy a safe asset class, which brings financial services providers new customers and investors. The steadily growing risk appetite of investors and the search for a new asset class after the financial crisis, enable the financial services providers to engage in capital switching and the creation of new circuits of value. This is how new products such as optimized bank loans, mezzanines, bonds and venture capital finance are being developed in the wind industry.

For all the aforementioned services, the advanced producer service firms receive a fee. The customers who pay this fee come both from the pro-

duction space and from the financial space. Thus, money flows from the two spaces towards the financial services providers and accumulates there. Whether there is an overaccumulation could not be determined.
Due to technical innovations and development, investment volumes have also steadily increased, which could be calculated. As a result, banks are able to provide larger loans for project finance. However, the offering of project financing is not left to the banking sector alone. There are already the first examples of the turbine manufacturers themselves acting as banks and structure financing. In the case of project financing offered by banks it could be determined that the banks simply handed over the financing to the KfW. KfW has very cheap refinancing costs since the Federal Republic of Germany acts as a guarantor for credit losses. KfW has used the banks to offer these loans for project finance through its widespread banking network. Banks are, however, to a small extent always involved in financing. This means, however, that KfW bank holds the biggest risk. Thus, the banks have transferred the liability risk to the KfW bank which now has a cluster risk.
Furthermore, it was found that the investment periods of funds that launched wind energy products have declined further and further. In the early days of the wind industry the investment period was 20 to 25 years, now it is 5 to 10 years. This implies that there has been a shift from a long-term investment to short- to medium-term investments. The highlight of this fund that launched wind energy products was however 2002. Since changes in the investment law book (German: Kapitalanlagegesetzbuch) the figures have steadily declined again. Although there was a small upswing again in 2013, there have been several insolvencies of wind energy firms that have issued such bonds. These failures and bankruptcies have led, among other things, to a decline in demand for such products. It could be shown that the pre-calculated returns on such products were generally not met.
It can be assumed that financialization processes are progressing even further in Germany. The analysis has shown that financially strong players are better positioned for the future in the wind industry than financially weak actors. This was also confirmed by interview partners. The competition and market consolidation are also clearly perceived in the indus-

try. Nevertheless, the situation in Germany is specific in that there may still be a chance for small players in the wind industry in Germany. Thus, a project developer summarized that "the project developer on-site is somehow linked in the region and can manage everything. But he does not have the financial strength. In other words, the big companies have the financial strength, but they do not have access to the projects because they are not so regionally linked" (INTVW 03 Project developer, 2015, para. 16). This would, however, mean that when large and small players work together, it becomes increasingly difficult for medium-sized companies in the German wind energy market.

## 5.2 Research Questions and Results

In order to answer the research question as well as the key questions, hypotheses were derived from the key questions. These hypotheses were analyzed and discussed in detail in chapter 4 (p. 132) using appropriate indicators. In the following, the verification or falsification of the hypotheses takes place, with the result that the research questions can be answered.

**Hypothesis 1a:** The structures of owners and investors of wind parks and the business activities of firms are shifting from the real economy towards the financial economy.

From the beginnings of the first use and testing of wind energy to the industrial and commercial use of wind energy, the structure of owners of wind parks has changed considerably. As has been pointed out, wind turbines were only used for research or ideological purposes until the 1980s (INTVW 03 Project developer, 2015, para. 38). With the introduction of the Electricity Feeding Act 1991 WTGs could be operated commercially for the first time. This law laid the foundations for the soon fast-growing industry. At the beginning of the 1990s, only a few WTGs were built in Germany. These were usually close to farms or villages. The owners of WTGs were farmers or landowners. In the years that followed, more and more citizens' wind parks[100] were developed (INTVW

[100] Citizens' wind parks refer to the German term "Bürgerwindpark".

22 Investor, 2016, para. 7). These citizens' wind parks were an association of the population living there to realize joint projects. The reasons for these associations also included the rising investment costs associated with larger turbines (INTVW 09 Manufacturer, 2016, para. 47; INTVW 01 Investor, 2015, para. 66).

In the mid-1990s, more and more professional project developers became involved as a result of changes to the building code and the designation of areas for wind parks by planning associations. As in the statistics shown, many projects developed by project developers are also attributed to the owner group "project developers". Discussions with interviewees and industry experts have shown, however, that behind these project companies, managed by project developers, are wealthy German private and small investors. Thus, the first tax-saving schemes in the wind industry were developed (INTVW 26 Manufacturer, 2016, para. 7; INTVW 14 Bank, 2016, para. 53). The ever-accelerating technology and development made it possible to build ever higher and larger WTGs and thus bigger wind parks. In the 2000s, planning processes became increasingly difficult and longer. As shown, development costs and equipment prices have made it increasingly difficult for private individuals to realize projects. Professional project developers are increasingly selling projects turnkey as a closed-end fund where private investors can participate. The own calculations showed, the peak of the fund emissions in Germany was in 2002. Emissions thereafter strongly declined. The reason for this was a change in legislation and associated higher requirements for the launch of funds. In addition, besides selling projects turnkey, project developers have started to operate and keep the projects on their own balance sheet. From the mid-2000s onwards, large-scale investors and institutional investors began to enter the German onshore market and acquire wind energy projects. The typical investors are insurance companies and pension funds (INTVW 05 Fund Manager, 2015, para. 23; INTVW 16 Bank, 2016, para. 13; INTVW 24 Manufacturer, 2016, para. 44; INTVW 01 Investor, 2015, para. 61).

At the latest from the 2010s onwards, wind energy has grown from a niche market into an industry. Meanwhile, large international investors are participating in German wind parks. As the statistics have shown, for new constructed wind parks the proportion of owners from the financial economy, namely banks and funds, has risen sharply. The share of private individuals has declined (INTVW 20 Consultant, 2016, para. 13). Thus, the hypothesis can be verified with certain remarks that there has been a shift from the real economy to the financial economy. Depending on how a shift is interpreted it must be noted that the ownership structure has not turned completely since a large proportion of the real economy still holds shares in wind parks, which results from the long investment period of 20 years. Because of this, the focus must be placed on the respective installation years and not on the total of all wind parks, which have been built over the years. However, due to the new legislation and the tendering procedure in 2017 it can be expected that this share will be significantly reduced by the risks involved in the tendering procedure, and that this proportion will be absorbed by actors from the financial economy who are willing to take higher risks.

**Hypothesis 1b:** To hedge risks and optimize returns, new financial products are created that extend the financial sector's field of activity, which leads to a change of actors and their functions.

With increasing development, the analysis showed that more and more products have become established in the wind energy market to hedge risks and optimize returns. The need for such products has arisen for two reasons.

On the one hand, a growing market for stock wind parks has emerged as a reason. Wind energy projects have been and still are financed and designed for at least 20 years. With the emergence of private banks and funds, a lucrative secondary market for wind energy projects has emerged. For institutional investors, an already built wind park was a lucrative investment. There were no risks from the construction (INTVW 23 Financial Service Provider, 2016, para. 5) and after a wind park has been in operation for several years, financial service providers can create an accurate OPEX calculation by checking the balance sheets (INTVW 23 Financial Service Provider, 2016, para. 7). Probably the most important factor was that after a few years, one knew exactly whether the wind reports, which had been prepared beforehand, were true or not. As a

result, low-risk fund products could be created, which were then redistributed to private investors through investment funds.
On the other hand, a further reason for the need for such products is the falling returns in the entire capital market. In order to meet the high return requirements of investors, the financial sector has always established more products for investors. This resulted in subordinated loans, mezzanine financing or other equity financing (INTVW 25 Financial Service Provider, 2016, para. 15). As a result of the higher risks associated with the products, a higher return could also be promised (INTVW 05 Fund Manager, 2015, para. 59; INTVW 06 Project developer, 2015, para. 59). The research has shown, however, that in reality many products are failing to deliver their promised returns. In addition, it was demonstrated by interview partners that the bundling of various wind parks creates new products for investors. These products are CDO-like fixed income securities that cover a certain portfolio of different wind parks (INTVW 23 Financial Service Provider, 2016, para. 29). The financial sector has copied these products from other areas such as the real estate market and placed them in the wind power market.
In the meantime, there are wind and weather derivatives that can be traded. However, it is of great importance to note that that the APS companies expand their field of activity not only by creating new products. Their presence is already necessary in the case of a transaction of wind energy projects, in order to examine and evaluate projects and to carry out a due diligence. (INTVW 20 Consultant, 2016, para. 11). Due to the professionalization and the now high complexity and risk requirements of institutional investors, it is impossible to commission a transaction without commissioning services from APS firms. It seems as if the financial sector has already become indispensable and is thus well placed in the commodity chain. Therefore, this hypothesis can also be verified.
Summarized it can be said, that new financial products have been created to hedge risks and optimize returns. The dissertation has proved that the establishment of such products extend the financial sector’s field of activity. It could not be proved that these processes led to a change of actors and their functions, but it could be proved that due to these processes

new actors and new functions have been established in the wind energy commodity chain.

**Hypothesis 1c:** Wind energy projects and electricity from wind energy are increasingly being traded and becoming an object of speculation, which changes the commodity chain's structure.

This hypothesis was addressed in the empirical part of this dissertation. A distinction was made between wind energy projects and electricity, which is produced by wind energy projects. With regard to the trade of electricity, it has been shown that the amount of traded electricity in Germany greatly exceeds German amount of electricity consumption. As can be determined by the interviews, trade is an important part of the financial sector (INTVW 10 Electricity Trader, 2016, para. 19). Trade as instrument for hedging and securing required amount of electricity is no longer the focus of attention, but rather the focus now lies on taking advantage of prices and price differences. Therefore, the hypothesis that electricity, including electricity from wind parks, is increasingly being traded and has also become an object of speculation can be verified.

It is worth mentioning a comment an electricity trader said in an interview. Electricity trading is largely automated, supported by computer programs that can buy and resell large amounts of electricity within a few milliseconds, and incorrect manual inputs can also lead to chain reactions where the market collapses (INTVW 10 Electricity Trader, 2016, para 45, 47, 49). Keeping this in mind it puts more emphasis on Harvey (2006) which stated "the large financial conglomerate has achieved the capacity to switch capital and manpower from one line to another and from one part of the world to another in the twinkling of an eye" (Harvey, 2006, p. 147). Finally, it must be added that the electricity from wind energy is not an individual case, but that all electricity from any source is treated equally at the electricity exchange (INTVW 10 Electricity Trader, 2016, para. 5). This means that wind energy is not traded more or less frequently than electricity from conventional energy sources.

In the case of trade and speculation of wind energy projects it was shown that wind energy projects and operating wind parks are traded more often than before. In addition, the investment period of investors has declined over time. The reasons for the growing trade rates can be explained as follows. On the one hand, many new investors from other investment areas have entered the wind energy market. Fixed remuneration gave the wind energy market a secure reputation with similarities to government bonds. At the same time, the return requirements have steadily declined (INTVW 08 Manufacturer, 2016, para. 55). Combined, these two factors have established the wind energy market as a very strong seller's market and have motivated operators of wind parks to sell their wind parks. However, a speculation of wind energy projects could not be observed within this dissertation (INTVW 04 Broker, 2015, para. 35). Therefore, only the part of this hypothesis pertaining to growing trade can be verified. However, it is to be assumed that due to the tendering process established in the EEG 2017 large-scale investors and actors are purchasing many small projects which are not yet erected. With these projects, financially strong investors can speculate as to whether the projects exceed the bidder's bid and receive a surcharge from the Federal Network Agency and thus can be realized.

**Key question 1:** Do financialization processes influence the German wind industry's commodity chain structure and do financialization processes change the actors and their functions?

As has been shown, there are financialization processes in the German wind industry. These processes affect the entire structure of the chain. Not only an increased trading behavior could be observed, but some initial signs of speculation could also be identified. From a niche market for the electricity generation of renewable energy, financial service providers have created an investment project for wind energy that is freely traded across national borders. It seems as if it is no longer the goal to produce green electricity but only to generate more returns than one would get with government bonds. At the same time, the financial sector not only changes the actors, but also partially takes over tasks from actors and replaces them in the chain. In addition, completely new actors from the financial economy have established themselves, which also perform new functions in the commodity chain.

**Hypothesis 2a:** The influence of the financial sector in the wind industry is increasing, which leads to a rising command and control position of financial actors in the commodity chain.

This hypothesis relates to governance in the wind energy commodity chain. It has been shown that the influence of the financial sector is steadily increasing. On the one hand, the total costs for projects per installed MW have steadily increased and will continue to rise in the future. As a general rule, the projects were financed by a bank through the rising investment costs and the debt capital increased due to rising investment costs. As the analysis of the interviews showed, the more a bank or an investor makes available to leverage, the more the bank or investor wants to have co-right to speak and is already intervening in operational decisions at an early stage of the project (INTVW 06 Project developer, 2015, para. 49).

On the other hand, the accumulation of capital in the market and the low interest rate policy have pushed the return expectations down sharply. Many projects are completely optimized by various measures. The final set-up to make a project more economical is the financial optimization. This is done either through tax optimization or a new structured financing (INTVW 05 Fund Manager, 2015, para. 27). Here, the financial sector can play on its strengths and knowledge that has been generated in other investment sectors.

As shown, the leverage effect is particularly important. As a result of the reduction in the equity ratio, the total IRR can be drastically increased (INTVW 13 Project developer, 2016, para. 43). For this purpose, however, experienced financial institutions are needed who can reduce the project's equity by means of certain know-how and ideas, as well as banks who are willing to take risks, who approach these ideas and proposals. For this reason, the financial sector is an important factor to influence both the capital side and the loan side.

**Hypothesis 2b:** Due to the rising power position, the financial sector receives extensive command and control functions within the chain, creates market barriers, controls market entries and thus has decision making power not only in the financial economy but also in the real economy.

Due to the analysis in this dissertation it turned out that the financial sector sits at a so-called switchman position. The reason for this power position is the knowledge transfer. The financial sector addressed here, with its APS, sits between the production space and the financial space. Thus, the financial sector is informed on the one hand by the transfer of knowledge from the financial space, knows the market situation in the financial market, recognizes trends and knows what the financial market needs for investments (INTVW 19 Financial Service Provider, 2016, para. 33).

Based on the results from the interviews it can be concluded that there is on the other hand a knowledge transfer with the production space. The financial sector knows what products exist in the market, where potentials can be improved and how to make the existing products palatable to the financial market (INTVW 20 Consultant, 2016, para. 7). The collected knowledge can be used to offer services, advice and consultancy on both sides. This accumulation of knowledge is not to be underestimated. As an extensive due diligence process is usually carried out with each transfer and financing of wind parks, the APS firms are given an above-average market overview. The service providers will receive information about prices, delivery times, guarantees, contract structures, customers, suppliers and plenty of other market information. Banks also see many different contracts and guarantees from their different customers and thus the banks also pursue a sort of cherry picking, as they want to have the best of everything while structuring finance (INTVW 26 Manufacturer, 2016, para. 25). In addition, the financial sector creates new circuits of value. This is achieved by the creation of new products[101], which in turn provides investors with a return on their investment.

The last function that is taken at the power position is the function of capital switching. Capital is thus transformed into another form of fixed capital. All three functions give the financial sector comprehensive command and control functions. Since a bank has become indispensable to the financing of wind parks, this can have an enormous impact not only on the financing itself but also on the real economy. The largest

[101] The creation of new products has been already discussed in this chapter with Hypothesis 1b: To hedge risks and optimize returns, new financial products are created that extend the financial sector's field of activity, which leads to a change of actors and their functions (p. 256).

value added share in a wind park project is the WTG itself. Banks can decide whether a WTG is bankable or not (INTVW 20 Consultant, 2016, para. 19; INTVW 13 Project developer, 2016, para. 71). For example, the bank can even prescribe the manufacturer which countries his suppliers may come from and which countries they cannot (INTVW 24 Manufacturer, 2016, para. 32). If a WTG cannot be financed, it is almost unsaleable. This can result in a vicious cycle for a manufacturer. Because the bank can demand a minimum number of built WTG before the bank is able to finance the WTG (INTVW 24 Manufacturer, 2016, para. 9). A financial investor can, for example, only buy WTGs, which have a corresponding market reputation, through financial institutions and through provisions from a fund (INTVW 05 Fund Manager, 2015, para. 7). This means that the bank sits at the crucial leverage point and thus creates market barriers as well as controls market entries.

**Hypothesis 2c:** Corporate management decisions are increasingly taken in a way that the business strategy is focused on shareholder value and thus the decision making is based on the return on investment.

Interviews with managers of listed wind turbine companies have shown that public statements about the operating business have an enormous impact on the share price and therefore also on the company value (INTVW 23 Financial Service Provider, 2016, para. 39). The quarterly reports focus on operational issues. Very good numbers are expected to be presented every quarter (INTVW 23 Financial Service Provider, 2016, para. 41). However, it has been shown in this dissertation that the market actors of the German onshore wind industry are still strongly influenced by small and medium-sized enterprises. These companies are not listed on a stock exchange and account for the majority of all actors in the wind industry. The analysis has shown that, with a few exceptions, listed companies are restricted to the sector of manufacturers. Therefore, the statements of managers of these listed companies cannot be regarded as representative for the whole industry.

However, individual cases were recorded in which manufacturers listed on stock exchanges were purchased by hedge funds (INTVW 04 Broker, 2015, para. 33). These companies were then taken off the stock exchange for a certain period of time, to start a new IPO at a later date. Experts have said in interviews that during the break the balance sheets were brightened by certain measures in order to achieve a better result during the stock exchanges. This particular case shows that the shareholder value is obviously the most important priority. However, this remains a unique case in the German onshore industry. Whether the behavior of the listed companies deviates from the shareholder value of other companies in other industries with similar size has not been analyzed but is to be doubted.

Therefore, this part of the hypothesis cannot be verified but cannot be falsified either. Nevertheless, a strong awareness of returns is apparent in all interviews. When one changes perspective from corporate decisions to the project level, it becomes clear through the interviews that the return on the performance of the projects for sellers and investors is the most important issue (INTVW 03 Project developer, 2015, para. 61). The technically most sensible or the most human-friendly and environmentally-friendly solution is in the background during transactions and in the planning process of the projects. The decision-makers move away from the real economy to the financial economy. Thus, the hypothesis can only be partly answered and with a limited degree of certainty.

**Key question 2:** How is governance organized within the wind energy commodity chain and is governance changed by financialization processes?

The organization of governance in the commodity chain has been illustrated. Initially, the market was dominated by project developers. The projects themselves, and not the turbine technology, were at the forefront. However, this has changed very quickly and extremely. Driven by profitability and falling compensation rates, it was necessary to use the best technology for the site. This lead to a market dominance of the manufacturers. The interviews showed that they could charge different high prices depending on the prognosticated wind potential on site. Manufacturers were busy and this led to very long delivery times for the turbine components (INTVW 03 Project developer, 2015, para. 71). The manufacturers were thus in a very comfortable and dominating position.

At the beginning of the development of the wind industry the manufacturers' dominance was limited to the process of planning, manufacture and construction. The interviews showed, that when the maintenance business proved to be profitable and provide a constant cash flow, the manufacturers also began to dominate the operation of wind turbines. Along with these changes, the financial sector was able to build up an extensive power position through its position, to provide equity and debt as well as related services. On the debt side banks have extensive command and control functions and on the equity side these functions are performed by professionalized financial investors. This governance structure is supported by an established network of service providers who specialize in the structuring of financing, the creation of investment funds and the audit or due diligences processes of projects and investments and which have a significant influence on the equity and debt side of due to their advisory mandates (INTVW 19 Financial Service Provider, 2016, para. 57).

**Hypothesis 3a:** Changes in the institutional framework strengthen the position of the financial sector in the wind energy commodity chain.

The empirical investigation has shown that the institutional framework in which the German wind industry is embedded has changed greatly. The following reasons could be identified for this change within this dissertation. The financial crisis starting in 2008 and the uncertainty in the stock market also led to capital flowing into the German wind energy market. Furthermore, since 2009, the entire economy has been in a low-interest phase. In the wind industry, the consequences of the low-interest phase are visible. The low interest rate also affected interest rates on the required debt. This enabled financial services providers to structure return-optimized financing to counteract falling returns in the market.

At the same time, further financial investors were pouring into the German wind industry, driven by high investment pressure (INTVW 03 Project developer, 2015, para. 45). The analysis of this dissertation has shown that the wind industry has developed into a low-risk investment model and a constant investment model in relation to other forms of investment. This growth has transformed the structure of operators in Germany in favor of the financial sector. In addition, it has been shown that the legal situation for renewable energies has changed steadily (INTVW 05 Fund Manager, 2015, para. 21). The regulations of the EEG have not only become more complex, but the progressive degression of remuneration has led to an enormous cost pressure, which could be proved with the help of the interviews (INTVW 07 Project developer, 2016, para. 5). The financial sector, with its APS, plays a special role here. Since the financial sector has acquired a great deal of industry knowledge and is very well informed about current prices and demand, it has been able to optimize the cost structure as a service provider at various cost positions within projects to make wind energy projects more profitable (INTVW 18 Lawyer, 2016, para. 51). The largest legislative change was made by the EEG 2017. Since the project owner only receives a feed-in tariff in an auction procedure and one has to deposit the bid with a financial security, this favors the situation of financially strong investors (INTVW 22 Investor, 2016, para. 5). This will in the lead to the operating structure developing further towards financially strong investors in the future. Thus, it can be stated, that the changes in the institutional framework strengthen the position of the financial sector in the wind industry.

**Hypothesis 3b:** Through changes in the institutional framework, wind energy plays a larger role in the capital market and thus attracts investment from other investment sectors.

Through the interviews, it was possible to determine that a predictable policy is the most important component for a stable wind energy market. Through fixed remuneration for a fixed period of time, wind energy as an investment form was ideally suited for capital investments (INTVW 11 Utility, 2016, para. 20). This has also been supported by the fact that Germany is a safe investment location with no surprises for investors (INTVW 03 Project developer, 2015, para. 41). International investment funds have confirmed that investments in Germany with a comparable lower return are preferable to investments in other European countries with comparable higher returns (INTVW 05 Fund Manager, 2015, para. 53). This is justified by the secure institutional framework in Germany. This led to an enormous increase in wind park funds which were brought to the market. As presented, financial service providers developed a variety of other investment products. A completely new industry for financial products from wind energy developed. It turned out that wind parks offer ideal investment opportunities. As a result, a high proportion of loan capital leads to a high payment of interest. Paying interest was made into an interesting investment vehicle for investors via tax depreciation models (INTVW 06 Project developer, 2015, para. 17). In addition, wind park projects can be structured in such a way as to provide an annual payout, which is very attractive for institutional investors, as they require an annual cash event.

In addition, wind energy projects are designed for 20 years, which provides an ideal investment horizon for insurance companies and pension funds, which could be concluded from the interviews (INTVW 13 Project developer, 2016, para. 20; INTVW 23 Financial Service Provider, 2016, para. 15). The image of wind energy in the investment sector should also not be discounted. Wind energy is considered a green investment by producing environmentally friendly electricity. This led to a sharp increase in investment products. These products formed a competing product for real estate funds, ship investments and investments in aircraft. The relatively high and stable returns despite the weak investment environment were attractive for the investors (INTVW 07 Project developer, 2016, para. 69). The signals were conveyed from the financial market that there is a high investment pressure. Thus, the wind industry has created a completely new investment area. In summary, it can be said that wind energy plays a greater role in the capital market and also attracts investments from other investment sectors. However, the reasons for this are not only the changes in the institutional framework, but also the involvement of the financial sector. Due to the mentioned changes in the institutional framework, it can be confirmed, that wind energy plays a larger role in the capital market and also attracts investment from other investment sectors.

**Hypothesis 3c:** Due to changes and a financialization of the industry, the readiness to assume risks increases, so that wind energy projects and the whole commodity chain are more susceptible to crises.

The interviewees agreed that the degression set down in the EEG, was responsible for stimulating cost-efficient projects, which triggered a strong cost pressure throughout the sector. Despite various changes and the enormous cost pressure, policy changes have been always very predictable. However, this led to a constant drop in the risk-return ratio

(INTVW 20 Consultant, 2016, para. 15). At the same time, however, the interviews showed that politics is also the greatest risk to the wind industry.

Due to tender in the EEG 2017, the risk-return ratio has now fundamentally changed. The tender does not provide a complete guarantee to get a bid and thus a feed in tariff. This means that all investments in the commodity chain up to construction are subject to considerable risk (INTVW 19 Financial Service Provider, 2016, para. 49). This will lead to a considerable change in the structure of the actors in Germany. Small project developers and individual investors will find it increasingly difficult in the tender process. Large financially strong actors, secured by large financial investors, can appear quite differently in a bidding process. Through their financial strength, they can enter the tender with many different projects and split the risk across the number of their projects (INTVW 07 Project developer, 2016, para. 47; INTVW 06 Project developer, 2015, para. 25).

The empirical analysis has shown that due to the low interest rate, the investment pressure and the great competition, the readiness to carry risks due to the EEG 2017 has increased (INTVW 07 Project developer, 2016, para. 5). In addition, the financial sector has developed various financial products for the financing of wind parks which pose a considerable risk. However, interviews with investors and banks have shown that banks do not put wind energy projects into bankruptcy if the debt service cannot be provided because the banks are also involved in the projects with their high share of leverage. The analysis has shown that there has already been a small crisis in the wind industry (INTVW 26 Manufacturer, 2016, para. 9). Due to the fact that current investments in wind energy are subject to significantly more risks and fewer safety margins than before, the potential for a crisis would increase if interest rates are strongly increased after the expiry of the fixed interest period or if the wind conditions deteriorate drastically in the coming years. Added to this, there is still a political risk that legal changes will lead to subsequent changes in the business case and worsen it (INTVW 22 Investor, 2016, para. 35). All three factors are possible in the future.

**Key question 3:** How does the institutional framework affect the German wind industry and do changes of the institutional framework favor financialization processes?

It has been stated and argued that the institutional framework has a significant impact on the wind industry. These include the capital market, interest rate policy and legislation under the EEG. The aim of the policy is to transfer electricity from wind energy into a free market. On the one hand, the growing risks serve as the basis for the creation of financial products, which are intended to manage these risks. On the other hand, the increasing risk prompts a change in the structure of the actors in the German wind industry. Small project developers and citizens' wind parks will disappear from the scene (INTVW 06 Project developer, 2015, para. 41). There will be an increasing number of actors from the financial economy active in the wind industry. These financial institutions are embedded in a network of financial services providers who are gradually being drawn into this industry and are specializing there. It is therefore proved that the institutional framework promotes financialization processes. Through the existing networks these processes are even raised to an international level, which makes the financial service network even bigger.

## 5.3 Causes of a Wind Energy Crisis

In the German wind industry, financialization processes take place and wind energy has developed into a tradable commodity. The risk of realizing projects is increasing in Germany and at the same time the entire electricity sector is to be further liberalized. The first signs of crises have already emerged in the wind industry. Is there a crisis in the wind industry as a result of the progressive financialization?

Crises can be understood and interpreted differently according to the scientific discipline. However, a crisis can generally be characterized as a difficult position, situation or time, which is the height and turning point of a dangerous development. Furthermore, crisis refers to a difficulty, a critical situation or a time of danger (Dudenredaktion, 2015).

How would a crisis in the wind industry emerge? The wind industry already encountered a difficult situation with negative development tendencies in 2002 and 2003. Some interview partners talked about a crisis in this context. During this period, private insolvencies and company insolvencies also increased, which has led to the sale of many wind energy projects on the market (INTVW 06 Project developer, 2015, para. 19). Many wind parks have gone bankrupt because the wind reports have been overvalued, the forecasted wind has not materialized, and the investors have also had a very different distribution ratio from the cash flow (INTVW 22 Investor, 2016, para. 15; INTVW 25 Financial Service Provider, 2016, para. 62). In the end, the market for wind energy has not collapsed, which would speak against a crisis at this time. However, this is also due to the fact that the bank has kept its protective hand over the project companies in case of insolvency. In many cases, the banks would therefore have to make the credit immediately due and thus have to drive the company into bankruptcy. However, this has never been done in practice, since the bank refinanced itself through KfW and a depreciation of a finance thus had worsened the banks' balance sheet. Thus, the banks have deferred, reduced or suspended the redemptions (INTVW 23 Financial Service Provider, 2016, para. 26, 27).

As this dissertation has shown, politics is the greatest threat to the wind industry. Until now, wind energy policy, through the EEG, created a market environment with stable conditions for the market participants to make planned investments. Due to the constant reductions in remuneration, on the one hand incentives were given to put wind parks into operation as soon as possible and on the other hand to be cost-efficient as far as possible. The invitation to tender has led to a sustainable change in the framework conditions. Since now an investor must offer a price but does not know whether he gets a surcharge for his bid, there is an increasing the uncertainty in the market. This uncertainty creates a sense of crisis in the German wind industry (INTVW 19 Financial Service Provider, 2016, para. 85).

At this time, however, no statement can be made as to whether wind energy is in a crisis. The first tender was in May 2017. A total of 2,800 MW will be distributed in 2017. This amount is far below the annual

installed wind capacity in recent years[102]. These figures show that manufacturers in Germany will have enormous overcapacities. Since factories must be constantly used to capacity by turbine manufacturers, this could lead to short-time work or even factory closures in Germany. The German manufacturer Senvion already announced in March 2017 that a large part of the production factories in Germany will be closed, and other factories are completely abandoned in other European countries. Furthermore, of the more than 100 project developers who have established themselves in the market in Germany, it is highly likely that only about 30 or less project developers will remain in the long term. These will be the developers who can offer competitive prices in the tender. This does not necessarily mean that small project developers will leave the market. There is also the possibility that these are bought up by large project developers, or consolidation or other mergers occur. Nevertheless, these would be the first signs of a crisis in the industry. It remains to be seen in the following tendering sessions how many project developers and investors will not be awarded their projects. However, at the present time, it can also be said that operators have to carry more risks through the tendering procedure and the enormous cost pressure than before. However, it follows that a system in which more risks have to be taken is more susceptible to crises, since the probability of any risk occurring is greater (INTVW 25 Financial Service Provider, 2016, para. 60).
But how these risks are recognized and finally evaluated? The task of APS firms as law firms during due diligence processes is to demonstrate these risks. In doing so, an APS firm takes an advisory role. If, therefore, an APS firm advises a client not to take certain risks, this advice is usually followed. Because as reported from interviews, a certain sovereignty of a client is required to enforce the recommendation of the legal department. An experienced lawyer reported in an interview that it is very difficult for a merchant to avoid legal reports from lawyers, which contain considerable risks (INTVW 18 Lawyer, 2016, para. 3). In fact, one lawyer went so far as to say, "we do not make the deal. [...]. Then it is always up to the company itself, whether the one who is responsible for

[102] The annual installed capacity was in the last years as follows: 2014: 4,750 MW; 2015: 3,731 MW; 2016: 4,625 MW.

the business can assert himself against the lawyer. Because the reflex of the lawyer [...] is then immediately to write a memo which says, that this is happening against my advice. This is in order not to get the accusation afterwards that you allowed something that went wrong" (INTVW 18 Lawyer, 2016, para. 25).

This influence of APS firms leads to the fact that companies, who are advised by APS firms do not carry certain risks. But what happens if the risk tolerance of the customer changes, as well as the risk tolerance of the consulting company? Eventual the "[c]ompetition within the APS complex played an important role in shaping the financial crisis of 2008 when finance was exposed to feed on itself. This was a typical case where holders of a class monopoly acted against their own class interest by endangering the class monopoly position. Nevertheless, we observe that this class monopoly has largely been reconstituted, despite the endurance of the crisis" (Bassens and van Meeteren, 2015, p. 17).

As stated, this competition also changes the risk tolerance of the participants in the chain. As a banker, who supervises many customers and wind parks, explains "the willingness of institutional investors to take risks is increasing. While it was only a few years ago that they started to buy wind parks after commissioning […] where the risk is lower, today, driven by the […] pressure on investments to get projects, […] they are ready accompany the construction phase with own money. And they are partly also ready to go into project development and pay money […]. They are prepared to take risks because it is a highly competitive market and because the demand cannot be met at the moment" (INTVW 14 Bank, 2016, para. 75).

The problem is that the participants are changing and an increasing number of pension funds and other institutional investors are pouring into the wind energy market. It seems that these actors "invest in wind energy as if it were a government loan. Absolutely safe with a 3 % return […]. In wind energy, where there are also operational risks […]" (INTVW 26 Manufacturer, 2016, para. 7). As a result of the change in the actor structure, it is likely that the relationship to the operational risks that exist in the wind industry is lost or at least changes.

Taking into account all the above factors and arguments, and the fact that the impact of the tender takes some time to have negative consequences in the industry, it can be assumed that from 2018 or 2019 the first consequences and crises-like phenomena will be observed in the German wind industry. Seen from the perspective, this will represent a similar crisis to the one the wind industry in Germany has already experienced. The crisis may be somewhat more pronounced. But it cannot be assumed that the wind industry will collapse and break down in Germany. It remains to be seen how the heat sector and the mobility sector will develop in the near future. If there is a strong shift in these two sectors, which means that heat and mobility can be supplied by renewable energies and electricity can be stored in batteries, new business areas are opened up which have not yet been financed at all. It remains to be seen whether these new business areas will counteract a possible crisis in the wind industry.

## 5.4 Outlook and Resulting Further Research

The energy sector is radically changing. Energy is no longer produced centrally in large power plants, but is decentralized in small production units based on renewable energies. The energy revolution is on track to grow and expand further not only in Germany, but worldwide. In Germany, at least, it is only a matter of time, until the use of coal ends. With a view to wind energy in Germany, it has become clear that the market for wind energy onshore is already very saturated. Regarding wind energy offshore, however, it is to be assumed that the market is only beginning to blossom. However, these investments are not comparable with the volumes made onshore. Therefore, offshore actors play a very different role. But financialization processes are also likely to become increasingly apparent offshore. This should be analyzed in further research studies.

Renewable energies worldwide will continue to grow steadily. Climate-neutral investments will become more and more important and thus increasingly important for financial services providers. The liberalization of the electricity market will continue in Germany, but also in Europe and the rest of the world. With regard to the power grids, a European power grid or maybe even a worldwide power grid will develop someday. It sounds like science fiction, but what if China produces wind energy and sells it in Germany? Technically this is already possible with ultra-high-voltage cables. Despite electricity generation costs, grid feed-in costs, transport and distribution costs, the sales price of this Chinese wind energy could even be offered at competitive prices in Germany. Networks will therefore play a decisive role in the future. Again, many new business ideas and investments in the financial sector are possible. Here, also further research is needed to analyze these business models regarding smart power grids.

But other developments, such as the blockchain technology that allows direct transactions of electricity, could also change the energy sector. This technology is already common in the banking sector and could also be used in the energy sector. The focus is on prosumers, who produce and consume electricity directly. One could sell this electricity in the future using the blockchain technology, without the need for a utility or electricity supplier for billing. In addition to the direct exchange of electricity, automated billing would also be possible for the producers. The reading, invoicing or even the documentation by a separate provider would be superfluous.

In addition to this, besides the energy revolution there will be also a heat revolution and a mobility revolution. Whether battery storage or hydrogen will continue to occur, especially in the case of mobility, remains unclear. Hydrogen is currently the only efficient, emission-free energy carrier that allows energy transfer across all three sectors in the required dimension and flexibility while decoupling power supply and energy demand. However, depending on an increase in the performance of batteries, the battery-powered drive could assert itself against the hydrogen technology. Perhaps a mix of both will be the most effective way.

In summary, however, these shifts result an enormous economic potential and thus also enormous potential for the financial sector. Thus, these developments also provide space for financialization processes. Therefore, there is a great need for research in these areas in order to show developments, to develop recommendations for action and to counteract negative development trends. This is the only way to achieve a shift in these areas and to drive forward the success story of the energy revolution and making it one of the largest modernization and investment projects of our time, bringing together climate protection and economic prosperity.

# Bibliography

Aalbers, M.B., 2008. The Financialization of Home and the Mortgage Market Crisis. Compet. Change 12, 148–166. doi:10.1179/102452908X289802

Abdelal, R., 2009. Capital Rules. Harvard University Press.

Adrian, J.M., 2017. Modularization in the Wind Turbine Industry - Discontinuity in the Governance of Value Chains and its Spatial Implications. LIT Verlag Berlin-Münster-Wien-Zürich-London.

AEE, 2014. Akteure der Energiewende - Großteil der Erneuerbaren Energien kommt aus Bürgerhand. Agentur für Erneuerbare Energien.

AGEB, 2016. Bruttostromerzeugung in Deutschland 2015 in TWh. AG Energiebilanzen.

Agora Energiewende, 2013. Entwicklung der Windenergie in Deutschland - Eine Beschreibung von aktuellen und zukünftigen Trends und Charakteristika der Einspeisung von Windenergieanlagen. Fraunhofer IWES.

Allen, J., 2009. Three spaces of power: territory, networks, plus a topological twist in the tale of domination and authority. J. Power 2, 197–212. doi:10.1080/17540290903064267

alpha ventus, 2010. alpha ventus - Ein Offshore-Windpark entsteht. Deutsche Offshore-Testfeld und Infrastruktur GmbH & Co. KG.

ARL, 2017. Eignungsgebiet / Vorranggebiet - Suitable Area / Priority Area. Akademie für Raumforschung und Landesplanung.

Arnold, R.A., 2013. Economics. Cengage Learning.

Arrighi, G., 1994. The Long Twentieth Century: Money, Power, and the Origins of Our Times. Verso.

AWEA, 2017. AWEA U.S. Wind Industry Annual Market Report Year Ending 2016. American Wind Energy Association.

Ayee, G., Lowe, M., Gereffi, G., 2009. Wind Power (Chapter 11): Generating Electricity and Employment. Manuf. Clim. Solut. - Carbon-Reducing Technol. US Jobs.

Bair, J., 2014. Editor's Introduction: Commodity Chains in and of the World-System. Spec. Issue Polit. Econ. Commod. Chains 20, 1.

Bair, J. (Ed.), 2008. Frontiers of Commodity Chain Research. Stanford University Press, Stanford, Calif.

Bair, J., 2005. Global Capitalism and Commodity Chains: Looking Back, Going Forward. Compet. Change 9, 153–180. doi:10.1179/102452905X45382

Bair, J., Gereffi, G., 2003. Upgrading, uneven development, and jobs in the North American apparel industry. Glob. Netw. 3, 143–169.

Bamber, P., Fernandez-Stark, K., Gereffi, G., 2016. Peru in the Mining Equipment Global Value Chain: Opportunities for Upgrading (Report). Duke CGGC (Duke University, Center on Globalization, Governance & Competitiveness).

Bankenverband, 2014. Zahlen, Daten, Fakten der Kreditwirtschaft. Bundesverband deutscher Banken e. V.

Bassens, D., van Meeteren, M., 2015. World cities under conditions of financialized globalization: Towards an augmented world city hypothesis. Prog. Hum. Geogr. 39, 752–775. doi:10.1177/0309132514558441

Baud, C., Durand, C., 2012. Financialization, globalization and the making of profits by leading retailers. Socio-Econ. Rev. 10, 241–266. doi:10.1093/ser/mwr016

BDEW, 2015. Netto-Stromverbrauch nach Verbrauchergruppen Entwicklung 1998 - 2014. Bundesverband der Energie- und Wasserwirtschaft e.V.

Becht, M., Röell, A., 1999. Blockholdings in Europe: Eur. Econ. Rev. 43, 1049–1056. doi:10.1016/S0014-2921(98)00113-5

Bergek, A., Jacobsson, S., 2003. The emergence of a growth industry: a comparative analysis of the German, Dutch and Swedish wind turbine industries, in: Metcalfe, P.J.S., Cantner, P.D.U. (Eds.), Change, Transformation and Development. Physica-Verlag HD, pp. 197–227.

BIS, 2016. OTC derivatives statistics. Bank for International Settlements.

BlackRock, 2015. Viewpoint - BlackRock weltweit führend in der Vermögensverwaltung und im Risikomanagement. BlackRock Inc.

Blaikie, N.W.H., 1991. A critique of the use of triangulation in social research. Qual. Quant. 25, 115–136. doi:10.1007/BF00145701

Blanco, M.I., 2009. The economics of wind energy. Renew. Sustain. Energy Rev. 13, 1372–1382. doi:10.1016/j.rser.2008.09.004

Bloss, M., Ernst, D., Häcker, J., Eil, N., 2009. Von der Subprime-Krise zur Finanzkrise : Immobilienblase: Ursachen, Auswirkungen, Handlungsempfehlungen. München : Oldenbourg.

BMWi, 2015. Erneuerbare Energien im Jahr 2014 - Erste Daten zur Entwicklung der erneuerbaren Energien in Deutschland auf Grundlage der Angaben der Arbeitsgruppe Erneuerbare Energien-Statistik. Bundesministerium für Wirtschaft und Energie.

BMWi, 2014. Eckpunkte für die Reform des EEG. Bundesministerium für Wirtschaft und Energie.

Bogner, A., Littig, B., Menz, W., 2014. Interviews mit Experten: Eine praxisorientierte Einführung. Springer-Verlag.

Borchert, J., Schemm, R., Korth, S., 2006. Stromhandel, 1st ed. Schäffer-Poeschel.

Böttcher, J., Blattner, P., 2013. Projektfinanzierung: Risikomanagement und Finanzierung, überarbeitete Auflage. ed. Oldenbourg Wissenschaftsverlag, München.

Böttcher, J., Blattner, P., 2009. Projektfinanzierung, unveränderte Auflage. ed. Oldenbourg Wissenschaftsverlag, München.

Bottler, S., 2011. Jonglieren mit großen Teilen - Windkraft-Analgenhersteller Nordex spart durch systematische Lieferkettenplanung zehn Prozent bei den Logistikkosten ein. VerkersRundschau 37/2011.

Brown, E., Derudder, B., Parnreiter, C., Pelupessy, W., Taylor, P.J., Witlox, F., 2010. World City Networks and Global Commodity Chains: towards a world-systems' integration. Glob. Netw. 10, 12–34. doi:10.1111/j.1471-0374.2010.00272.x bsi, 2014. Branchenzahlen 2013. Bundesverband Sachwerte und Investmentvermögen e.V.

BTM Consult, 2015. World Wind Energy Market Update 2015.

Bundesnetzagentur, 2016. EEG in Zahlen für das Berichtsjahr 2014. Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen.

BWE, 2015. Positionspapier des Bundesverbandes Windenergie zu den Herausforderungen bei Schwerlasttransporten. Bundesverband WindEnergie e.V.

BWE, 2014. Inhalte von Verträgen zur technischen und kaufmännischen Betriebsführung - Leitfaden des Betriebsführerbeirats im Bundesverband WindEnergie. Bundesverband WindEnergie e.V.

BWE, 2012a. Potenzial der Windenergienutzung an Land. Bundesverband WindEnergie.

BWE, 2012b. Repowering von Windenergieanlagen - Effizienz, Klimaschutz, regionale Wertschöpfung. Bundesverband WindEnergie e.V.

BWE, 2012c. BWE Marktübersicht Spezial- Windenergie Finanzierung - Onshore & Offshore, Bundesverband WindEnergie e.V.

BWE, 2002. Zahlen und Fakten zur Windenergie. Bundesverband WindEnergie e.V.

Capital Stage, 2016. Geschäftsbericht 2016. http://www.capitalstage.com/investor-relations/ publikationen.html.

Capital Stage, 2015. Geschäftsbericht 2015. http://www.capitalstage.com/investor-relations/publikationen.html.

Capital Stage, 2014. Geschäftsbericht 2014. http://www.capitalstage.com/investor-relations/publikationen.html.

Capital Stage, 2013. Geschäftsbericht 2013. http://www.capitalstage.com/investor-relations/publikationen.html.

Capital Stage, 2012. Geschäftsbericht 2012. http://www.capitalstage.com/investor-relations/publikationen.html.

Capital Stage, 2011. Geschäftsbericht 2011. http://www.capitalstage.com/investor-relations/publikationen.html.

Capital Stage, 2010. Geschäftsbericht 2010. http://www.capitalstage.com/investor-relations/publikationen.html.

Christopherson, S., Martin, R., Pollard, J., 2013. Financialisation: roots and repercussions. Camb. J. Reg. Econ. Soc. 6, 351–357. doi:10.1093/cjres/rst023

Clark, G.L., Wójcik, D., 2003. An Economic Geography of Global Finance: Ownership Concentration and Stock-Price Volatility in German Firms and Regions. Ann. Assoc. Am. Geogr. 93, 909–924. doi:10.1111/j.1467-8306.2003.09304012.x

Coe, N., Kelly, P., Yeung, H.W.C., 2013. Economic Geography: A Contemporary Introduction, 2nd ed. John Wiley & Sons, Hoboken, N.J.

Coe, N.M., 2012. Geographies of production II: A global production network A-Z. Prog. Hum. Geogr. 36, 389–402. doi:10.1177/0309132511402784

Coe, N.M., Dicken, P., Hess, M., 2008. Global production networks: realizing the potential. J. Econ. Geogr. 8, 271–295. doi:10.1093/jeg/lbn002

Coe, N.M., Lai, K.P.Y., Wójcik, D., 2014a. Integrating Finance into Global Production Networks. Reg. Stud. 48, 761–777. doi:10.1080/00343404.2014.886772

Coe, N.M., Lai, K.P.Y., Wójcik, D., 2014b. Integrating Finance into Global Production Networks (SSRN Scholarly Paper No. ID 2252622). Social Science Research Network, Rochester, NY.

Crang, M., Hughes, A., Gregson, N., Norris, L., Ahamed, F., 2013. Rethinking governance and value in commodity chains through global recycling networks: Rethinking governance and value in commodity chains. Trans. Inst. Br. Geogr. 38, 12–24. doi:10.1111/j.1475-5661.2012.00515.x

Czaykowski, M., Wink, K., Theiselmann, T., Gehring, H., 2009. Konsumverhalten und Hypothekenmarkt in den USA, in: Elschen, P.D.R., Lieven, D.T. (Eds.), Der Werdegang der Krise. Gabler, pp. 29–45. doi:10.1007/978-3-8349-8547-7_2

DECC, 2012. Electricity Generation Costs (December 2013). The Department of Energy & Climate Change, United Kingdom.

Decker, C., 2008. Internationale Projektfinanzierung: Konzeption und Prüfung, 1., Aufl. ed. Books on Demand, Norderstedt.

Deutsche Kreditbank, 2015. Liste - Durch die DKB annerkannte Windgutachter. Deutsche Kreditbank AG.

Deutsche WindGuard, 2015a. Kostensituation der Windenergie an Land in Deutschland Update. Deutsche WindGuard GmbH.

Deutsche WindGuard, 2015b. Status des Windenergieausbaus an Land in Deutschland - Zusätzliche Auswertungen und Daten für das Jahr 2014. Deutsche WindGuard GmbH.

Deutsche WindGuard, 2014. Kostensituation der Windenergie an Land - Internationaler Vergleich. Deutsche WindGuard GmbH.

Deutsche WindGuard, 2013. Kostensituation der Windenergie an Land in Deutschland. Deutsche WindGuard GmbH.

DEWI, 2016. Windenergienutzung in Deutschland. 31.12.2015. DEWI Magazin 48.

DEWI, 2002. Studie zur aktuellen Kostensituation der Windenergienutzung in Deutschland 2002. Deutsche Windenergie-Institut, DEWI Magazin Nr. 21.

DEWI, 1999. Studie zur aktuellen Kostensituation der Windenergienutzung in Deutschland - Endbericht. Deutsche Windenergie-Institut.

Dicken, P., 2015. Global Shift: Mapping the Changing Contours of the World Economy. Guilford Publications.

Dicken, P., 2011. Global Shift: Mapping the Changing Contours of the World Economy, Sixth Edition, ed. Guilford Pubn, New York.

Dicken, P., 2003. Global Shift: Reshaping the Global Economic Map in the 21st Century. SAGE.

Dimensional, 2016. An introduction to Dimensional Fund Advisors. Dimensional Advisors LP.

DLR, IWES, IFNE, 2012. Langfristszenarien und Strategien für den Ausbau der erneuerbaren Energien in Deutschland bei Berücksichtigung der Entwicklung in Europa und global. Arbeitsgemeinschaft: Deutsches Zentrum für Luft- und Raumfahrt, Fraunhofer Institut für Windenergie und Energiesystemtechnik, Ingenierbüro für neue Energien.

Dolan, C., Humphrey, J., 2004. Changing Governance Patterns in the Trade in Fresh Vegetables between Africa and the United Kingdom. Environ. Plan. A 36, 491–509. doi:10.1068/a35281

Dolan, C., Humphrey, J., 2000. Governance and Trade in Fresh Vegetables: The Impact of UK Supermarkets on the African Horticulture Industry. J. Dev. Stud. 37, 147–176. doi:10.1080/713600072

Döring, N., Bortz, J., 2015. Forschungsmethoden und Evaluation in den Sozial- und Humanwissenschaften. Springer-Verlag.

Dörry, S., 2016. The Geographies of Industrialised Finance: Probing the Global Production Networks of Asset Management: Production of Finance. Geogr. Compass 10, 3–14. doi:10.1111/gec3.12256

Dörry, S., 2010. Europäische Finanzzentren im Sog der Finanzialisierung : Büromärkte und Stadtpolitik in Frankfurt, London und Paris. Informationen Zur Raumentwickl., Informationen zur Raumentwicklung. - Stuttgart : Steiner, ISSN 0303-2493, ZDB-ID 1877306. - 2010, 5/6, S. 351-364.

Dörry, S., 2008. Globale Wertschöpfungsketten im Tourismus: ohnmächtige Unternehmen in mächtiger Position? ; relationale Governance bei der Organisation deutscher Pauschalreisen nach Jordanien. LIT Verlag Münster.

Dörry, S., Musil, R., 2015. Europäische Finanzzentren als strategischer Knoten in der Finanzindustrie. Geographische Rundschau - Jahrgang 67 Februar 2015 Heft 2.

Dossani, R., Kenney, M., 2007. Implications of globalization for software engineering. ResearchGate 49–68.

Dudenredaktion, 2015. Duden - Deutsches Universalwörterbuch: Das umfassende Bedeutungswörterbuch der deutschen Gegenwartssprache, 8., überarb. u. erw. Aufl. ed. Bibliographisches Institut, Berlin.

Edinger, R., 2012. Distributed Electricity Generation with Renewable Resources: Assessing the Economics of Photovoltaic Technologies in Vertically Integrated and in Restructured Energy Markets. Tectum Verlag DE.

EEG 2000, 2000. Gesetz für den Vorrang Erneuerbarer Energien (Erneuerbare-Energien-Gesetz – EEG) sowie zur Änderung des Energiewirtschaftsgesetzes und des Mineralölsteuergesetzes. Bundesgesetzblatt Jahrgang 2000 Teil I Nr. 13.

EEG 2004, 2004. Gesetz zur Neuregelung des Rechts der Erneuerbaren Energien im Strombereich. Bundesgesetzblatt Jahrgang 2004 Teil I Nr. 40.

EEG 2009, 2008. Gesetz zur Neuregelung des Rechts der Erneuerbaren Energien im Strombereich und zur Änderung damit zusammenhängender Vorschriften. Bundesgesetzblatt Jahrgang 2008 Teil I Nr. 49.

EEG 2012, 2011. Gesetz zur Neuregelung des Rechtsrahmens für die Förderung der Stromerzeug ung aus erneuerbaren Energien. Bundesgesetzblatt Jahrgang 2011 Teil I Nr. 42.

EEG 2014, 2014. Gesetz zur grundlegenden Reform des Erneuerbare-Energien-Gesetzes und zur Änderung weiterer Bestimmungen des Energiewirtschaftsrechts. Bundesgesetzblatt Jahrgang 2014 Teil I Nr. 33.

EEG 2017, 2016. Gesetz zur Änderung der Bestimmungen zur Stromerzeugung aus Kraft-Wärme-Kopplung und zur Eigenversorgung. Bundesgesetzblatt Jahrgang 2016 Teil I Nr. 65.

EEX, 2016a. Wind Power Futures - Upcoming: Wind Power Futures enable dedicated. European Energy Exchange AG.

EEX, 2016b. EEX-Gruppe: Kennzahlen für 2015 - Press Release. European Energy Exchange AG.

EEX, 2015a. EEX - Zahlen & Fakten - Die EEX-Gruppe stellt den zentralen Marktplatz für Energie, energienahe Produkte und Commodity-Produkte. European Energy Exchange AG.

EEX, 2015b. Geschäftsbericht 2014. European Energy Exchange AG.

EEX, 2008. Börslicher Energiehandel an der EEX. European Energy Exchange AG.

eFonds Solutions, 2016. Der Marktplatz für Sachwert Investments. Database.

Enercon, 2014. Windblatt - Enercon Magazin für Windenergie 04/14. ENERCON GmbH.

Enercon, 2013. Enercon E-Ship 1 - A Wind-Hybrid Commercial Cargo Ship. ENERCON GmbH.

EnergieKontor, 2016. Geschäftsbericht 2016. http://login.energiekontor.de /Finanzberichte.html.

EnergieKontor, 2015. Geschäftsbericht 2015. http://login.energiekontor.de /Finanzberichte.html.

EnergieKontor, 2014. Geschäftsbericht 2014. http://login.energiekontor.de /Finanzberichte.html.

EnergieKontor, 2013. Geschäftsbericht 2013. http://login.energiekontor.de /Finanzberichte.html.

EnergieKontor, 2012. Geschäftsbericht 2012. http://login.energiekontor.de /Finanzberichte.html.

EnergieKontor, 2011. Jahresfinanzbericht 2011. http://login.energiekontor.de /Finanzberichte.html.

EnergieKontor, 2010. Jahresfinanzbericht 2010. http://login.energiekontor.de /Finanzberichte.html.

Energiekontor AG, 2006. Press Release: WPD AG erwirbt über fünf Prozent Energiekontor-Aktien.

Epstein, G.A., 2005. Financialization and the World Economy. Edward Elgar Publishing.

Epstein, G.A., 2001. Financialization, rentier interests, and central bank policy. Manuscr. Dep. Econ. Univ. Mass. Amherst MA Dec.

Epstein, G.A., Jayadev, A., 2005. The rise of rentier incomes in OECD countries : financialization, central bank policy and labor solidarity. Financ. World Econ., Financialization and the world economy. - Cheltenham [u.a.] : Elgar, ISBN 1843768747. - 2005, S. 46-74.

Europäische Union, 2014. Mitteilung der Kommission - Leitlinien für staatliche Umweltschutz- und Energiebeihilfen 2014-2020. Amstblatt der Europäischen Union, Mitteilungen der Organe, Einrichtungen und sonstigen Stellen der Europäischen Union.

EWEA, 2016. Wind in power - 2015 European statistics. European Wind Energy Association.

EWEA, 2009. The Economics of Wind Energy - A report by the European Wind Energy Association. European Wind Energy Association.

EZB, 2016. Entwicklung des Zinssatzes der Europäischen Zentralbank für das Hauptrefinanzierungsgeschäft in den Jahren 1999 bis 2014. Europäische Zentralbank.

Faust, M., Bahnmüller, R., Fisecker, C., 2011. Das kapitalmarktorientierte Unternehmen : externe Erwartungen, Unternehmenspolitik, Personalwesen und Mitbestimmung, Forschung aus der Hans-Böckler-Stiftung. Berlin : Ed. Sigma.

FED, 2016. Leitzinsentwicklung der US-Zentralbank Fed von 2001 bis 2015. Federal Reserve System.

Fernández, V.R., 2014. Global Value Chains in Global Political Networks Tool for Development or Neoliberal Device? Rev. Radic. Polit. Econ. 0486613414532769. doi:10.1177/0486613414532769

Fischer, K., Reiner, C., 2012. Globale Warenketten: Analysen zur Geographie der Wertschöpfung. Zeitschrift Marxistische Erneuerung, Z. Nr. 89.

Fischer, K., Reiner, C., 2010. Globale Güterketten: Weltweite Arbeitsteilung und ungleiche Entwicklung. Promedia, Wien.

Fitter, R., Kaplinksy, R., 2001. Who Gains from Product Rents as the Coffee Market Becomes More Differentiated? A Value-chain Analysis. IDS Bull. 32, 69–82. doi:10.1111/j.1759-5436.2001.mp32003008.x

Flick, 2014. Qualitative Sozialforschung. Eine Einführung. Rowohlt, Reinbek bei Hamburg.

Flick, U., 2009. An Introduction to Qualitative Research. SAGE.

Flick, U., 1999. Qualitative Forschung. Theorie, Methoden, Anwendung in Psychologie und Sozialwissenschaften. Rowohlt Tb., Reinbek bei Hamburg.

Flick, U., 1995. Handbuch qualitative Sozialforschung: Grundlagen, Konzepte, Methoden und Anwendungen. 2. Aufl., Beltz, Psychologie Verlags Union. Weinheim.

Fraunhofer ISE, 2013. Studie Stromgestehungskosten Erneuerbare Energien November 2013.

Fraunhofer ISE, 2012. Studie Stromgestehungskosten Erneuerbare Energien.

Fraunhofer IWES, 2015a. Windnergie Report Deutschland 2014. Fraunhofer Institut für Windenergie und Energietechnik (IWES).

Fraunhofer IWES, 2015b. Wind Monitor - Zeitliche Entwicklung der installierten onshore Windleistung in Deutschland. Fraunhofer Institut für Windenergie und Energietechnik (IWES).

Fraunhofer IWES, 2013. Windnergie Report Deutschland 2012. Fraunhofer Institut für Windenergie und Energietechnik (IWES).

Fraunhofer IWES, 2012. Windnergie Report Deutschland 2011. Fraunhofer Institut für Windenergie und Energietechnik (IWES).

French, S., Leyshon, A., Wainwright, T., 2011. Financializing space, spacing financialization. Prog. Hum. Geogr. 35, 798–819. doi:10.1177/0309132510396749

Froud, J., Haslam, C., Johal, S., Williams, K., 2000. Shareholder value and Financialization: consultancy promises, management moves. Econ. Soc. 29, 80–110. doi:10.1080/030851400360578

Froud, J., Johal, S., Leaver, A., Williams, K., 2006. Financialization and Strategy: Narrative and Numbers, 1 edition. ed. Routledge, London ; New York.

Galletta, A., 2013. Mastering the Semi-Structured Interview and Beyond: From Research Design to Analysis and Publication. NYU Press.

Gamesa, 2016. Annual Report 2016. http://www.gamesacorp.com/en/investors-and-shareholders/ financial-information/.

Gamesa, 2015. Annual Report 2015. http://www.gamesacorp.com/en/investors-and-shareholders/ financial-information/.

Gamesa, 2014. Annual Report 2014. http://www.gamesacorp.com/en/investors-and-shareholders/ financial-information/.

Gamesa, 2013. Annual Report 2013. http://www.gamesacorp.com/en/investors-and-shareholders/ financial-information/.

Gamesa, 2012. Annual Report 2012. http://www.gamesacorp.com/en/investors-and-shareholders/ financial-information/.

Gamesa, 2011. Annual Report 2011. http://www.gamesacorp.com/en/investors-and-shareholders/ financial-information/.

Gamesa, 2010. Annual Report 2010. http://www.gamesacorp.com/en/investors-and-shareholders/ financial-information/.

Gasch, R., Twele, J., Bade, P., Conrad, W., Heilmann, C., Kaiser, K., Kortenkamp, R., Kühn, M., Langreder, W., Liersch, J., Maurer, J., Ohde, K., Reuter, A., Schubert, M., Stoffel, A., Sundermann, B., 2013. Windkraftanlagen: Grundlagen, Entwurf, Planung und Betrieb, Auflage: 8., überarb. Aufl. 2013. ed. Springer Vieweg.

Gereffi, G., 1999a. Commodity Chains Framework for Analyzing Global Industries.

Gereffi, G., 1999b. International trade and industrial upgrading in the apparel commodity chain. J. Int. Econ. 48, 37–70.

Gereffi, G., 1995. Global Production Systems and Third World Development.

Gereffi, G., 1994. The Organization of Buyer-Driven Global Commodity Chains: How US Retailers Shape Overseas Production Networks. Commod. Chains Glob. Capital.

Gereffi, G., Dubay, K., Lowe, M., 2008. Manufacturing Climate Solutions - Carbon-Reducing Technologies and U.S. Jobs. Center on Globalization, Governance & Competitiveness, Duke University.

Gereffi, G., Frederick, S., 2010. The Global Apparel Value Chain, Trade and the Crisis: Challenges and Opportunities for Developing Countries (SSRN Scholarly Paper No. ID 1596491). Social Science Research Network, Rochester, NY.

Gereffi, G., Humphrey, J., Kaplinsky, R., Sturgeon, T.J., 2001. Introduction: Globalisation, Value Chains and Development. IDS Bull. 32, 1–8. doi:10.1111/j.1759-5436.2001.mp32003001.x

Gereffi, G., Humphrey, J., Sturgeon, T., 2005. The governance of global value chains. Rev. Int. Polit. Econ. 12, 78–104. doi:10.1080/09692290500049805

Gereffi, G., Korzeniewicz, M. (Eds.), 1994. Commodity Chains and Global Capitalism. Praeger, Westport, Conn.

Gereffi, G., Memedovic, O., 2003. The global apparel value chain: What prospects for upgrading by developing countries. United Nations Industrial Development Organization Vienna.

Geurts, M., Schubert, L., 2014. KAGB kompakt: Eine strukturelle Einführung in das neue Investmentrecht, 1st ed. Bank-Verlag.

Gibbon, P., Ponte, S., 2005. Trading down: Africa, value chains, and the global economy. Temple University Press.

Glaser, B.G., Strauss, A.L., 2008. Grounded Theory: Strategien qualitativer Forschung, 1. Nachdr. 2008 der 2. Aufl. 2005. ed. Huber, Bern, Bern.

Glaser, B.G., Strauss, A.L., 1979. Die Entdeckung gegenstandsbezogener Theorie: Eine Grundstrategie qualitativer Sozialforschung. Hopf C WE Hrsg Qual. Sozialforschung 91–111.

Gläser, J., Laudel, G., 2010. Experteninterviews und Qualitative Inhaltsanalyse. VS Verlag.

Gomm, D.M., 2008. Supply Chain Finanzierung: Optimierung der Finanzflüsse in Wertschöpfungsketten. Erich Schmidt Verlag GmbH & Co, Berlin.

GWEC, 2017. Global Wind Statistics 2016. Global Wind Energy Council.

GWEC, 2016. Global Wind Report - Annual Market Update 2016. Global Wind Energy Council.

GWEC, 2015. Global Wind Report - Annual Market Update 2016. Global Wind Energy Council.

GWEC, 2014. Global Wind Report - Annual Market Update 2014. Global Wind Energy Council.

GWEC, 2006. Global Wind 2006 Report. Global Wind Energy Council.

Gwynne, R.N., 2006. Governance and the wine commodity chain: Upstream and downstream strategies in New Zealand and Chilean wine firms. Asia Pac. Viewp. 47, 381–395. doi:10.1111/j.1467-8373.2006.00321.x

Harvey, D., 2006. [1982] The Limits to Capital (2nd edn). Verso.

Harvey, D., 2005. Der neue Imperialismus. VSA, Hamburg.

Hau, E., 2014. Windkraftanlagen: Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Auflage: 5., vollst. neu bearb. Aufl. 2014. ed. Springer, Berlin.

Hau, E., 2008. Windkraftanlagen: Grundlagen, Technik, Einsatz, Wirtschaftlichkeit. Springer.

Hauschildt, J., Pulczynski, J., 1996. Growian: Zielbildung für bedeutende Innovationsvorhaben, in: Brockhoff, K. (Ed.), Management von Innovationen. Gabler Verlag, Wiesbaden, pp. 45–54. doi:10.1007/978-3-322-90376-1_4

Heires, M., Nölke, A., 2014a. Finanzialisierung, in: Wullweber, D.J., Graf, A., Behrens, P.D.M. (Eds.), Theorien der Internationalen Politischen Ökonomie, Globale Politische Ökonomie. Springer Fachmedien Wiesbaden, pp. 253–266. doi:10.1007/978-3-658-02527-4_15

Heires, M., Nölke, P.D.A., 2014b. Die Politische Ökonomie der Finanzialisierung., in: Heires, M., Nölke, A. (Eds.), Politische Ökonomie der Finanzialisierung, Globale Politische Ökonomie. Springer Fachmedien Wiesbaden, pp. 19–29. doi:10.1007/978-3-658-03778-9_1

Helleiner, E., 1996. States and the Reemergence of Global Finance: From Bretton Woods to the 1990s. Cornell University Press.

Henderson, J., Dicken, P., Hess, M., Coe, N., Yeung, H.W.-C., 2002. Global Production Networks and the Analysis of Economic Development. Rev. Int. Polit. Econ. 9, 436–464.

Heymann, M., 1997. Die Geschichte der Windenergienutzung. 1890 - 1990. Campus Verlag GmbH, Frankfurt ; New York.

Höld, R., 2007. Zur Transkription von Audiodaten, in: Buber, A.-P.D.R., Holzmüller, P.H.H. (Eds.), Qualitative Marktforschung. Gabler, pp. 655–668. doi:10.1007/978-3-8349-9258-1_41

Holmes, C., 2009. Seeking Alpha or Creating Beta? Charting the Rise of Hedge Fund-Based Financial Ecosystems. New Polit. Econ. 14, 431–450. doi:10.1080/13563460903287231

Holzmüller, J., 2013. Weiterbetrieb von Windenergieanlagen. Windenerg. Rep. Dtschl. 2012 Fraunhofer IWES Windenergie Report Deutschland 2012.

Hopf, C., 2016a. Schriften zu Methodologie und Methoden qualitativer Sozialforschung. Springer Fachmedien Wiesbaden. doi:10.1007/978-3-658-11482-4_1

Hopf, C., 2016b. Die Pseudo-Exploration – Überlegungen zur Technik qualitativer Interviews in der Sozialforschung / Pseudo-exploration – Thoughts on the techniques of qualitative interviews in social research. Z. Für Soziol. 7, 97–115. doi:10.1515/zfsoz-1978-0201

Hopkins, T.K., Wallerstein, I., 1986. Commodity Chains in the World-Economy Prior to 1800. Rev. Fernand Braudel Cent. 10, 157–170.

Hopkins, T.K., Wallerstein, I., 1977. Patterns of development of the modern world-system. Rev. Fernand Braudel Cent. 111–145.

Hoppe-Kilpper, M., 2004. Perspektiven der Windnergienutzung in Deutschland - Zukünftige Anforderungen an Forschung, Entwicklung und Markterschließung. Albrecht Koschützke, Stabsabteilung der Friedrich-Ebert-Stiftung.

Hoppe-Kilpper, M., 2003. Entwicklung der Windenergietechnik in Deutschland und der Einfluss staatlicher Förderpolitik - Technikentwicklung in den 90er Jahren zwischen Markt und Forschungsförderung. Fachbereich Elektrotechnik an der Universität Kassel.

Hoppe-Kilpper, M., Durstewitz, M., Kleinkauf, W., Stump, N., Windheim, R., 1997. Stand und Perspektiven der Windenergienutzung in Deutschland - Ergebnisse aus dem Wissenschaftlichen Meß- und Evaluierungsprogramm. Forschungsverbund Sonnenenergie "Themen 96/97."

HSH Nordbank, 2016. Branchenstudie Windenergie September 2016.

Hughes, A., 2001. Global commodity networks, ethical trade and governmentality: organizing business responsibility in the Kenyan cut flower industry. Trans. Inst. Br. Geogr. 26, 390–406. doi:10.1111/1475-5661.00031

Humphrey, J., Schmitz, H., 2002. How does insertion in global value chains affect upgrading in industrial clusters? Reg. Stud. 36, 1017–1027. doi:10.1080/0034340022000022198

Humphrey, J., Schmitz, H., 2001. Governance in Global Value Chains. IDS Bull. 32, 19–29. doi:10.1111/j.1759-5436.2001.mp32003003.x

Huth, T., 2009. Aggressives Marketing von Banken und Finanzvermittlern, in: Elschen, P.D.R., Lieven, D.T. (Eds.), Der Werdegang der Krise. Gabler, pp. 47–63. doi:10.1007/978-3-8349-8547-7_3

IE Leipzig, 2014. Vorbereitung und Begleitung der Erstellung des Erfahrungsberichts 2014 gemäß § 65 EEG - Vorhaben IIe Stromerzeugung aus Windenergie. Leipziger Institut für Energie.

IJGlobal, 2015. Euromoney Institutional Investor PLC.

Iken, J., 2012. Weiterbetrieb von Windenergieanlagen - Eisenschweine im Vorteil Sonne Wind & Wärme.

International Monetary Fund, 2008. Global Financial Stability Report: Containing Systemic Risks and Restoring Financial Soundness, April 2008. International Monetary Fund.

INTVW 01, (2015). Interviewee: Investor, Interviewer: Philipp Jantz. Location: Office. January 27, 2015.

INTVW 02, (2015). Interviewee: Politicians, Interviewer: Philipp Jantz. Location: Office. April 24, 2015.

INTVW 03, (2015). Interviewee: Project developer, Interviewer: Philipp Jantz. Location: Office. April 25, 2015.

INTVW 04, (2015). Interviewee: Broker, Interviewer: Philipp Jantz. Location: Telephone. April 30, 2015.

INTVW 05, (2015). Interviewee: Fund Manager, Interviewer: Philipp Jantz. Location: Telephone. May 7, 2015.

INTVW 06, (2015). Interviewee: Project Developer, Interviewer: Philipp Jantz. Location: Office. May 11, 2015.

INTVW 07, (2016). Interviewee: Project Developer, Interviewer: Philipp Jantz. Location: Office. February 28, 2016.

INTVW 08, (2016). Interviewee: Manufacturer, Interviewer: Philipp Jantz. Location: Restaurant. February 29, 2016.

INTVW 09, (2016). Interviewee: Manufacturer, Interviewer: Philipp Jantz. Location: Restaurant. February 29, 2016.

INTVW 10, (2016). Interviewee: Electricity Trader, Interviewer: Philipp Jantz. Location: Restaurant. March 8, 2016.

INTVW 11, (2016). Interviewee: Utility, Interviewer: Philipp Jantz. Location: Restaurant. March 10, 2016.

INTVW 12, (2016). Interviewee: Technical and commercial Management Provider, Interviewer: Philipp Jantz. Location: Telephone. March 18, 2016.

INTVW 13, (2016). Interviewee: Project Developer, Interviewer: Philipp Jantz. Location: Office. March 30, 2016.

INTVW 14, (2016). Interviewee: Banker, Interviewer: Philipp Jantz. Location: Telephone. April 1, 2016.

INTVW 15, (2016). Interviewee: Maintenance service provider, Interviewer: Philipp Jantz. Location: Telephone. April 5, 2016.

INTVW 16, (2016). Interviewee: Banker, Interviewer: Philipp Jantz. Location: Telephone. April 5, 2016.

INTVW 17, (2016). Interviewee: Planning association, Interviewer: Philipp Jantz. Location: Restaurant. April 13, 2016.

INTVW 18, (2016). Interviewee: Lawyer, Interviewer: Philipp Jantz. Location: Office. May 3, 2016.

INTVW 19, (2016). Interviewee: Financial Service Provider, Interviewer: Philipp Jantz. Location: Office. May 3, 2016.

INTVW 20, (2016). Interviewee: Consultant, Interviewer: Philipp Jantz. Location: Office. May 11, 2016.

INTVW 21, (2016). Interviewee: Service Provider for direct marketing, Interviewer: Philipp Jantz. Location: Telephone. June 9, 2016

INTVW 22, (2016). Interviewee: Investor, Interviewer: Philipp Jantz. Location: Telephone. July 11, 2016.

INTVW 23, (2016). Interviewee: Financial service provider, Interviewer: Philipp Jantz. Location: Restaurant. July 14, 2016.

INTVW 24, (2016). Interviewee: Manufacturer, Interviewer: Philipp Jantz. Location: Telephone. August 16, 2016.

INTVW 25, (2016). Interviewee: Financial Service Provider, Interviewer: Philipp Jantz. Location: Office. November 2, 2016.

INTVW 26, (2016). Interviewee: Manufacturer, Interviewer: Philipp Jantz. Location: Office. November 16, 2016.

Jacobson, M.Z., 2009. Review of solutions to global warming, air pollution, and energy security. Energy Environ. Sci. 2, 148–173. doi:10.1039/B809990C

Jäger-Ambrożewicz, M., Voigtländer, M., 2008. Hintergründe und Lehren aus der Subprime-Krise. IW-Trends Vierteljahresschr. Zur Empirischen Wirtsch. Aus Dem Inst. Dtsch. Wirtsch. Köln, IW-Trends : Vierteljahresschrift zur empirischen Wirtschaftsforschung aus dem Institut der Deutschen Wirtschaft Köln. - Köln : Inst. der Dt. Wirtschaft Köln Medien GmbH, ISSN 0941-6838, ZDB-ID 5187424. - Bd. 35.2008, 3, S. 17-29 35.

Kädtler, J., Sperling, H.J., 2002. After globalisation and financialisation : logics of bargaining in the German automotive industry. Compet. Change J. Glob. Bus. Polit. Econ., Competition & change : the journal of global business and political economy. - London [u.a.] : Sage, ISSN 1024-5294, ZDB-ID 14034347. - Bd. 6.2002, 2, S. 149-168 6.

Kaiser, O., Seitz, H., 2014. Ressourceneffizienz von Windenergieanlagen - Kurzanalyse Nr. 9 und Dokumentation des Fachgesprächs. VDI Technologiezentrum GmbH.

Kaiserwetter, 2014. Kaiserwetter Energy Asset Management presents Integrated Services for Renewable Energies. Kaiserwetter Energy Asset Management GmbH.

Kammer, J., 2011. Die Windenergieindustrie. Evolution von Akteuren und Unternehmensstrukturen in einer Wachstumsindustrie mit räumlicher Perspektive, 1. Aufl. ed. Franz Steiner Verlag, Hamburg : Stuttgart.

Kaplinsky, R., 2005. Globalization, Poverty and Inequality: Between a Rock and a Hard Place, 1st ed. Polity Press, Cambridge, UK ; Malden, MA.

Kelle, U., Kluge, S., 1999. Vom Einzelfall zum Typus. Fallvergleich Fallkontrastierung Qual. Sozialforschung Oplad.

Kenney, M., Florida, R., 1994. Japanese maquiladoras: Production organization and global commodity chains. World Dev. 22, 27–44. doi:10.1016/0305-750X(94)90166-X

KfW, 2015. Kondtitionenübersicht für Endkreditnehmer in den Förderprogrammen der KfW Bankengruppe (Stand: 15.08.2015). KfW Bankengruppe.

KfW, 2014. Nachhaltigkeitsbericht Fakten-Update 2014. KfW Bankengruppe.

KfW, 2013. Gesetz über die Kreditanstalt für Wiederaufbau. KfW Bankengruppe.

Klagge, B., Dörry, S., 2015. Geographien der Finanzwirtschaft. Geographische Rundschau - Jahrgang 67 Februar 2015 Heft 2.

Klagge, P.D.B., Anz, J., 2014. Finanzialisierung der Windenergienutzung in Deutschland?, in: Heires, M., Nölke, A. (Eds.), Politische Ökonomie der Finanzialisierung, Globale Politische Ökonomie. Springer Fachmedien Wiesbaden, pp. 241–257. doi:10.1007/978-3-658-03778-9_15

Klug, H., 2006. What does Exceedance Probabilities P90-P75-P50 Mean? DEWI Magazin Nr. 28.

KNi, 2011. Marktakteure Erneuerbare Energien Anlagen in der Stromerzeugung - Im Rahmen des Forschungsprojektes: Genossenschaftliche Unterstützungsstrukturen für eine sozialräumliche Energiewirtschaft. KLAUS NOVY iNSTiTUT.

Knopp, P., 2012. Attraktive Finanzierungsmodelle für Windparks - Handlungsmöglichkeiten Windkraft für Schwarzwaldkommunen. Deutsche Kreditbank AG.

Kowal, S., O'Connell, D.C., 2000. Zur Transkription von Gesprächen. Flick U Kardoff E V Steinke IHrsg Qual. Forsch. Ein Handb. Hambg. Rowohlt 437 446.

Krassin, A., Tran, T.M.Y., Lieven, D.T., 2009. Asset Backed Securities (ABS) und ihr Einfluss auf die Entwicklung der Finanzkrise, in: Elschen, P.D.R., Lieven, D.T. (Eds.), Der Werdegang der Krise. Gabler, pp. 67–95. doi:10.1007/978-3-8349-8547-7_4

Krippner, G.R., 2005. The financialization of the American economy. Socio-Econ. Rev. 3, 173–208. doi:10.1093/SER/mwi008

Kuckartz, U., 2009. Einführung in die Computergestützte Analyse qualitativer Daten (German Edition): 3. Aktualisierte Auflage, 3rd ed. VS Verlag für Sozialwissenschaften, Wiesbaden.

Kuypers, F., 2012. Physik für Ingenieure und Naturwissenschaftler, Band 1: Mechanik und Thermodynamik, Auflage: 3. überarb. u. erw. Auflage. ed. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim.

La Porta, R., Lopez-De-Silanes, F., Shleifer, A., 1999. Corporate Ownership Around the World. J. Finance 54, 471–517. doi:10.1111/0022-1082.00115

Labban, M., 2010. Oil in parallax: Scarcity, markets, and the financialization of accumulation. Geoforum 41, 541–552. doi:10.1016/j.geoforum.2009.12.002

Lamnek, 1993. Qualitative Sozialforschung. Psychologie Verlags Union, Weinheim.

Lee, J., 2010. Global Commodity Chains and Global Value Chains. Int. Stud. Encycl. 2987–3006.

Levy, D.L., 2008. Political Contestation in Global Production Networks. Acad. Manage. Rev. 33, 943–963. doi:10.5465/AMR.2008.34422006

Leyshon, A., Thrift, N., 2007. The Capitalization of Almost Everything The Future of Finance and Capitalism. Theory Cult. Soc. 24, 97–115. doi:10.1177/0263276407084699

Lu, X., McElroy, M.B., Kiviluoma, J., 2009. Global potential for wind-generated electricity. Proc. Natl. Acad. Sci. 106, 10933–10938. doi:10.1073/pnas.0904101106

Machatschke, M., 2008. Enercon - Vom Winde verwöhnt. manager magazin 11/2008.

Markus, G., Rüschen, T., Sandhövel, A., 2011. Finanzierung Erneuerbarer Energien, 1st ed. Frankfurt School Verlag, Frankfurt am Main.

Marx, K., Engels, F., 1867. Das Kapital: Kritik der politischen Oekonomie. Meissner.

MAXQDA, 2016. MAXQDA 12 Referenzhandbuch. VERBI Software.

May, A., Eschenbaum, F., Breitenstein, O., 2013. Projektentwicklung im CRE-Management: Leitfaden zur Ausschöpfung von Wertsteigerungs- und Kostensenkungspotentialen im Flächenmanagement. Springer-Verlag.

Mayer, H.O., 2012. Interview und schriftliche Befragung: Grundlagen und Methoden empirischer Sozialforschung. Oldenbourg Verlag.

Mayring, P., 2016. Einführung in die qualitative Sozialforschung, 6th ed. Beltz.

Mayring, P., 2015. Qualitative Inhaltsanalyse: Grundlagen und Techniken, 12th ed. Beltz, Weinheim, Bergstr.

Mayring, P., 1999. Zum Verhältnis qualitativer und quantitativer Analyse, in: Bolscho, D., Bolscho, G.M. (Eds.), Methoden der Umweltbildungsforschung, Schriftenreihe "Ökologie und Erziehungswissenschaft" der Arbeitsgruppe "Umweltbildung" der Deutschen Gesellschaft für Erziehungswissenschaft. VS Verlag für Sozialwissenschaften, pp. 13–25. doi:10.1007/978-3-322-92317-2_1

Mayring, P., 1989. Die qualitative Wende. Grundlagen, Techniken und Integrationsmöglichkeiten qualitativer Forschung in der Psychologie. Ber. Über Den 36, 306–313.

Milberg, W., 2008. Shifting sources and uses of profits: sustaining US financialization with global value chains. Econ. Soc. 37, 420–451. doi:10.1080/03085140802172706

Milberg, W., Winkler, D., 2010. Financialisation and the dynamics of offshoring in the USA. Camb. J. Econ. 34, 275–293. doi:10.1093/cje/bep061

Misoch, S., 2015. Qualitative Interviews. Walter de Gruyter GmbH & Co KG.

Möllers, T.M.J., Kloyer, A., 2013. Das neue Kapitalanlagegesetzbuch: Tagung vom 14./15. Juni 2013 in Augsburg, 1st ed. C.H.Beck.

Neddermann, B., 2015. Repowering in Germany in 2014: Last Chance to use the Repowering Bonus.

neue energie, 2014. Eigentümerstruktur von Onshore Windparks in Deutschland 2012. Magazin für Erneuerbare Energien 05/2014.

Nevitt, P.K., Fabozzi, F.J., 2000. Project Financing : 7th edition, 7th edition. ed. Euromoney Books, London.

Newman, S.A., 2009. Financialization and Changes in the Social Relations along Commodity Chains: The Case of Coffee. Rev. Radic. Polit. Econ. 41, 539–559. doi:10.1177/0486613409341454

Nordex, 2016. Geschäftsbericht 2016. http://www.nordex-online.com/en/nordex/downloads.html#c982.

Nordex, 2015a. Nordex 360°: 30 Jahre Nordex - Firmengründer und CEO im Interview - Ausgabe 2 2015. Nordex SE.

Nordex, 2015b. Geschäftsbericht 2015. http://www.nordex-online.com/en/investor-relations/ publications.html

Nordex, 2014. Geschäftsbericht 2014. http://www.nordex-online.com/en/investor-relations/ publications.html

Nordex, 2013. Geschäftsbericht 2013. http://www.nordex-online.com/en/investor-relations/ publications.html

Nordex, 2012. Geschäftsbericht 2012. http://www.nordex-online.com/en/investor-relations/ publications.html

Nordex, 2011. Geschäftsbericht 2011. http://www.nordex-online.com/en/investor-relations/ publications.html

Nordex, 2010. Geschäftsbericht 2010. http://www.nordex-online.com/en/investor-relations/ publications.html

OECD, WTO, World Bank Group, 2014. Global Value Chains: Challenges, Opportunities and Implications for Policy (Report prepared for submission to the G20 Trade Ministers Meeting). Sydney, Australia.

Ohlhorst, D., 2009. Windenergie in Deutschland: Konstellationen, Dynamiken und Regulierungspotenziale im Innovationsprozess, 1st ed, Energiepolitik und Klimaschutz. Energy Policy and Climate Protection. VS, Verl. für Sozialwiss., Wiesbaden.

Oßenbrügge, J., 2011. The economic crisis and the reshaping of geography. DIE ERDE - Journal of the Geographical Society of Berlin 142.4.

O'Sullivan, M., 2000. The innovative enterprise and corporate governance. Camb. J. Econ. 24, 393–416.

Palley, T.I., 2007. Financialization: What it is and Why it Matters (SSRN Scholarly Paper No. ID 1077923). Social Science Research Network, Rochester, NY.

Palpacuer, F., 2008. Bringing the social context back in: governance and wealth distribution in global commodity chains. Econ. Soc. 37, 393–419. doi:10.1080/03085140802172698

Palpacuer, F., 2000. Characterizing governance in value chain analysis. Paper prepared for the IDS/ Rockefeller Foundation meeting on global value chains, Bellagio, Italy.

Palpacuer, F., Gibbon, P., Thomsen, L., 2005. New challenges for developing country suppliers in global clothing chains: a comparative European perspective. World Dev. 33, 409–430.

Panos, K., 2009. Praxishandbuch Energiewirtschaft. Energieumwandlung, -transport und -beschaffung im liberalisierten Markt. Berlin - Heidelberg.

Parnreiter, C., 2015. Managing and governing commodity chains: the role of producer service firms in the secondary global city of Hamburg. ERDE–Journal Geogr. Soc. Berl. 146, 1–15.

Parnreiter, C., 2010. Global cities in Global Commodity Chains: exploring the role of Mexico City in the geography of global economic governance. Glob. Netw. 10, 35–53. doi:10.1111/j.1471-0374.2010.00273.x

Parnreiter, C., Fischer, K., Imhof, K., 2005. 'The world's local bank': Finanzdienstleister, globale Güterketten und das World City Network'. Mitteilungen der Österreichischen Geogr. Ges. 147.

Phyne, J., Mansilla, J., 2003. Forging Linkages in the Commodity Chain: The Case of the Chilean Salmon Farming Industry, 1987–2001. Sociol. Rural. 43, 108–127. doi:10.1111/1467-9523.00234

Pietrowicz, M., Quentin, J., 2015. Dauer und Kosten des Planungs- und Genehmigungsprozesses von Windenergieanlagen an Land. Fachagentur Windenergie an Land.

Pike, A., Pollard, J., 2010. Economic Geographies of Financialization. Econ. Geogr. 86, 29–51. doi:10.1111/j.1944-8287.2009.01057.x

PNE Wind, 2016. Geschäftsbericht 2016. https://www.pnewind.com/investor-relations/veroeffentlichungen/.

PNE Wind, 2015. Geschäftsbericht 2015. https://www.pnewind.com/investor-relations/veroeffentlichungen/.

PNE Wind, 2014. Geschäftsbericht 2014. https://www.pnewind.com/investor-relations/veroeffentlichungen/.

PNE Wind, 2013a. Geschäftsbericht 2013. https://www.pnewind.com/investor-relations/veroeffentlichungen/.

PNE Wind, 2013b. PNE Wind AG hat Übernahme der Mehrheitsantele an der WKB AG abgeschlossen und hält jetzt rund 53 Prozent. Press Release.

PNE Wind, 2012a. Geschäftsbericht 2012. https://www.pnewind.com/investor-relations/veroeffentlichungen/.

PNE Wind, 2012b. Die drei Offshore-Windparkprojekte Gode Wind I-III an Dong Energy für 157 Mio.? Verkauft. Press Release.

PNE Wind, 2011. Geschäftsbericht 2011. https://www.pnewind.com/investor-relations/veroeffentlichungen/.

PNE Wind, 2010. Geschäftsbericht 2010. https://www.pnewind.com/investor-relations/veroeffentlichungen/.

Pollard, J.S., 2003. Small firm finance and economic geography. J. Econ. Geogr. 3, 429–452. doi:10.1093/jeg/lbg015

Ponte, S., Sturgeon, T., 2014. Explaining governance in global value chains: A modular theory-building effort. Rev. Int. Polit. Econ. 21, 195–223. doi:10.1080/09692290.2013.809596

Przybilla, A., 2014. Projektfinanzierungen im Rahmen des Risikomanagements von Projekten, 1., Aufl. ed. Europaeischer Hochschulverlag, Bremen.

Raikes, P., Friis Jensen, M., Ponte, S., 2000. Global commodity chain analysis and the French filière approach: comparison and critique. Econ. Soc. 29, 390–417. doi:10.1080/03085140050084589

Ramskogler, P., 2015. Tracing the origins of the financial crisis. OECD J. Financ. Mark. Trends. doi:10.1787/fmt-2014-5js3dqmsl4br

Raworth, K., Kidder, T., 2009. Mimicking 'lean' in global value chains: Its the workers who get leaned on. In: Bair J (ed.) Frontiers of Commodity Chain Research, Stanford: Stanford University Press, pp. 165–189.

Regionaler Planungsverband Westmecklenburg, 2016. Regionales Raumentwicklungsprogramm Westmecklenburg - Teilfortschreibung Entwurf des Kapitels 6.5 Energie zur ersten Stufe des Beteiligungsverfahrens. Amt für Raumordnung und Landesplanung Westmecklenburg.

Regionaler Planungsverband Westmecklenburg, 2013. Neue Flächen für die Windenergienutzung - Bürgerinformation zum Planungsverfahren.

REpower, 2011. Squeeze-out-Beschluss der REpower Systems SE ins Handelsregister eingetragen - Press Release. REpower Systems SE.

REpower Systems AG, 2011. Geschäftsbericht 2010/11 - 10 Jahre Wachstum und Erfolg. Hamburg.

Reuber, P., Pfaffenbach, C., 2005. Methoden der empirischen Humangeographie - Das geographische Seminar. Westermann Verlag, Braunschweig.

Rinck, M., Richter, J., 2015. Versorgungssicherheit ohne Markteingriff - Die Energiewende handelbar machen. European Energy Exchange AG.

Rubin, H.J., Rubin, I.S., 2011. Qualitative interviewing: The art of hearing data. Sage.

Sassen, S., 2010. Global inter-city networks and commodity chains: any intersections? Glob. Netw. 10, 150–163. doi:10.1111/j.1471-0374.2010.00279.x

Schaffarczyk, Ce. eG / A., 2012. Einführung in die Windenergietechnik. Carl Hanser Verlag GmbH & Co. KG, München.

Schmitz, H., Knorringa, P., 2000. Learning from global buyers. J. Dev. Stud. 37, 177–205.

Schoenberger, E., 1991. The Coporate Interview as a Research Method in Economic Geography. Prof. Geogr. 43, 180–189. doi:10.1111/j.0033-0124.1991.00180.x

Schorer, T., Levée, P., 2013. Review of the Real Energy Production Data of Operating Wind Farms in Comparison to Former Predicted Energy Yields DEWI MAGAZIN NO. 42.

Schumacher, I., Würfel, P., 2015. Strategien zur Strombeschaffung in Unternehmen: Energieeinkauf optimieren, Kosten senken. Springer-Verlag.

Seiler, E., Bilitewski, B., Woidasky, J., 2013. Recycling von Windkraftanlagen. Fraunhofer-Institut für Chemische Technologie ICT & Fakultät für Forst-, Geo- und Hydrowissenschaften, Institut für Abfallwirtschaft und Altlasten, Technische Universität Dresden.

Selwyn, B., 2015. Commodity chains, creative destruction and global inequality: a class analysis. J. Econ. Geogr. 15, 253–274. doi:10.1093/jeg/lbu014

Senvion, 2016. Senvion plant Börsengang im ersten Halbjahr - Press Release. Senvion GmbH.

Smolka, T., Weck, K.-H., Bartsch, M., 2008. eBWK Bd. 60 Nr 4.

Sommer, P., 2015. Die Entwicklung der Windenergie: Onshore versus Offshore: Industrieräumlicher Wandel in Europa zwischen inkrementeller und radikaler Innovation, 1st ed. Franz Steiner Verlag, Hamburg : Stuttgart.

Sonntag-O'Brien, V., Usher, E., 2004. Mobilising Finance For Renewable Energies - Thematic Background Paper. Secretariat of the International Conference for Renewable Energies, Bonn 2004.

S&P Capital IQ, 2017. Pricing & Market Data. S&P Capital IQ McGrae Hill Financial.

Staiß, F., 2003. Jahrbuch Erneuerbare Energien 02/03 plus, 1., Aufl. ed. Bieberstein, H.

Stiftung Warentest, 2015. Schlimme Bilanz - Finanztest - Geschlossene Fonds. 10/2015 Finanztest.

Stockhammer, E., 2004. Financialisation and the slowdown of accumulation. Camb. J. Econ. 28, 719–741. doi:10.1093/cje/beh032

Strack, M., Winkler, W., 2003. Analysis of Uncertainties in Energy Yield Calculation of Wind Farm Projects DEWI Magazin Nr. 22.

Ströbele, W., Pfaffenberger, W., Heuterkes, M., 2012. Energiewirtschaft: Einführung in Theorie und Politik. Oldenbourg Verlag.

Sturgeon, T.J., 2009. From commodity chains to value chains: Interdisciplinary theory building in an age of globalization. Presented at the In J. Bair (Ed.), Frontiers of Commodity Chain Research.

Sturgeon, T.J., Memedovic, O., Van Biesebroeck, J., Gereffi, G., 2008. Globalisation of the automotive industry: main features and trends. Int. J. Technol. Learn. Innov. Dev. 2, 7–24.

Takoutsing, P., Wamkeue, R., Ouhrouche, M., Slaoui-Hasnaoui, F., Tameghe, T., Ekemb, G., 2014. Wind Turbine Condition Monitoring: State-of-the-Art Review, New Trends, and Future Challenges. Energies 7, 2595–2630. doi:10.3390/en7042595

Talbot, J.M., 2002. Tropical commodity chains, forward integration strategies and international inequality: coffee, cocoa and tea. Rev. Int. Polit. Econ. 9, 701–734. doi:10.1080/09692290220000021862

Taylor, P.J., Derudder, B., Hoyler, M., Witlox, F., 2012. Advanced producer servicing networks of world cities. Edward Elgar.

Tisdale, M., Grau, T., Neuhoff, K., 2014. Impact of Renewable Energy Act Reform on Wind Project Finance. Deutsches Institut für Wirtschaftsforschung.

TMWAT, 2010. Thüringer Gründer-Initiative (ThGI) für innovative und technologieorientierte Unternehmen. Thüringer Ministerium für Wirtschaft, Arbeit und Technologie (TMWAT).

UNCTAD, 2011. Price formation in financialized commodity markets - The role of information. United Nations Conference on Trade and Development.

UNCTAD, 2007. The Least Developed Countries Report 2007. United Nations Conference on Trade and Development.

Van Meeteren, M., Bassens, D., 2016. World Cities and the Uneven Geographies of Financialization: Unveiling Stratification and Hierarchy in the World City Archipelago: World Cities and the Uneven Geographies of Financialization. Int. J. Urban Reg. Res. 40, 62–81. doi:10.1111/1468-2427.12344

Van Treeck, T., 2009. The political economy debate on 'financialization'–a macroeconomic perspective. Rev. Int. Polit. Econ. 16, 907–944.

Vensys, 2015. Mehr Energie für unsere Zukunft. VENSYS Energy AG.

Vernimmen, P., Quiry, P., Dallocchio, M., Fur, Y.L., Salvi, A., 2014. Corporate Finance: Theory and Practice. John Wiley & Sons.

Vestas, 2016. Annual Report 2016. https://www.vestas.com/en/investor/financial_reports.

Vestas, 2015. Annual Report 2015. https://www.vestas.com/en/investor/financial_reports.

Vestas, 2014. Annual Report 2014. https://www.vestas.com/en/investor/financial_reports.

Vestas, 2013. Annual Report 2013. https://www.vestas.com/en/investor/financial_reports.

Vestas, 2012. Annual Report 2012. https://www.vestas.com/en/investor/financial_reports.

Vestas, 2011. Annual Report 2011. https://www.vestas.com/en/investor/financial_reports.

Vestas, 2010. Annual Report 2010. https://www.vestas.com/en/investor/financial_reports.

VGF, 2013. VGF Branchenzahlen 2012. Verband Geschlossene Fonds e.V.

VGF, 2012. VGF Branchenzahlen 2011. Verband Geschlossene Fonds e.V.

VGF, 2011. VGF Branchenzahlen 2010. Verband Geschlossene Fonds e.V.

VGF, 2010. Präsentation der VGF Branchenzahlen 2009. Verband Geschlossene Fonds e.V.

VGF, 2009. Präsentation "Offizielle VGF Marktzahlen 2008." Verband Geschlossene Fonds e.V.

Vinter, G.D., Price, G., 2006. Project Finance: A Legal Guide. Sweet & Maxwell.

Vogel, W., 2015. New ID3-Price index on continuous German Intraday market - An indicator for short-term forecast corrections - Press Release. EPEX SPOT SE.

Wallerstein, I.M., 1984. Der historische Kapitalismus. Argument-Verlag.

Watter, H., 2011. Regenerative Energiesysteme: Grundlagen, Systemtechnik und Anwendungsbeispiele aus der Praxis, 2nd ed. Vieweg+Teubner Verlag.

Weber, B., Alfen, W., Maser, S., 2006. Projektfinanzierung und PPP: Praktische Anleitung für PPP und andere Projektfinanzierungen, Stand: 2006. ed. Bank-Verlag.

WID, 2015. Max Bögl baut den 160 Meter-Turm - Fachartikel, Technik, Planung. Bundesverband WindEnergie e.V.

Williams, K., 2000. From shareholder value to present-day capitalism. Econ. Soc. 29, 1–12. doi:10.1080/030851400360532

Wind Directions, 2007. Supply Chain: The race to meet demand. European Wind Energy Association.

Windpower Monthly, 2014. Enercon launches 4MW turbine platform.

wind:research, 2014. Eigentümerstruktur im Bereich Onshore-Windenergie (Gesamtbestand Status 2012). Neue Energie 05/2014. BWE, 2015. Akteursstrukturen von Windenergieprojekten in Deutschland.

Wissel, S., Rath-Nagel, S., Blesl, M., Fahl, U., Vo\s s, A., 2008. Stromerzeugungskosten im Vergleich. Arbeitsbericht Univ. Stuttg. Inst. Für Energiewirtschaft Ration. Energieanwendung IER.

Wójcik, D., 2013. Where governance fails: Advanced business services and the offshore world. Prog. Hum. Geogr. 37, 330–347. doi:10.1177/0309132512460904

Wójcik, D., 2006. Convergence in corporate governance: evidence from Europe and the challenge for economic geography. J. Econ. Geogr. 6, 639–660. doi:10.1093/jeg/lbl003

World Bank, 2016a. 2016 Edition of World Development Indicators. World Bank national accounts data, and OECD National Accounts data files.

World Bank, 2016b. GDP at market prices (current US$). World Bank national accounts data, and OECD National Accounts data files.

WWEA, 2012. World Wind Energy Report 2011. World Wind Energy Assoc.

Yescombe, E.R., 2013. Principles of Project Finance, 2. Auflage. ed. Academic Press, Amsterdam ; Boston.

Yeung, H.W., Coe, N.M., 2015. Toward a Dynamic Theory of Global Production Networks: GPN Theory. Econ. Geogr. 91, 29–58. doi:10.1111/ecge.12063

Young, H.D., Freedman, R.A., Ford, L., 2007. University Physics with Modern Physics, 12th ed. Addison-Wesley.

Zademach, H.-M., 2014. Finanzgeographie. WBG, Darmstadt.

Ziem, V., 2010. Länger, höher, schwerer - Logistische Herausforderungen im Windenergieanlagenbau. ENERCON GmbH.