MENDEL UNIVERSITY IN BRNO

FACULTY OF BUSINESS AND ECONOMICS

DISSERTATION THESES

BRNO 2014 **Sylvia Böcker**

MENDEL UNIVERSITY IN BRNO

FACULTY OF BUSINESS AND ECONOMICS

FACILITATION OF NECESSARY CHANGES IN THE GERMAN WIND ENERGY THROUGH ANALYZING MENTAL MODELS

DISSERTATION THESIS

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BRNO 2014

DECLARATION

Brno, 15 October 2014

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In Moers, Germany on: 15th October 2014

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Sylvia Böcker

ACKNOWLEDGEMENTS

I would like to thank my supervisor for his assistance and consultations within elaboration in the thesis.

ABSTRACT

The main objective of this thesis is to apply KANTOR`s approach to mental modelling and to formulate proposals resulting from its application in the change process of the German wind energy industry within the current transformation process in the field of energy supply. KANTOR provides an entire concept of mental modelling and change. The Meta Model includes the Theory of Thing, the Theory of Change and the Theory of Practice as well as the Team Learning Model.

After the Fukushima accident the German government decided for a phasing-out of the nuclear energy. The German wind industry is the main column of the German energy transformation process and acknowledged worldwide. The provided wind energy solutions are mainly oriented centralized represented by the unique three-bladed large technical design. Politically, decentralized small wind approaches are not evaluated to be of importance in the renewed energy system.

Applying the KANTOR model, the author elaborates the mental models of the wind actors using a qualitative research approach. Their original small and decentralized oriented mental models refer back to the anti-nuclear movement. The investigation focuses on the analysis of the process of adjustment of the original models, the interconnection of the mental models with other levels of the business field and their actual guiding influence within the wind energy. Due to the circumstances and the specialities in the field, a mainstream model was established that affects the strategy of the energy transformation process in general. The research is guided by the Case Learning Meta Model considering the four dimensions of the Theory of Thing to work out the Theory of Change and Practice of Case to be able to formulate recommendations to the governmental level, the wind industry and the small wind sector. The reflection of the mental models is assessed as the leverage for a successful change to achieve a future energy concept on the industrial and political level. This process of elaboration can be applied in the managerial practice. It is of special interest for the transformation of the worldwide energy supply system.

Key words: Mental model, energy transformation, wind energy, small wind technology, structural traps, boundary profile, mainstream model

ABSTRAKT

Hlavním cílem této disertační práce bylo aplikovat KANTORŮV přístup k mentálním modelům a formulovat návrhy vyplývající z jeho aplikace v procesu změn v německém odvětví využívání větrné energie v rámci běžícího transformačního procesu v oblasti energetických zdrojů. KANTOR nabízí celkový koncept mentálního modelování a řízení změn. Jeho meta-model zahrnuje Teorii věci, Teorii změny a Teorii praxe, a také Model týmového učení se.

Po nehodě ve Fukušimě se německá vláda rozhodla postupně opustit využívání nukleární energie. Německé odvětví využívání větrné energie je hlavní součástí transformačního procesu v oblasti energetických zdrojů, kterému je věnována i celosvětová pozornost. Stávající řešení využívání větrné energie jsou orientována na centralizaci představovanou jedinečným technickým designem tří-listých turbín. Z politického hlediska nejsou decentralizované malé jednotky hodnoceny jako významné pro transformovaný systém energetických zdrojů.

Aplikací KANTOROVA modelu autorka rozpracovává mentální modely účastníků v odvětví větrné energie s využitím přístupu kvalitativního výzkumu. Původní malé decentralizovaně orientované mentální modely mají vazbu na dřívější anti-nukleární hnutí. Zkoumání se zaměřuje na analýzu procesu přizpůsobování původních modelů, jejich propojení s dalšími úrovněmi v daném odvětví, a jejich skutečný vliv na odvětví větrné energie. S ohledem na okolnosti a specifika odvětví byl uplatněn model hlavního proudu, který ovlivňuje strategii transformačního procesu v energetickém sektoru obecně. Výzkum je veden Meta-modelem učení se na příkladech (Case learning meta model), který uvažuje čtyři dimenze Teorie věcí ke zpracování Teorie změny a Případové praxe za účelem formulace doporučení pro vládní úroveň, odvětví větrné energie a sektor malých větrných elektráren. Dopad mentálních modelů je hodnocen jako možný katalyzátor úspěšné změny k dosažení budoucího energetického konceptu na úrovni odvětví i v politické oblasti. Tento proces zpracování je využitelný v praxi. Je zvláště významný pro transformaci celosvětového systému energetických zdrojů.

Klíčová slova:
Mentální model, transformace energetiky, větrná energie, malé větrné elektrárny, strukturální pasti, hraniční profil, model hlavního proudu.

ABBREVIATIONS

BEE	German Renewable Energy Federation
BMWi	German Ministry of Economics
BMU	Ministry for the Environment Nature Conservation and Nuclear Safety
BVKW	German Association for Small Wind Turbines
BWE	German Wind Energy Association
CO_2	Carbon dioxide
DENA	German Energy Agency
EEC	Renewable Energy Compensation
EEG	Erneuerbare Energie Gesetz, Renewable Energy Act
EWEA	European Wind Energy Association
GWEC	Global Wind Energy Council
IEC	International Electrotechnical Commission
IPCC	International Panel of Climate Change
ISET	Institute for Solar Energy Technical Supply
IT	Information Technology
IWES	Fraunhofer Institute for Wind Energy und Energy System Technology
NREAP	National Renewable Action Plan
R&D	Research and development
SMART	Self Monitoring Analysis Reporting Technology
TÜV	German Technical Control Board
UNEP	United Nations Environmental Programme
US(A)	United States (of America)
WGBU	German Advisory Board on Climate Goals
WWEA	World Wind Energy Association

CONTENTS

1 INTRODUCTION

SENGE states "one thing all managers know is that many of the best ideas never get into practice. Brilliant strategies fail to get translated into action....We are coming increasingly to believe that this...stems not from weak intentions, wavering will, or even non systemic understanding, but from *mental models"*.[1] The discipline of the mental models is one of the five disciplines of the learning organization.[2]

DAVID KANTOR elaborated an entire concept of mental modelling over decades. This dissertation will apply parts of his concept in order to get an insight in the thinking patterns of the wind energy business field. The author sees the necessity to explore those patterns or mental models because of the obvious results in this field that are affecting the whole society in Germany.

The wind energy is the main industry in the renewable energy field in Germany and therefore the backbone of the energy transformation. The modern wind industry started in the last quarter of the previous century and expanded worldwide within one generation. It is a story of success. The actors were pioneers and engraved the whole field based on the assumptions drawn out of the experience in the early years. The technical path that allowed the story of success is still the sole design. The thinking of wind mills in three horizontal blades - high and large - is the exclusive way of thinking and strongly influences political and economic decisions that lead to long lasting consequences. The original path of the wind pioneers of a decentralized and autonomous approach was discarded by the centralized orientation.

The main stream is illustrated in a nice way by this citation: "usually children were thinking of the traditional wind mills when they were painting a wind wheel, now it is the three-bladed turbine version instead".[3]

The epoch of fossil energy use changed the way of life and doing business. In the last quarter of the previous century it became more and more obvious that fossil energy sources are limited and that the use of this energy has negative consequences for the

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[1] SENGE (1994) p. 174

[2] See ibid. (1994) pp. 174ff.; See SENGE ET AL. (1994) pp. 235ff.

[3] ALBERS (2012)

environment. Especially the first ´wind scientists` warned to address the issue of the increasing global warmth caused through the carbon dioxide (CO_2) emissions. This and the first oil crisis caused a change of thinking in the most industrialized countries and the search for alternatives became relevant as well as the claim for a transition in the energy field. The alternatives were seen in renewable energies. Worldwide discussions lead to conferences and first international commitments to reduce the CO_2 emissions.

During these decades the promotion of the nuclear energy started as well. This form of energy was heavily criticized by the public because of the risk of a catastrophe and the unanswered question where to put the nuclear waste. The anti-nuclear movement in Germany and the founding of the Green Party were closely linked together. In the early 80ies, first decentralized wind projects mainly with small wind turbines were realized. The first large wind turbine called Growian was installed but it failed. Technical variations were discussed at this moment of time until the three-bladed horizontal-axis wind turbines became the dominant version.

The nuclear accident of Chernobyl brought a push for the development of the wind energy business field and it was growing although the actors were facing a lot of obstacles. Within one generation the industry expanded internationally and German wind experts are well acknowledged worldwide. The export factor of the wind industry is high and wind energy is seen as the most important renewable energy in Germany.

Although the percentage of renewables was increasing, the energy transition did not reach the progress many people were aiming for, even after international political commitments like the Kyoto Protocol. SCHEER stated in 2005 that the use of fossil energy increased by about 44 % in the period of 1992-2004, whereas the growth of the renewables reached about 33 %.[4] In 2007 the worldwide energy was made up by fossils to 80 %, nuclear to 6 % and renewable energy to 13 %.[5]

As the search for alternative forms of energy became relevant again, nuclear energy was assessed as being a reliable option in many countries, although the above mentioned most important questions were still unanswered.

[4] SCHEER (2005) p. 10

[5] HENNICKE/FISCHERDICK (2007) p. 20

The accident in the nuclear power station of Fukushima in Japan on the 11th of March 2011, caused by a tsunami which was triggered by an earthquake, was a turning point in the German energy history. In June 2011, the German Federal Government decided as the first country in the world to shut down all nuclear power stations until 2022. This decision was backed up by the Ethics Commission that was established by Chancellor Merkel in March 2011.[6]

Fukushima caused a vacuum. Survey of VERIVOX (2011) shows that shortly after the accident the percentage of people who were willing to order electricity made out of renewable energy increased by about 30-50%.

The political definition of the energy transformation shows the radical and deep change in the whole energy field. The German government has to work out a model of success to prove that economic growth can go along with environmental protection and efficient use of natural resources as well as the security of supply.[7] It is a high-stake situation. In 2011 the costs for the energy transformation were estimated up to 200 billion euro.[8]

The decade-long ongoing discussion about renewables reached a new dimension after the decision of the German government, substantially changing the requirements.

The reliability and security of supply have to be provided with cost efficiency and environmental- as well as climate protection. The announcements and programs for environmental protection with emphasis on CO_2 reduction that were established before become more pressing due to the definite time limit. New concepts and road maps are to be developed. It is a change process that includes technical, economic, social and political aspects.

Wind energy as the major renewable industry in Germany plays an important role in this process of transformation. It is represented by companies that produce large horizontal-axis wind turbines. They will be described as the big wind industry in this thesis. The solutions so far are focusing on using mainly offshore wind resources or

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[6] KNOPF ET AL. (2011) p. 8

[7] BUNDESREGIERUNG (2011) www.bundesregierung.de; RÖTTGEN (2012)

[8] BUNDESVERBAND DEUTSCHER BANKEN (2011) p. 3

onshore wind parks. The large wind turbines are installed in special regions and authorized spaces. The request for those turbines is to be higher and larger. The actual discussion shows that even after the decision of the phasing-out of nuclear, decentralized versions of energy production by using small wind technology are no issue.

The adjustment (2012) of the German Renewable Energy Act (EEG) was finalized without considering the small wind turbines.[9] In comparison to other states like Great Britain or Japan, Germany is not prepared to invest in small wind technology and the installed capacity is minimal.[10] Great Britain set up a feed-in tariff of 32,65 pence[11] and the Japanese government of 55,9 euro cent per kilowatt for small turbines with a capacity up to 20 kilowatts to strengthen the new direction of the energy politics.[12]

In Germany, smaller or vertical versions have not been an issue at all, the vertical-axis wind turbines being an option as part of the solution for a renewable energy system are not considered to be important. These versions are partially applicable within the infrastructure and architecture and match the requirements for a decentralized energy structure based on renewables. Intelligent energy management systems, called Self Monitoring Analysis Reporting Technologies (SMART), SMART communities and SMART grids, that are supposed to be one major column of the future energy management system, are facing a lack of suitable decentralized technologies to harvest the wind.

The recent energy providing system based on huge, central power stations running on primary fossil or nuclear energy need to be replaced by energy primarily harvested through renewables. The structures of the energy system, established over a long period of time, need to be reflected and adjusted. SCHEER states: “the change to an energy system based on renewables is the most deep and wide lasting change of economic structures since the industrial revolution...furthermore, this will not be done without

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[9] See GERMAN RENEWABLE ENERGY FEDERATION (BEE) (2013) www.bee-ev.de

[10] See HANDELSBLATT (2010)

[11] The feed-in tariff in Great Britain started on the 1st December 2012 to 31st March 2013, ENERGY SAVING TRUST (2013)

[12] See LIDZBA ET AL. (2012) pp. 1ff.

conflicts of interest...the economical complex of energy is the biggest and politically most influencing sector of the global economics“.[13] VERHEYEN (2012) gave the following description: ”this process will change the energy sector completely, nothing will remain the same...in the future we will have different actors or the same actors who will not be the same anymore“.[14]

The actors of the wind industry were pioneers in the field of the renewable energies. They were the change agents or leaders in terms of knowledge and experience. Their thinking is reflected in the way of dealing with the energy transformation. Therefore, it is of importance to understand their thinking patterns and mental models. This is the chance to evaluate and approve if the models fit to the changed conditions nowadays and in the future.

Even in organizations, transformation- or deep change processes are characterized by an involvement of the basic assumptions and the change of the paradigm within the philosophy of the organization. Those changes are radical or revolutionary and holistic. They include the human values and the structural features that are the basis of the behaviour in a system. It is essential, even in organizations, to have maps for orientation and guidance.[15]

Referring to ROBERTS, the discipline of the mental models offers the highest leverage for change.[16] In 1990 SENGE stated: “that is why the discipline of managing mental models - surfacing, testing and improving our internal pictures of how the world works - promises to be a major breakthrough for building learning organizations“.[17]

KANTOR is a specialist in model building in change processes and leadership. His concept contains the Team Learning Model. This systemic model will be the major model in this thesis because it unveils the existence of invisible structures of human behaviour and contains the dynamics of different levels of structures. It will be applied

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[13] SCHEER (2005) p. 13

[14] VERHEYEN (2012) interview

[15] See FATZER (2005a) pp. 17ff.

[16] ROBERTS (1994) p. 239

[17] SENGE (1994) p. 174

on the business field of wind energy. This application is uncommon because the model is so far mainly used on the team- and organizational level.

The Team Learning Model will be embedded in the Meta Model of KANTOR that contains the Theory of Thing, the Theory of Change and the Theory of Practice. This map guides the whole process of research and structures the complexity given by the interconnection between human elements and economic development.[18]

1.1 Problem Definition

The mental models in the wind energy field in Germany that evolved to a mainstream mental model hinder the development and market entry of versions that do not represent this model.

The actual technical model is determined by the attributes of being large, horizontal and three-bladed. This leads to a lack of alternative technologies that are needed for the transformation of the energy field. The wide range of decentral possibilities and applications are neglected and furthermore, the negligence is not being noticed by the political decision makers and the actors in this field. This means it is so far not estimated as being a problem.

The strategic solutions for the transformation process that are provided until now are solely elaborated based on the mainstream mental model.

Small wind turbines are categorized as being non-functional, non-economical and non-competitive. The feed-in tariff in the legislation is not defined for these technical variations and applications.

This discarding of additional technologies in the wind energy leads to long-term effects such as:

- Lack of funding from the government for the development of high quality products in the small wind sector.

[18] See KANTOR (1995) seminar script

- Lack of reliable technical solutions that can be put in the infrastructure and urban environments.

- Vacuum in the market because the customer demand cannot be satisfied.

- SMART communities and SMART grids are supposed to be the future energy management system. Decentralized programs are requested that can be installed with storage and close to the infrastructure.

- New strategies such as green marketing do not have reliable products.

- The demand for off-grid solutions in the market cannot be satisfied (nationally and internationally).

These aspects minimize the success of the sustainable strategy and will have long-term consequences in the energy sector. The active mental models influence the whole field. They are decided as the key factor to analyse.

The active mental models as part of the current professional culture in the wind energy business field influence the transformation process and the way of finding solutions. The result is seen as leverage for the success in the change process of the wind energy field and the energy sector. The current thinking patterns in the field are of crucial importance. They have to be elaborated in order to identify structural dynamics of such patterns.

One of the assumptions of this dissertation is that those active mental models that were drawn up under different conditions are driving the actual communication which leads to a performance impairment of the actors. This affects all communication levels and therefore the decision-making processes in the wind energy and governmental areas. This weakens the ability to find appropriate solutions to meet the requirements for the wind energy field as part of the renewables.

2 OBJECTIVES

The main objective of this work is to apply KANTOR`s approach to mental modelling and to formulate first theories about the situation and proposals as well as interventions resulting from its application in the change process of the German wind energy industry within the current transformation process in the field of energy supply.

Gaining the ability to reflect the own mental models by first expressing and visualizing is one leverage for change because it includes the chance to evaluate the current mental models of the main actors in the field. The understanding of the underlying basic assumptions and active mental models of the actors in this field will lead to an additional insight in this business field. Based on the first theories, this thesis will formulate proposals for possible interventions. Those interventions could lead to a new way of learning and exploring of the mental models in a wider range.

Based on the results of applying the KANTOR model, a Theory of Change of Case and a Theory of Practice of Case will be formulated. Recommendations for interventions on different levels will be given to:

1. Representatives of the political level such as the Environment Nature Conservation and Nuclear Safety (BMU) and the Ministry of Economics and Energy (BMWi)[19]

2. Representatives of the German big wind industry including the German Wind Energy Association (BWE)

3. Representatives of the German Association for Small Wind Turbines (BVKW) that represent small- and middle-sized companies in the small wind industry.

Furthermore, applying the KANTOR model will provide a road map to understand the influences and interconnection between the different structural levels starting from the mental models which could be used in managerial practice.

The dissertation will provide additional data of the human element in the analysis of the macro-environmental issue.[20] This approach could provide insights in economic

[19] This name is the name of the Ministry of Economics after the election 2013

analysis and could be transferred to other situations to complete the economic analysis methods.

EISLER states: “we can`t change economic systems by just focusing on economics. Economic systems are embedded in larger social systems. To effectively change dysfunctional economic policies and practices we need an understanding of their larger social matrix“.[21]

Additionally, we can hypothesize that the Team Learning Model by KANTOR and the KANTOR`s approach are beneficiary for the situation. The Team Learning Model has been so far mainly applied in team- and organizational change processes or in leadership, but this thesis will prove its applicability in even more complex situations.

This will be a contribution of useful research because the process of the application can be a guiding model for effective management practice.[22] The approach can be integrated in the transformation research as part of the Transformation Quartet of the Society of Knowledge by the German Advisory Council on Global Change (WBGU).[23]

2.1 Limitations

This dissertation will not provide a quantitative research, nor a generalization of the results for the whole field of wind and energetics. It will provide a deeper understanding of the situation in this industry to be able to formulate first theories about the situation which could lead to next steps and further analysis.

Furthermore, the dissertation cannot provide the applications of all models and methods of KANTOR because there is no access to team- or inner-organizational dynamics and there will not be included organizational development activities for companies.

[20] See VAN DER ZOUWEN (2011) pp. 86f.

[21] EISLER (2008) p. 93

[22] BARTUNEK/SCHEIN (2011) p. 233

[23] WBGU (2011) p. 23

3 SURVEY OF LITERATURE

The survey of literature provides the context information and is the frame for the further research. Related to KANTOR, it is the first dimension of the Theory of Thing. It starts with the approach of KANTOR`s mental modelling. This includes the Meta Model, the Team Learning Model, the process of model building and structural dynamics. This is followed by theories of change, change models and the connection between systems and change including aspects of cultural dynamics and dimensions of innovations. The next focus is energy. Related topics such as physics of energy, energy economics, energy structure and political aspects are described. Basic knowledge about electricity and wind energy as part of the renewable energy is also covered.

3.1 The Approach of DAVID KANTOR

KANTOR established an entire concept for change processes, communication structures and model building. He divides between concept, models and methods. Starting as a family therapist, he was confronted with systems theory and was one of the pioneers in this field.[24] The focus of his work changed from family therapy to the field of consulting, change management and leadership. The communication structures are the core element of his work. They are bound together through systems dynamics in each level of the defined system based on systems dynamics in general.[25] KANTOR thinks he has found an universal theory of communication structures.[26]

3.1.1 KANTOR`S Mental Modelling

KANTOR states why models and concepts are necessary: “our concepts are templates - they name and organize into conceptual frames an otherwise blinding profusion of information, they are the basic foundations of how we think, what we see when we are doing our work...without a model, a surgeon would routinely kill, without a model, a car mechanic would gum up his engine and probably kill, too. The surgeon, the car mechanic and the consultant all rely on Theories of Thing, Theory of Change

[24] See KANTOR (2012) pp. X f.; See FATZER (2011) pp. 60 ff.

[25] See KANTOR (2012) p. 82

[26] KLEINER (2013) p. 1

and Theory of Practice to diagnose and effect the entities in which they do their work“.[27]

KANTOR differentiates in hierarchy between models and tools. He states: “all professionals have special tools without which their models and their desired results would, in the very least, suffer, when they do not in fact, fail. Yet, our tools are not our models. The model is the master; tools are its servants. Understanding this is crucial to serving clients at the high levels of performance. Our models and our model´s tools are, or should be, organically related. Would a surgeon use a wrench to remove tissue or a mechanic a scalpel to remove a carburator”.[28] In terms of KANTOR, model building is a process of exploring, understanding and an efficient use of the own mental models to increase the professionalism. A model is not a static entity, it is a dynamic process and models can change with experience.

One of KANTOR`s basic assumptions is that: “a leader falls short of greatness without great skill in face-to-face talk...this is true in the corporate world as it is in government, communities, and families”.[29] The ability of what KANTOR calls Reading the Room[30] is essential for effective leadership, in general and in change processes. The leader is the one who articulates the narrative purpose within the organization. He keeps the organization together and promotes its success. The personal structure of a leader establishes other levels of structures within a group or any other entity.[31] KANTOR elaborates the Leadership System Model.[32]

Therefore, model building and understanding is a process of reflection to reach awareness and efficient use of the mental models. The difference is between being aware and reflecting, and not reflecting and not being aware. The non-reflected use of mental models is quite common and increases the risk to get stuck, especially during change processes with high complexity and conflict potential. KANTOR is talking about a ´stuck situation` and a ´model clash`. The stuck situation leads to misleading,

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[27] KANTOR (1997) seminar script; BÖCKER (2011) p. 80

[28] KANTOR (1997) seminar script

[29] Ibid. (2012) p. 1

[30] This is also the title of his book published in 2012

[31] KANTOR (2012) pp. 151 ff.

[32] Ibid. (2012a) p. 35

misguiding and to insufficient results. These descriptions show the importance of exploration and reflection of the mental models.

Referring to KANTOR, mental models are always existent and guide the actual behaviour as part of the current reality although their influencing strength is mostly unknown. The process of reflection by questioning, reasoning and approving is of highest importance for the guidance during a change process.[33] “Being aware of and being able to articulate one`s own model inevitably increase their strength and influence. This awareness and ability also provide the recognition that **everyone** operates from a model...that every model brings clarity in that we would be unable to make **any** sense of the world (circumstances, facts, data, problems, opportunities, people) without some model or template; distortion in that **every** model reduces the complexity of what we can see...consciously examining our models is the realization that `truth´ is in some ways a construct of our model“.[34]

Mental modelling is both, the knowledge that human behaviour in every day`s situations is steadily influenced by mental models (like an hourglass)[35] and the knowledge of the necessity to explore mental models in high-stake situations like change, conflicts or crisis. KANTOR is talking about two models in fact.[36] His models, visualizing the complexity in terms of interconnection between the individual level, the society and the economical level, guide through this jungle of different structural levels.

3.1.2 KANTOR`S Meta Model

KANTOR`s Meta Model for change processes is a frame-work that defines all aspects of a robust model. The Meta Model contains the Theory of Thing, the Theory of Change and the Theory of Practice.[37]

The Theory of Thing reflects the understanding of ´what is it all about`, and ´what is it`, and what are the components and principles of the thing. In this thesis ´the thing` is

[33] KANTOR (1995) seminar script; See BÖCKER-KAMRADT (2000) p. 298., (2001) p. 66

[34] KANTOR (2012) p. 282

[35] Ibid. (2012) p. 236

[36] KLEINER (2013) p. 1

[37] KANTOR (2012) p. 286; See RAPPE-GIESECKE (2002) pp. 55ff., FATZER (2005) p. 41

described as the principles of energy and wind, the structures of energy supply and the internalized structures that are established by humans to deal with these principles. The Team Learning Model is the ´map of the thing` and will be the main model to explore the Theory of Thing on different structural levels as far as possible.

The Theory of Change describes the nature of change and how change could happen, e.g. what the prerequisites of change are, in general and for a specific entity. Knowing about the theories of change is essential to be able to utilize the model.

The Theory of Practice indicates the planned approach of how to intervene. It includes the set up of goals and actions to be taken into account in order for the thing to change. The Theory of Practice contains the plan to fill the gap between the actual situation and the achieved goals. It is of highest importance to be aware of the other theories (the thing/change) including the level of mental models to elaborate a suitable Theory of Practice.[38]

3.1.3 The Team Learning Model

The Team Learning Model is a systemic model that provides the structure for elaborating the Theory of Thing. This model is chosen because it includes the economic structural levels as well as the level of the mental models, the beliefs and images that represent the current culture. This level is normally not considered in economic analysis. The model shows that the less and least visible levels are always existent and influence the face-to-face level steadily. The face-to-face level is the level of interpersonal communication and behaviour as well as the results. The systemic model provides a visualization of the different structural levels, including the less visible parts that are shown in figure 1.

KANTOR divides between three levels of structures. These are the broader social structures, the face-to-face structures and the deeper individual structures.

[38] KANTOR (1995) seminar script; See ibid. (2012) pp. 286 ff.; See FATZER (2005) pp. 40 ff.; See ibid. (2011) pp. 58ff.

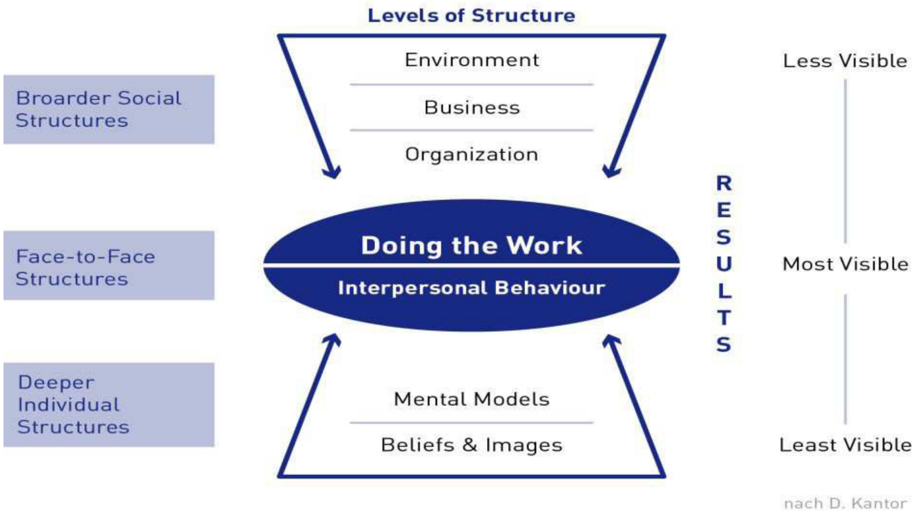

Figure 1 Team Learning Model, KANTOR 1995[39]

The levels of structures that are well known in the strategic management are the broader social structures. They include the environment, the business and the organizational level. It is the structural level where external events take place and influence the team situation, e.g. change in the environment.[40] NATH calls these levels ´traditional territory`. These levels are, in comparison to the level of the face-to-face structures, less visible.[41] The face-to-face structures are most visible. This level is the level of obvious interpersonal behaviour, the way how people do their job, the way they talk and negotiate with each other and the way they make decisions. It is also the level of group dynamics and where conflicts are obvious. The results are also located in this level. A result could be a long-term economic result in terms of turnover, profit or market position or a middle-term result that could include different aspects of running the operation, e.g. new strategies of the company or structural changes. This could be an implementing of a total quality management system or to open a research and development (R&D) department.

[39] KANTOR (1995) seminar script

[40] See ibid. (1995) seminar script, (2012) p. 237; See BÖCKER-KAMRADT (2000) pp. 300 ff., (2001) pp. 77ff.; See BÖCKER (2012) p. 4

[41] See NATH (2008) pp. 24f.; See BÖCKER (2012) p. 4

Short term results are an outcome of meetings, discussions or any other communication as well as actions based on the results of decisions. The interpersonal behaviour produces steady results. Obvious results in this thesis are e.g. the decision for the exit of the nuclear power stations or the decision to focus on central wind energy fields. Such basic decisions are results of discussions and interactions with other people in groups or teams. Due to this, the quality of communication is essential.[42]

Stuck situations and model clashes become obvious at times of conflicts and crisis that are often caused by high-stake situations.[43] The involved people are not aware of being stuck in a model clash in most of the cases. A process of exploring the situation (e.g. by using the model) would be necessary to understand the interconnection between their mental models and the conflict situation they are in. While exploring the situation a cross-model conversation would be possible that could lead to new insights for the people involved. Two principles underlie this process:

- Difference is a key source of learning about ourselves and other models.
- Every model has its limit and it is not to ask which one is better than another one, the only bad model is the one that is determined to be complete and better than other models.[44]

The level of the deeper individual structures is described as the least visible level in the model. It includes the mental models and the beliefs of the people as well as the core beliefs, critical images and stories. "Stories are the primary means by which human beings make sense of the world and of themselves...story is the device that allows us to store, organize, and retrieve meaning from the images we choose to remember...images are memories, depicted representations of events, thoughts in visual form. They involve the self and at least one other person".[45] KANTOR states further that shared stories are essential to forming and perpetuating the identity of a group.[46] The level of the deeper individual structures could be both, personal and cultural and is connected to

[42] KLEINER (2013) p. 1

[43] KANTOR (1997) seminar script; KLEINER (2013) p. 1; See BÖCKER-KAMRADT (2000) pp. 310 ff., (2001) pp. 78ff.

[44] KANTOR (2012) p. 283

[45] Ibid. (2012) p. 130

[46] Ibid. (2012) p. 151

experience. This experience was made within the biography of persons, organizations or any other group.[47]

Mental models are connected to the individual history in a specific culture within specific conditions. The ingredients build the substitute model. This is the interpretation of how people do have to behave. It is the guidance in a given situation to decide whether something is right or wrong, whether you win or lose. That is why KANTOR talks about mental models as ´moral models`.[48]

The steady trickling influence of the different levels in direction of the face-to-face structures is illustrated by the hourglass diagram. This is the basis model to show the structural dynamics. KANTOR states: "the hourglass diagram represents influences that bear on the various interfaces in an organization. I use it in identifying morally corruptive influences or mechanisms throughout a system on all three levels".[49] He defines five behaviour patterns to elicit and amplify what he calls moral corruption. The five patterns are the empowerment paradox, courteous compliance, co-opting the inner-circle, silencing the witness and forgetting history.[50]

3.1.4 Structural Levels in complex Systems

KANTOR`s description of structural levels in complex systems that is illustrated in figure 2 contains:

- The action level
- The pattern level
- The level of paradigm
- The level of myth.[51]

The four levels of structures describe the interconnection of the structural dynamics determined by the level of the critical images and myth. This level influences the more visible levels directly.[52]

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[47] See SCHEIN (1995) pp. 20ff.

[48] KANTOR (2012b) interview

[49] Ibid. (2012) p. 236

[50] See ibid. (2012) pp. 237ff.

[51] Ibid. (2012) pp. 23ff.

Level 1: The action level describes four different psycho-political stances which are typical in communication. KANTOR calls them the Mover, the Follower, the Opposer and the Bystander. These different roles in the Four Player System are positions in a speech act. They do not depend on the content people are talking about. It is the typical flow of speech act and sequences that is also categorized in typical behaviour and patterns. Two behaviour archetypes are ´point-counterpoint` and ´courteous compliance`.[53]

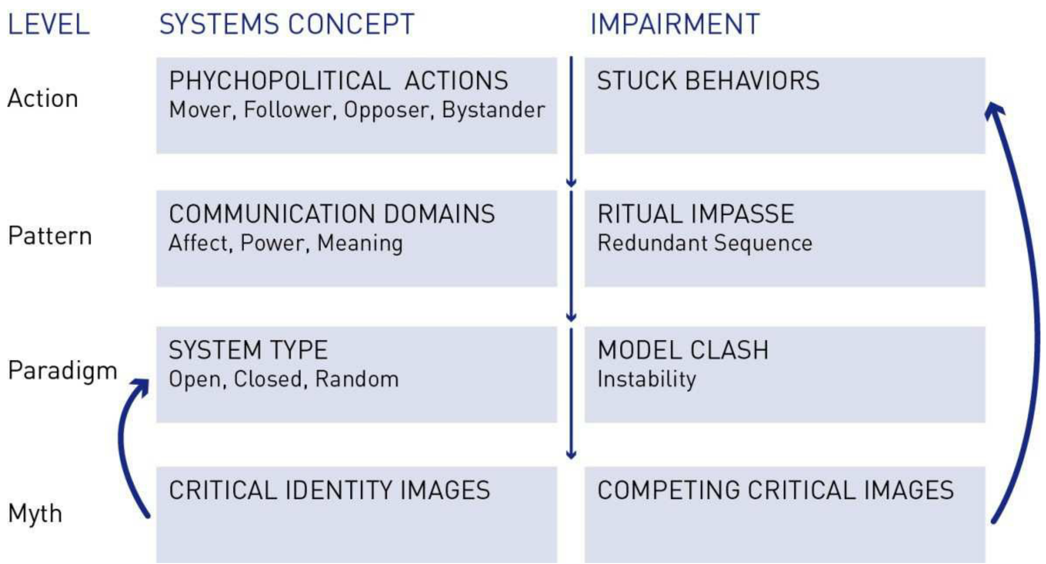

Figure 2 Structural levels in complex systems, KANTOR 1996[54]

Level 2: The pattern level or domain of communication contains the domains of Affect (feelings), Power (getting things done), and Meaning (what it all means).[55] The domains describe the territory where actions originate and their purpose.[56] Many situations are getting confused because the involved people are operating in different communication domains.[57]

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[52] Ibid. (2012) pp. 8ff.

[53] Ibid. (1996) seminar script, See ibid. (2012) pp. 23ff.; See KANTOR/LONSTEIN (1994) p. 415; See KLEINER (2013) p. 1

[54] KANTOR (1996) seminar script

[55] See ibid. (2012) pp. 49 ff.; See KANTOR/LEHR (2003) p. 150, here described as „three distance regulation styles“ which also includes the domains space, time and energy

[56] KANTOR (2012) p. 49

[57] KANTOR/LONSTEIN (1994) p. 415

Level 3: The paradigm level indicates the set of rules for governing behaviour in human systems. Each set of rules forms a type of system. The systems are called closed, open or random.[58] KANTOR states: “ultimate conversational power rests not in individuals but in the systems they create and deploy speech behaviour...for ´system` you might also think of the phrases ´governance pattern` or ´authority paradigm`”.[59]

Level 4: Level of myth is the identity-forming level. KANTOR states: “no single concept is more ubiquitous“[60] in one`s life and the most difficult to unravel. Identity-forming stories are essential, they give the accomplishment to human needs that “one is the coherent sense of self that distinguishes us from other human entities; second, they give each of us recognizable voice that allows us to be heard, understood, and responded in human communication“.[61]

3.1.5 Structural Traps

´Structural traps` are recurring stuck situations. KANTOR states: “if key structural traps are not seen clearly and are addressed successfully, they can undermine, neutralize or destroy change efforts”.[62] To identify structural traps on different levels and to find out the origins of the traps is the leverage in change processes.
The characteristics of structural traps are:

- Experienced by people who are attempting to change the system
- Often experienced but not clearly understood
- People are blind-sided by structural traps, outsiders step into them without knowing it, insiders sense the trap but they are unable to act
- At one level or time in the system, the structure inherent in the trap is appropriate
- The structure becomes a trap at sub-system interfaces - at one level or another level; in the old system, in the new system.[63]

[58] KANTOR (1996) seminar script
[59] Ibid. (2012) p. 79
[60] Ibid. (2012) p. 127
[61] Ibid. (2012) p. 127
[62] KANTOR (1995) seminar script
[63] Ibid. (1995) seminar script

3.1.6 Steps in the Process of Model Building

Model building is an interactive and dynamic process. KANTOR states: “it is the discipline of reflecting on and systematically enhancing our deeply embedded views of the world, of ourselves and our work. It begins with standing outside ourselves to observe our interactions in the world. We notice how our behaviours come together with the behaviours of others to produce both good and bad results. Those reflections are incorporated back into our underlying belief systems“.[64] This process relies on the quality of reflection. The process is described in the following steps:

1. A practitioner enters a field of practice with a practice model. This is the expressed model, the intention of what to do.

2. The practitioner and the model are confronted with forces which are not under control of the practitioner. The model in practice is strained. This leads to the displayed model, what is actually said and done and not what was intended to do at the outset.

3. Reacting to constraints, the practitioner adjusts and adopts the plan.

4. Serious push backs over time and the accumulation of constraints result in more serious change in the aspects the model is constrained. The forces are:

- The nature (dominant profiles of the system to deal with)
- Models of individual members of the system that compete with the practitioner`s model
- The larger organizational context (e.g. its culture)
- The way the practitioner`s own behavioural profile modifies, particularly in the face of personal challenge. This includes the expressed and the displayed model.

5. When a model is constrained and produces unanticipated results, the practitioner has three choices:

- The decision of noticing the ´noise` and dismissing it
- Realization that the model has failed and that the gaps must be filled

[64] Ibid. (2012) p. 283

- Responding spontaneously and coming up with a technique that is added to the model.

6. The practitioner engages in reflection. This leads to a change of the expressed model.

Constraint is defined by KANTOR as the creative tension that is generated when the model is confronted with other models such as different theories, methods or approaches. Constraint will either lead to positive learning effects or to frustration.[65]

The ability of a person to reflect such situations and the quality of reflection is important for the future. It decides if the model clash is kept as experience of learning or if it is kept in the person`s level of unawareness. KANTOR divides the process of model building in three different stages such as imitation, constraint and autonomy.[66]

3.1.7 The Boundary Profile

Referred to KANTOR, the Boundary Profile is the meeting ground between personal history and organizational reality. It is the interface at which significant, sometimes highly charged, activities between teams or organizations take place to conduct the business. Some of the structures remain invisible, though everybody feels their presence and cannot deny their existence".[67] Kantor states: "the Boundary Profile - so what:

1. It sheds bright light on the relationship between your inner and outer world
2. It links your work to your personal history (should you even care to know)
3. It explains why you get along with X, but not with Y; why you work well with some people and not with others, why you flourish in some contexts whereas in others you are a disaster".[68]

The trigger is different from person to person, and one person can have more than one trigger. The trigger can be either a person (or typical behavioural pattern) or a powerful personal theme. This is called a ´toxic theme`. The trigger leads to emotional reactions (noise inside) and creates a high-stake situation for the actor. It shows both,

[65] See ibid. (2012) pp. 285f.

[66] Ibid. (2012) p. 290

[67] Ibid. (1996) seminar script

[68] Ibid. (1996) seminar script

the extreme sensitivity individuals have to specific themes and the intensity of their reactions.[69] The height of the high-stake situation is determined by the intensity of the emotional reaction and the affection of the powerful theme.[70] The following figure illustrates this.

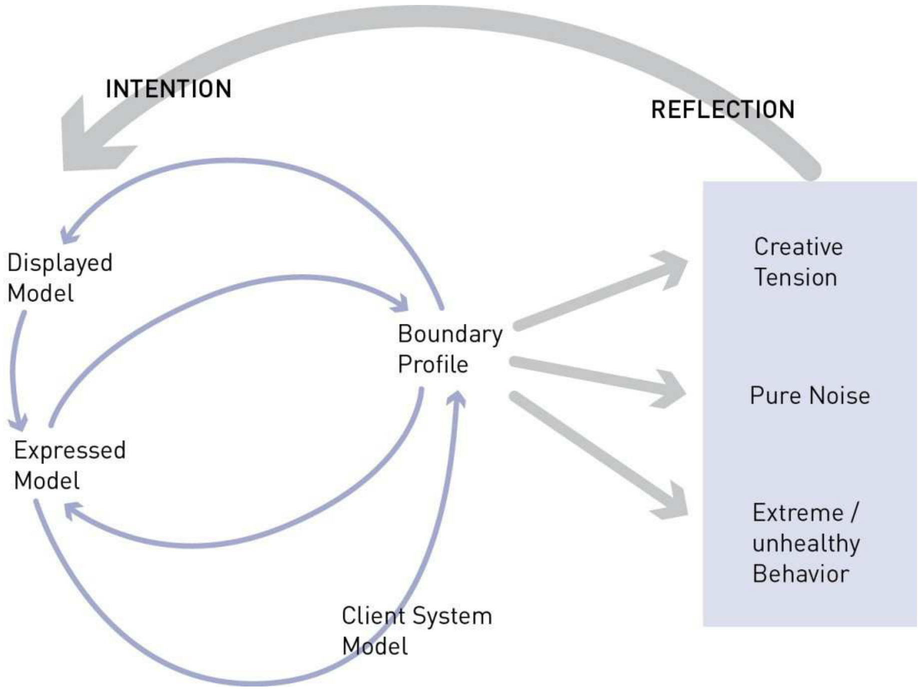

Figure 3 Dynamics of model building, KANTOR 1996[71]

3.1.8 The Leadership System Model

The Leadership System Model proposes a new way of leading a company especially in times of fluctuation. The new model changes from a powerful individual to a team of leaders. The members of the leading team complement each other to achieve the best performance. The Leadership System Model respects four powerful aspects:

1. How members see themselves and their roles
2. Its range of capabilities
3. Its place in the organizational design
4. Its collective intelligence.[72]

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[69] Ibid. (2012) p. 175

[70] Ibid. (2012) p. 167

[71] Ibid. (1996) seminar script

[72] Ibid. (2012a) p. 36

KANTOR describes what he calls the Five Leadership Pathways containing the Performance Leaders, the Vision Leaders, the Wisdom Leaders, the Citizen Leaders and the Exit Leaders.

The Performance Leaders are the guardians of the company`s profit statement. They lead the struggle to sustain the economic viability of an organization. The Vision Leaders are the futurists of the organization by challenging their own and the organization`s basic premises. The Wisdom Leaders are the guardians of the spiritual essence articulating "what is this all about". The Citizen Leaders are the ones for the organization`s architecture and focus on structuring. The Exit Leaders are what KANTOR calls the iconoclasts with the main task "to recognize and call out the aspects of the organization and its performance that others lack the courage to challenge".[73]

KANTOR states further that this task is not meant as just criticism. It is a way of constantly seeking for the highest performance by ongoing self- and organizational reflection to guide the organization towards the future.[74]

3.2 Theory of Change

The business field of wind energy is regarded as a socioeconomic system. The theory of systems dynamics will be described as theory to understand the dynamics arising in a transformation process like this. Therefore, understanding change and understanding systems are related whether it is in groups, organizations or people.[75] Different approaches of systems dynamics, culture and change will be shown from e.g. LEWIN, BECKHARD, SCHEIN, FORRESTER and MEADOWS.

3.2.1 Social Systems

A system is not just a collection of things. It consists of three kinds of components, the elements, interconnections and a function or purpose.[76] Social systems are part of a whole society system. They are established by human intentions and goals. They are built up, guided and changed in their pattern of regularity. They are stamped by history

[73] Ibid. (2012a) p. 38

[74] Ibid. (2012a) p. 39

[75] See FATZER (2000) pp. 85 ff.; See WILLKE (1996) pp. 5ff.; See KÖNIG/VOLLMER (1994) pp. 11ff.

[76] MEADOWS (2010) p. 26

and tradition and patterns of interaction. Those patterns were established due to being successful to fulfil the purpose. The overall society and the social systems are interconnected to each other through production and their frame of reference. They define the systems by purpose. At the same time, the systems border and autonomy are perpetuated.[77] Human systems are not to understand without their purpose.[78]

Every part of a system is connected to the other parts. The system behaves like a whole, not only in isolated parts. The parts are interconnected and influence each other steadily. Therefore, a system is more than the sum of its parts. Many of the interconnections in a system operate through the flow of information and feedback. This is the connection to its environment. The least obvious part of the system, its function or purpose, is often the most crucial determinant of the system`s behaviour. Systems work in loops and establish patterns. A system`s behaviour reveals itself as a series of events over time and build structures. System structures are a source of behaviour.[79]

Systems maintain their stability by fluctuations and adjustments. Those fluctuations and adjustments are circulating steadily through the system. A system has feedback, internal and external. Sometimes it is possible to follow the feedback as a consequence of a decision because the time line is short. Very often you cannot see the feedback of decisions or actions immediately because the time is too long until the feedback returns to the system. It is also possible that the feedback is returning from parts of the system or the outside without being involved before.[80] FORRESTER describes a conflict between short-term run and long-term run in social systems. Connections between initiation and symptoms are often far removed in both, time and space.[81] Delays are pervasive in systems and they determine the behaviour strongly.[82]

Systems are built on structures. The structures are the way in which the system components are interrelated. They are invisible and subtle. To understand those structures it is needed to differentiate between events, patterns and structure. Structure

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[77] PROBST (1987) p. 69; See LEWIN (1953) p. 78

[78] PROBST (1987) p. 71

[79] See MEADOWS (2010) pp. 27ff.

[80] See ANDERSON/JOHNSON (1997) pp. 3ff

[81] See FORRESTER (1971/2010) p. 29

[82] MEADOWS (2009) p. 57

is the core element because it is the background for explanation of all the events and trends we see happening and therefore, they are guiding the behaviour.[83] Solving problems in a short-term range create frequently unintended consequences in the long-term range and increase the problems someone is facing. Systems thinking strengthens the awareness that the people who made the decision are involved in this feedback system.[84]

The typical behaviour structures or archetypes are found in many organizations from internal personal dynamics and team dynamics on different levels or scales up to global international relations.[85] Examples are e.g. blaming somebody and short-term solutions. They illustrate the systems dynamics by loops that represent components of the system. They show the relations and interrelations between the components. Balancing and reinforcing processes are visible. Important archetypes are e.g. Fixes that Fail, Shifting the Burden and Limits to Success.[86] Systems archetypes help to identify the leverage point of systems and help to resist the immediate wish to solve the problem by illustrating short-term and long-term effects.[87] Leverage points are points of power. Small changes at these points could lead to a large shift in behaviour, but more often they push the change in the wrong direction.[88]

3.2.2 Change in Systems

LEWIN considered his concept of life space as an ecological concept in an ecological system. The human being is embedded in ecological systems with different levels.[89] LEWIN determined human behaviour as manifestations of a deeper intra-psychic activity generated by the interaction with the psychically relevant environment. His life space concept provides a framework to structure the underlying dynamics of the

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[83] SENGE (1994) pp. 51ff.

[84] ANDERSON/JOHNSON (1997) pp. 20f.

[85] KIM/ANDERSON (1998) p. 1; SENGE describes the example of a process chain in a brewery that is called ´Beer GAME`, SENGE (1994) pp. 27ff., the Beer Game was played in different cultures, on different levels with similar results, KIM (1995) seminar

[86] See ANDERSON/JOHNSON (1997) pp. 124ff.; See KIM/ANDERSON (1998) pp. 4ff.

[87] ANDERSON/JOHNSON (1997) p. 90

[88] MEADOWS (2009) p. 146

[89] OERTER (2008) pp. 85ff.

person-environmental field based on the totality of concurrent and coexisting facts being psychological relevant for the person. The life space concept describes human behaviour by the formula B=f (P, E), the person and his environment. It considers the time dimension. This is the psychological past as well as the future and includes the dimensions of reality and irreality. This describes a continuum from tangible, sensible reality to intangible reality such as phantasies and hopes.[90]

It is necessary to have a model of a system in a stable state if you want to understand change. Referring to LEWIN[91], the stable state is a quasi stationary equilibrium. Every living system is in a state of steadily changes such as growth, conversion or decline and is striving for equilibrium although the sub-systems can change differently in speed. The tendency of equilibrium is achieved by forces that are pushing in different directions.[92]

“Specifically, the level of behaviour at any moment in time is the result of two sets of forces - those striving to maintain the status quo and those pushing for change. When both sets of forces are about equal, current levels of behaviour are maintained in what Lewin termed a state of ´quasi-stationary equilibrium`“.[93] When no compensating forces occur, the system moves to another level of equilibrium. This is why it is called quasi stationary. In processes of change the forces of the field are shifted.[94] LEWIN states: “to be able to induce a change at all, it is necessary to eliminate the balance between the forces that cause the social self-regulation on a decent level“.[95] This is possible either by increasing the forces that are driving for change or to decrease those forces that are driving for maintaining the quasi equilibrium.[96]

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[90] EVERED (1997) p. 10

[91] LEWIN``s influence in the development of social psychology was immense. His work covered the field dynamics, basis change models, the basics of action research and group dynamics. One focus of his research was finding ways to social conflicts and democratizing people (Germans after the 2nd world war) and other issues of society, see HORKHEIMER (1953) pp. 7f.; See EVERED (1997) pp. 2ff.; See FREY (2011) pp. 8f.

[92] See SCHEIN (2005) p. 245; See KAST/ROSENZWEIG (1970) p. 125

[93] CUMMINGS/WORLEY(1993) p. 53

[94] See SCHEIN (2005) pp. 244ff.; See FATZER (2000) pp. 88ff.; See LIPPITT (2012) p. 12

[95] LEWIN (1953) p. 79

[96] CUMMINGS/WORLEY(1993) p. 53

LEWIN`s model (1948) to enable change consists of three steps and is the basis for most change models in the field of economics and organizational development.[97]

1. Unfreezing: Creating a motivation for change. This step is determined by questioning, creating anxiety to survive and feeling of guilt. At the same time, an atmosphere of psychological safety is to be created to surmount the anxiety to learn. Frequently, those forces that have the tendency to maintain the present state are reduced.

2. Change/Moving: Learning of new formulations, meanings and standards. This step is determined by imitation and identification with new models of roles and by searching for new solutions based on trial and error. The behaviour is shifted to a new level by involving new behaviours, values and attitudes through changing organizational structures and processes.

3. Refreezing: Stabilizing of the new formulations, meanings and standards by internalising the new ones in the self-perception and identity. This step stabilizes the organization at the new state of equilibrium. This is frequently achieved by a supporting mechanism to reinforce this new state.[98]

The classical Change Curve Model (figure 4) of seven phases during a change or transformation process shows the most important steps and the emotional flow during a change or development process no matter of being personal or organizational systems. The accompanying factors of change are feelings of not being competent anymore, uncertainty and fear. The curve was elaborated by CHAPMAN/JUPP (1992) and shows the subjective reality of the people related to time, starting from the start of change.[99]

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[97] See FATZER (1990), p. 58; See BARGHORN (2010) pp. 18ff. here originated 1947

[98] SCHEIN (2005) p. 248; CUMMINGS/WORLEY (1993) p. 53; See SCHEIN/BENNIS (1965) pp. 43 ff.; See FATZER (1990) pp. 58ff.; See SCHERMERHORN (1996) pp. 444f.

[99] FATZER (1999) p. 13, (2005a) pp. 19f.

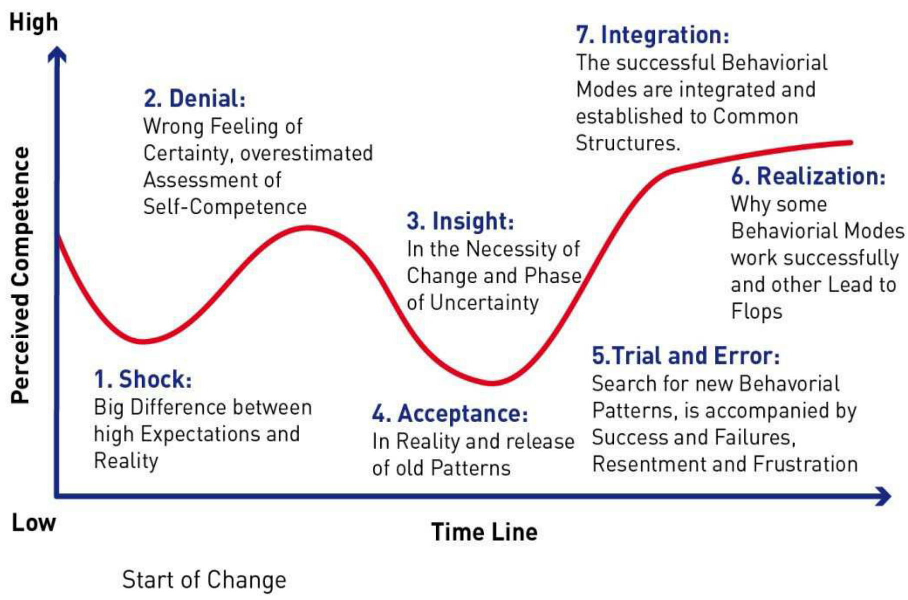

Figure 4 Change Curve Model, 7 steps of change, FATZER 1993[100]

1. Shock: big difference between high expectations and reality
2. Denial: wrong feeling of certainty, overestimated assessment of self-competence, frequently obvious by doing more of the same ´old` behaviour
3. Insight: in the necessity of change and phase of uncertainty
4. Acceptance: in reality and release of old patterns
5. Trial and error: search for new behavioural patterns, accompanied by success and failures, resentment and frustration
6. Realization: why some behavioural modes work successfully and others lead to flops
7. Integration: the successful behavioural modes are integrated and established to common structures.[101]

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[100] Ibid. (1993) p. 33, (1999) p. 14, (2005a) p. 20

[101] See (1999) pp. 15ff.

3.2.3 Importance of Culture

HOFSTEDE states: “each person carries within himself deep patterns of feeling, thinking and potential acting which one learned within his life. Most of it was learned in the early childhood in a stage of life when the sensibility for learning- and assimilation processes is high...if those patterns of feeling, thinking and acting are tightened in the brains of a human...they have to be released before it is possible to learn something new...it is more difficult to discard something than learning it as the first time“.[102]

THOMAS/INKSON state: “we have a hard time escaping our culture, even when we want to. The mental programming involved is strong. Even when we mentally question the rationality of some aspects...we have a natural tendency to revert back to our cultural roots“.[103]

Culture is a collective phenomenon that is shared by people who are living in the same social environment. It is the collective program that differentiates members of one group or category of humans from another.[104] A manifestation of culture is a combination of symbols, heroes, rituals and values.[105] A human is born into a relatively stable order of social interactions and physical structures, culture is systematic and organized.[106] KRIZ calls this the expatriation of chaos in the society.[107] LITTERER states: “when we spoke earlier of culture providing solutions to common problems in life we were speaking of these as deeply ingrained lessons“.[108]

SCHEIN explores the cultural dynamics in organizations. He states: “the stability of those assumptions derives from the fact that together they provide group members with a way of giving meaning to their daily lives, setting guidelines and rules for how to

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[102] HOFTSTEDE (1997) p. 2

[103] THOMAS/INKSON (2009) p. 26

[104] See HOFSTEDE (1997) pp. 4ff.; See HOFSTEDE ET AL. (2010) p. 6; See THOMAS/INKSON (2009) p. 24

[105] See HOFSTEDE (1997) pp. 8ff.; See HOFSTEDE ET AL. (2010) pp. 7ff.

[106] THOMAS/INKSON (2009) p. 27

[107] KRIZ (1997) pp. 26f.

[108] LITTERER (1973) p. 261

behave, and, most important, reducing and containing the anxiety of dealing with an unpredictable and uncertain environment“.[109]

If a group has established a set of shared assumptions, it will tend to stick to them. They are taken for granted and dropped out of awareness. They are not questioned anymore and established as a matter of course. This is why cultural elements are very difficult to change.[110] SCHEIN gives the following definition for the culture within a group: “a pattern of shared basic assumptions that the group learned as it solved their problems of external adaptation and internal integration that have worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems“.[111] The strength of the assumed culture and subculture is related to the founders. They have a major impact on how the things are to be done.[112]

SCHEIN divides three levels of culture in organization. The artefacts are on the level of highest awareness. They are the visible manifestations of the other cultural levels such as the architecture and visible structures. This level is easy to describe but it is hard to decipher. The espoused values are the values which are told and shown in the principles, values, ethics and visions. It is the description of how the organization ought to be. The basic assumptions are the deepest, unconscious level with taken for granted and tacit assumptions about how the problems are to be solved and the work is to be done. They tell the members how to feel, perceive, think and act. They are not debatable and out of awareness.[113]

Patterns of assumptions are dwelled together because they are patterns. Isolated patterns cannot be changed unless the whole structure of patterns is changed. Thus, to understand the cultural phenomena it is of importance to go back in the learning history because the patterns are supposed to be the answers to survive in environmental

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[109] SCHEIN (1991) p. 15; See THARP (2009) p. 5

[110] See SCHEIN (1991) p. 15, (2005a) pp. 40ff.; See CUMMINGS/WORLEY (1993) pp. 526ff.

[111] SCHEIN (1995) p. 25, (1991a) p. 247

[112] See ibid. (1991) p. 15; (2005a) p. 41

[113] See ibid. (1991a) pp. 252ff., (1995) pp. 29 ff., (1999) pp. 15ff., (2003) pp. 31ff.; See CUMMINGS/WORLEY (1993) pp. 526ff.

pressures.[114] SCHEIN`s concept of Anxiety 1 and Anxiety 2 in change processes refers also to this point. Anxiety 1 is the anxiety on the first level that is connected to the feeling of not to be willing to learn or the avoidance to unlearn. Anxiety 2 is the second level of existential anxiety. In processes of unlearning, the cultural habit Anxiety 1 is to be surmounted by increasing Anxiety 2.[115]

TUSHMAN/O`REILLY are talking about the paradox of organizational culture. On one hand, the culture is based on success and is the vehicle for success in a competitive environment. On the other hand, cultural idleness hinders the adjustment in new situations and is a barrier when change is needed.[116]

3.2.4 Mental Models

Mental models are tacit maps of the world that are held by people in the long-term memories and the short-term perceptions that people build up as part of their daily reasoning processes.[117] Mental models are simplifications and generalizations. Mental models affect what we see and therefore they affect what we do.[118] CRAIK (1943) was one of the first model theorists. He argued that the fundamental power of mental models is to predict events. “If the organism carries a ´small-scale model` of external reality and of possible actions within its head, it is able to try out various alternatives, conclude which is the best of them, react to future situations before they arise, utilize the knowledge of past events in dealing with the present and the future, and in every way to react in a much fuller, safer and more competent manner to emergencies which face it“.[119] This power depends on three steps:

1. “The translation of an external process into words, numbers or other symbols, which can function as a model of the world.
2. A process of reasoning from these symbols leading to others.

[114] See SCHEIN (1991a) pp. 250f.

[115] See ibid. (1995a) pp. 5ff.; See FATZER (2005a) p. 18

[116] See TUSHMAN/O`REILLY (1998) pp. 36ff.

[117] SENGE ET AL. (1994) p. 237

[118] SENGE (1994) p. 175

[119] JOHNSON-LAIRD (2005) p. 179, citation from CRAIK (1943)

3. The retranslation back from the resulting symbols into external processes or at least a recognition that they correspond to external processes".[120]

Mental models are generally invisible for humans until they look for it in special. Mental models are explanations in our mind of ourselves, others, institutions and every aspect of the world. They are images, stories, assumptions that subtly distort our perceptions. All these maps are needed to regulate the complexity. They navigate the humans through the complex environment, but all these maps are flawed in some way.[121] SENGE states: "the problems with mental models do not lie whether they are right or wrong - by definition all models are simplifications. The problems with mental models arise when models are tacit - when they exist below the level of awareness".[122]

KRIZ describes order as form of reduction of complexity and as result of intrinsic avoidance against chaos. Chaos goes along with the loose of order that is one of the basic existential fears of human beings. Chaos also provides the possibility of creative change. If this creative chaos with a decompensation of order and values happens on a large scale, it is only possible to stick it out without damage for a short period of time. This is a transition phase. Perception is seen as a complex process. Stimuli are structured to conformations. Those classes of phenomena structure the chaos, enable forecasts, reduce uncertainty and provide reliability. At the same time, these structuring processes limit the creativity and can establish rigorous reinforcing archetypes of interactions in which anybody is a victim who is involved as an actor.[123]

FORRESTER (1971) states: "the human mind is not adoptable to interpreting how social systems behave...in the long history of evolution it has not been necessary until very recent historical times for people to understand complex feedback systems. Evolutionary processes have not given us the mental ability to interpret properly the dynamic behaviour of complex systems in which we are now embedded".[124] He points out the weakness of the human brain is to fail in complex systems while acting on the basis of their mental models. He describes this as counterintuitive. This can be either

[120] Ibid. (2005) p. 182

[121] SENGE ET AL. (1994) p. 235

[122] SENGE (1994) p. 176

[123] See KRIZ (1997) pp. 6ff.

[124] FORRESTER (1971/2010) p. 23

individually or as a group consensus - the mental mind is: “apt to draw the wrong implications for the future“.[125] By using computer simulation, the difference between human assumptions and the outcome of those simulations are obvious. FORRESTER sees the main difference of human mental models and the computer models in the fact that once a computer is fed with the right information, it states explicit and unambiguous. In contradiction, mental models are fuzzy, incomplete and imprecisely stated.[126]

3.2.5 Role of Leadership

The role of leadership has different aspects in terms of change. As described above, in most of the cases the leaders are the founders of the companies or have the highest influential status. Their ideas and their behaviour patterns have the highest impacts on the development of cultural aspects.

The leaders are also the ones who could initiate change processes as a planned process. In their role, they are responsible for changing the existing patterns in the system. Change is a part of creativity and innovations that are still the growing topics in the economics.[127] Leading by understanding, perceiving and reflecting requires different attitudes and abilities, therefore leading is differentiated from just managing.[128] SENGE states that the most crucial mental models in any organization are those who are shared by the key decision makers.[129]

Culture and leadership cannot be understood separately. SCHEIN states that the creation and the supervision of culture are the only real important tasks of leaders. The special talent for leadership is the knowledge and ability to work with culture. This does not mean that the leaders could control the whole culture or that it is an easy task to establish an organizational culture.[130] Vision building, ability of high effective communication, trust building and empowerment are the core elements together with

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125 Ibid. (1971/2010) p. 25

126 See ibid. (1971/2010) p. 25

127 See SCHERMERHORN (1996) p. 442

128 See WILDEMANN (1999) p. 23; See BENNIS (1990) pp. 48f.

129 SENGE (1994) p. 186

130 See SCHEIN (1995) p. 20

the ability to reflect and to act congruently. BENNIS describes four core strategies for effective leadership: creating attention through a vision, making sense through communication, creating trust through positioning, empowerment and self-conception.[131] KOTTER defined eight steps for a successful transforming of organizations. They illustrate the close connection between leadership and change.[132]

3.2.6 Change Model by BECKHARD

Change is determined by BECKHARD through three distinct conditions that are the future state, the present state and the transition state that is illustrated in figure 5. Therefore, it is necessary to define the future, to assess the present and to manage the transition.[133]

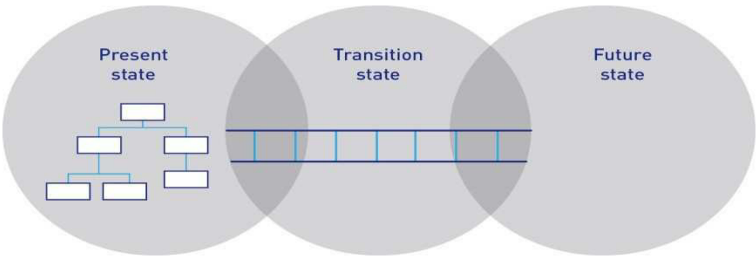

Figure 5 Three distinct conditions, BECKHARD/HARRIS 1987[134]

The change model by BECKHARD (1987) and SCHEIN (1987) is presented as an overview for change and transformation processes. The model considers all relevant aspects for change in complex social systems. It is a systemic model and refers back to LEWIN`s field forces in the field theory.[135]

The process of change has to start with answering the question why change is needed. This should include the different possible options. BECKHARD describes them as degree of choices. The map of change process is demonstrated in figure 6.

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[131] See BENNIS/NANUS (1992) p. 33; See BENNIS (1994) p. 122

[132] See KOTTER (2007) pp. 126f.; (1997) pp. 38f.; See BACH (2010) pp. 24ff.

[133] BECKHARD/HARRIS (1987) p. 29; BECKHARD/PRITCHARD (1992) p. 14

[134] BECKHARD/HARRIS (1987) p. 29

[135] FATZER (1999) p. 12

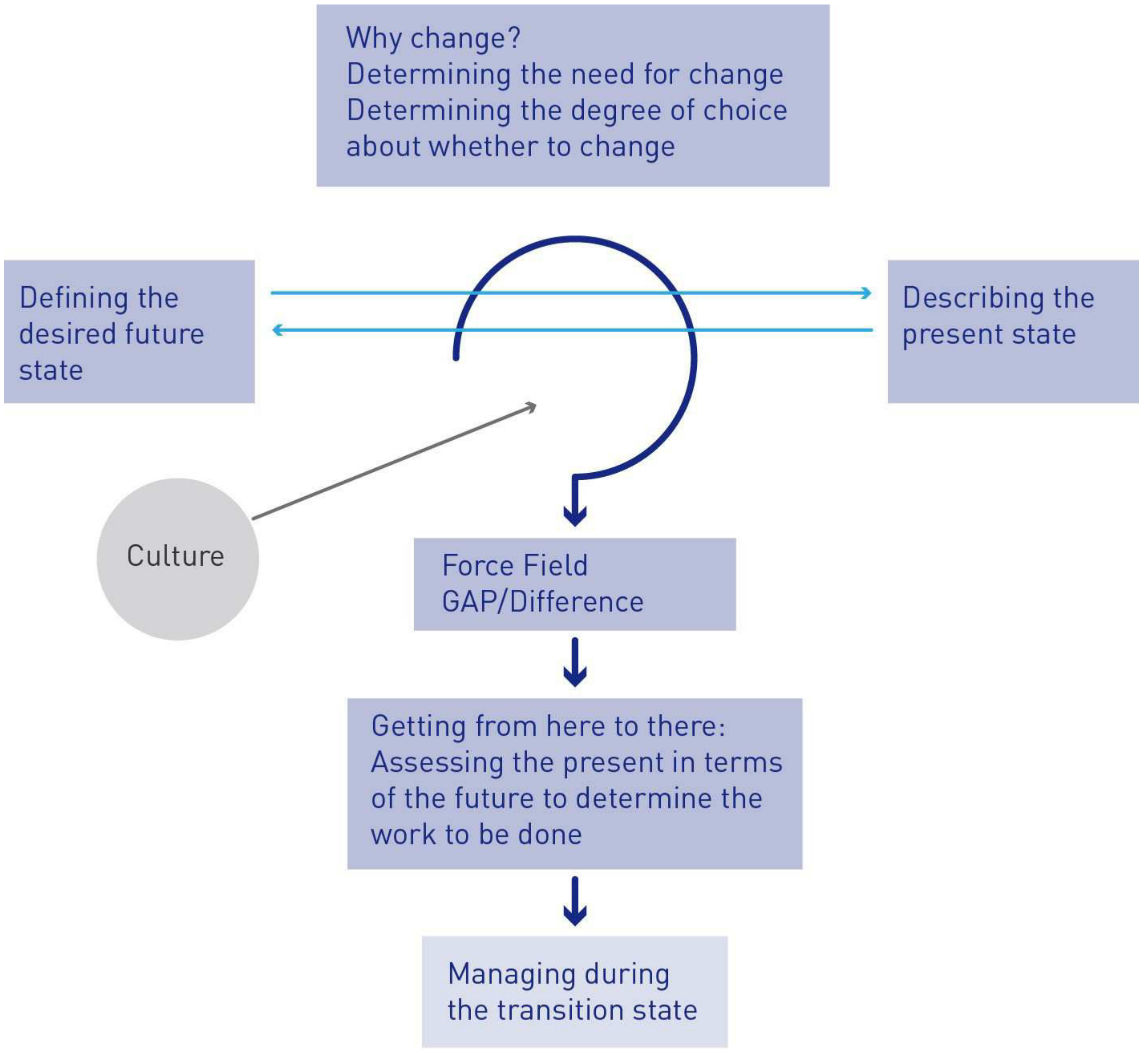

Figure 6 Map of change process, BECKHARD 1987[136] adjusted by SCHEIN 1987, FATZER 1999/2005[137]

The need for change tends to originate from the outside such as changes in the socioeconomics or new technologies. In this thesis it is caused, besides others, by a governmental regulation related to the necessity of general change in the energy field. The next step is to set the conditions for the final state, the visions and the desired goals. In this thesis it is the nuclear exit in the year 2022.

The further process is the elaboration of the present state under the conditions given by the final state. The forces are driving in different directions, maintaining the present

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136 BECKHARD/HARRIS (1987) p. 31

137 FATZER (1999) p. 11, (2005) p. 29; SCHEIN (2005) p. 257

state and driving for change. Defining the future state leads to more optimism, less uncertainty and high identification.[138] The assessment of the present state includes the situational analysis of both, economical factors and soft factors including the behaviour patterns. The outcome leads to a process of managing the transition, the gap between the present state and the future. It is the phase of unlearning and to release old, previous successful behaviour to come to a new orientation[139]. Therein, the specific ´culture` of the system has a major influence and was added in the graph as well as the ´force field`.[140] In this term, culture is not only meant as a national culture but also as a professional or an organizational culture.[141] The cultural part including the mental models as part of the current state in the change process is the focus of the research process in this thesis.

3.2.7 Transformation

Besides its use in e.g. physics, the term transformation is traditionally used for change of whole societies. Normal change processes are nowadays part of the daily work in organizations.[142] SCHOEFER proposes a differentiation between definitions of change and transformation as the following:

“Change or change management in organizations means accompany and support of transformation or change of people and/or organizations. Its purpose is to achieve growth. Transformation in organizations is the transition and transformation of social contexts. Its purpose is to achieve sustainability. Transition and transformation of social systems depend on the sustainability of the organization proportionally. In this context, sustainability means the stable security of the basic needs for future generations which is not *exclusively slanted towards growth* and includes the willingness of self-limitation of the present generation“.[143]

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[138] BECKHARD/HARRIS (1987) pp. 48ff.

[139] KRIZANITS (2004) p. 90, (2005) p. 73

[140] See FATZER (1999) p. 13

[141] See SCHEIN (1993) pp. 41ff., (1995) pp. 20ff.

[142] See SCHOEFER (2005) pp. 94f.

[143] Ibid. (2005) pp. 97f.

SCHARMER is talking about a crisis of our time. It is not the crisis of single persons or leaders, of one country or a special region. It is the crisis of an old social- and thinking structure with traditional patterns of institutionalisation and social formations.[144] He sees the transition point in the field at the cutting point between the obvious level - what we do, say and see - and the ´internal constitution` - the origin what we do, say and see.[145] The positive message for the transformation is that those hidden cutting points are the same on the individual level that is the micro-level, on the group level that is the meso-level, on the institutional level that is the macro-level and on the global level that is the mundo-level.[146]

BRAND is talking about a multiple crisis. Herein, the dynamics of the ecological crisis is deeply anchored in the globalization process. The ecological crisis is a social and ecological crisis caused besides others through the fact that the occupancy of nature is the dominant design.[147] The perspective of just changing the economical globalization is insufficient. He states: "it is all about a change of the political content, institutional structures and the connected articulation of interest and balance of power of the society. This is related to a deep transformation of orientation in the politics and society away from a nature disturbing and socially disrupting accepting way of life".[148]

The WBGU is claiming for a new contract of association for the world economics that include the world`s society. This contract should be based on a commitment for climate protection and sustainability. Also taken into account is the collective responsibility that averts damages to the mankind as part of the earth system. This huge transformation will not happen automatically, it will be dependent on the designing of the non-projectable if it succeeds in the given time limit. This is unique in history because all huge energy transformations were evolutionary before. The fossil economical system is in imposition, the change in values towards sustainability and long-term orientation is approved by studies. The WBGU claims further that the

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[144] SCHARMER (2011) p. 26

[145] Ibid. (2011) p. 37

[146] Ibid. (2011) p. 48.

[147] BRAND (2009) p. 5

[148] Ibid. (2009) p. 12

political system is now in charge to eliminate the blockades and to accelerate the transition process. A master plan is requested.[149]

REICHE/BECHBERGER gave a description of transformation in the energy sector in 2006: “related to the energy sector the term *Transformation* means a (possible) transition from the traditional nuclear-fossil towards an ecological based energy supply system that is characterized by structural disruptions, crisis and turbulences that will possibly bifurcate within the change process depending on the way how the energetic and ecological problems are negotiated, the evolving conflicts are to be solved and basic decisions are made to change the fundamental structural conditions. This means that the process can be determined as an open future process related to the decisions made within the process of change“.[150]

3.2.8 Systems Dynamics on a Society Level

FORRESTER was the pioneer in systems dynamics.[151] FORRESTER was asked to apply the complex systems dynamics approach to the global ecologic system by the Club of Rome.[152] Characteristics of social systems were set into a global perspective. The visualizing of future scenarios was done by computer simulation. The ingredients were world population, quality of life, energy sources, capital investment and pollution. The results were published in the reports World Dynamics, Limits to Growth and Beyond the Limits.[153] The precondition for such applications was the technical progress in the field of computerization. The programs could be used to analyze a complex social system.[154] The research visualized that the world`s capacity will be reached within the next hundred years (status 1972) and that a collapse of the world system is pre-assigned.

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[149] WBGU (2011) pp. 1f.

[150] REICHE/BECHBERGER (2006) p. 2

[151] KIM/ANDERSON (1998) p. 2

[152] The *Club of Rome* thinks and acts in global relations und refuses mono-causal and short-term thinking, its guiding vision or purpose is the sustainable development that requests a consideration of the need of humans worldwide and of future generations. See SYPIEN (2008) p. 2

[153] See MEADOWS ET AL. (2004) pp. ixff.; See SYPIEN (2008) p. 2; See SYSTEMS DYNAMICS (2010) p. 44;

[154] FORRESTER (1961/1999) pp. Viiff.

These reports were a signal and a start of different thinking in parts of the world. They are evaluated as the origin of sustainable development.[155] MEADOWS states: “we did increase the awareness and concern about environmental issues in the early days of the environmental movement“.[156] The interpretation about the research by just proclaiming the end of energy resources was not the main ambition of the surveyors. The main purpose was to illustrate that the current policies will produce global overshoot “through ineffective efforts to anticipate and cope with ecological limits“.[157] The basic behavioural choices of the system are the ones that are involved in creating the collapse. This message was evaluated by MEADOWS as insufficiently transferred.[158]

MERKEL states that the systems approach heuristically has potential in the research of transformation processes because it is close connected to the important juristic issues and stabilization of political regimes. The analysis of dysfunctional sub-systems and the stabilization of the whole can be elaborated systematically in order to survive.[159] This refers to EASTON who defined the political systems as an open system analogous to the organizational system. He states: “if we hold the system of political actions as a unit before our mind`s eye...what keeps the system going are inputs of various kinds. These inputs are converted through the system in outputs, and these, in turn, have consequences both for the system and for the environment in which the system exists“.[160]

3.2.9 Macroshift Model

LAZSLO`s Macroshift model illustrates a transformation process on the level of society or parts of the society. The transformation always needs a trigger phase. The transformation process includes a phase of chaos. The exit of this critical phase is determined by two possible paths of proceeding. This point is called bifurcation. It shows the decision point of the system`s further process.[161] He states that we are now

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155 SYPIEN (2008) p. 2

156 MEADOWS ET AL. (2004) p. xx

157 Ibid. (2004) p. xx

158 SYPIEN (2008) p. 3

159 MERKEL (2010) p. 65

160 EASTON (1957) p. 384

161 See FATZER (2005a) p. 22f;

living in a period of social- and ecological instability. There are definite limits to the *kind of growth* that is occurring today. He calls this crucial state decision window. LASZLO states that a point of chaos will be reached whilst ignoring the planet`s limits. The point of chaos will occur all of a sudden, it will appear out of the blue, meaning, that the normal fluctuation will be joined by chaotic and strange attractors. In this period, the world is supersensitive and small fluctuations can lead to large-scale effects. This is known as the butterfly effect.[162]

LASZLO identifies four major phases in the Macroshift. The phases are:

1. The trigger phase that contains innovations in hard technologies such as tools, machines that bring greater efficiency in the manipulation of nature for human needs. A trigger could be innovations like the information technologies (IT).

2. The transformation phase or accumulation phase that is determined by hard technologies changing the internal structure of social relations and the external relations to the embedded system. They successfully bring:

- Higher levels of resource production
- Faster growth of population
- Greater societal complexity, and
- Growing impact on the social and the natural environment.

3. The critical or (chaos) phase or the decision window. The established culture or order is under pressure and is questioned by the changed social- and environmental relations. The society becomes unstable and chaotic. It does not lack order but exhibits a subtle order that is supersensitive to fluctuations. The evolution of the dominant culture, the way people`s values, views and ethics respond to change determine the outcome of the systems chaos leap.

4. The chaos point and bifurcation. The system is critically unstable. The status quo becomes unstable and the system`s evolution chooses one of the two directions, breakdown or breakthrough.

4a. The breakdown phase or evolution towards breakdown or devolution. The values, world views and ethics of a critical mass of people are resistant to change or change too

[162] LASZLO (2003) pp. 28ff., (2006) pp. 10ff.

slowly. The established institutions are too rigid to allow for timely transformation. Unmanageable stress is created by inequity, conflict, social complexity and a degenerating and impoverished environment. The social order is exposed to a series of crisis that degenerates into conflict and violence.

4b. The breakthrough phase or evolution. The mindset of a critical mass of people evolves in time and shifts the culture and development of the society into a more adoptable mode. As these changes remain, the system establishes itself based on an improved order governed by more adopted values, worldviews and ethics. The political, economic and ecological dimensions of society stabilize sustainable.[163]

3.3 Innovation

Innovations are part of the society and are related to their environment. An innovation is an innovation as the result of a social judgement. Besides the technical focus, an innovation includes political and societal aspects. This implicates that innovations are not linear and plannable but embedded in a special social context and relations of interactions.[164] “Innovations need society and society needs innovations“.[165] LUTZ claims that technological innovations have to be beneficiary for the social environment.[166]

The concept of the ´window of opportunity` shows the complexity and dynamics of the decision-making processes. Three different streams are differentiated such as the problem stream, the policy stream and the political stream. If all streams are compatible a window of opportunity is possible. This could lead to a redirection in politics. The policy entrepreneurs connect the different streams actively to make change and innovation possible. Based on the evolutionary economics, innovation processes are as well to be understood as non-linear and dynamical. The conditions in with the innovation process is embedded do have a high meaning.[167] Processes of innovations

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163 LASZLO (2003) pp. 37ff., (2006) pp. 13f., (2008)pp. 26ff., (2008a) pp. 34ff.; See FATZER (2005a) pp. 22f.

164 See HOWALDT ET AL. (2007) p. 5; See BLÄTTEL-MINK (2007) pp. 17f.

165 HOWALDT ET AL. (2007) p. 5

166 See LUTZ (1992) pp. 16ff.

167 See OHLHORST (2009) pp. 49ff.

are assessed more multi-causal in difference to the classical phases of innovation.[168] Innovations are differentiated in depth:

- Radical innovations that are fundamental changes deviating from the actual structures, with a change of direction
- Incremental innovations that are partly adjustments or improvements, compatible with the actual structures
- Additional innovations that are expansionary innovation[169]
- Disruptive innovations that destroy established markets by finding new ways of commercialization of the same technologies, e.g. cheap airlines. [170]

3.3.1 Innovation Cycles

SCHUMPETER gave the following definition of innovation: “the doing of new things or the doing of things that are already done, in a new way“.[171] He divides between invention and innovation. The phases of innovation referred to SCHUMPETER are:

1. Invention - generalization of an idea, prototypes and concept development, trial and error
2. Innovation - invention that reaches the marketability
3. Diffusion - widespread expansion of the innovation in different levels of economics and society.[172]

SCHUMPETER calls the persons who are carrying the innovations ´entrepreneurs`. The entrepreneur is the driving force for innovations. Entrepreneurs are defined by

[168] See BRUNS ET AL. (2008) p. 24

[169] Ibid. (2008) p. 23

[170] See WOLF (2007) pp. 38ff.

[171] BORBELY (2008) p. 401, citation of SCHUMPETER (1947)

[172] Ibid. (2008) pp. 402f.

BRAUNERHJELM/SVENSSON as persons who are innovative and perceive and create new opportunities.[173]

PARKER also differentiates between invention and innovation. He states: "invention involves origin. It is the first stage in the process of technological innovation. It is the act of insight by which a new promising technical possibility is recognized and it is worked out in its essential, most rudimentary form. This can be done mentally or physically".[174]

UTTERBACK describes also different phases of technological innovations that are illustrated in his model (figure 7). It combines two levels of innovation and illustrates the product- and process phases identifying three distinct phases: the ´fluid phase, the transition phase and the specific phase` (also called UTTERBACK-ABERNATZHY model, 1975).[175] During the fluid phase, the product innovation is on a high level. The new innovation provides new functionalities that have not been provided until this moment of time. The first part is an uncoordinated stage of process innovation and determined by non-standardized processes using general equipment and manual operations. The product can be changed flexibly to reach the demand of the customer. The product performance plays a major role in the competition. The expectations of the market are high. This phase enters in a performance-maximizing stage. The dominant design has not yet been set and the production processes are not determined and fixed.

The transition phase is determined by a focus on cost optimization, product maximization and questions of commercialization. The product innovations become less important and the importance of the process innovation increases. A dominant design starts to be established that allows a cost minimizing of production. The focus shifts from R&D to an established production standardization.

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[173] TICHY (2011) pp. 1069f.

[174] PARKER (1978) p. 46

[175] See ALLIANCE-CAPABILITY (2013) www.alliance-capability.com; See WOHLFAHRTSTÄTTER/BOUTELLIER (2009) p. 48

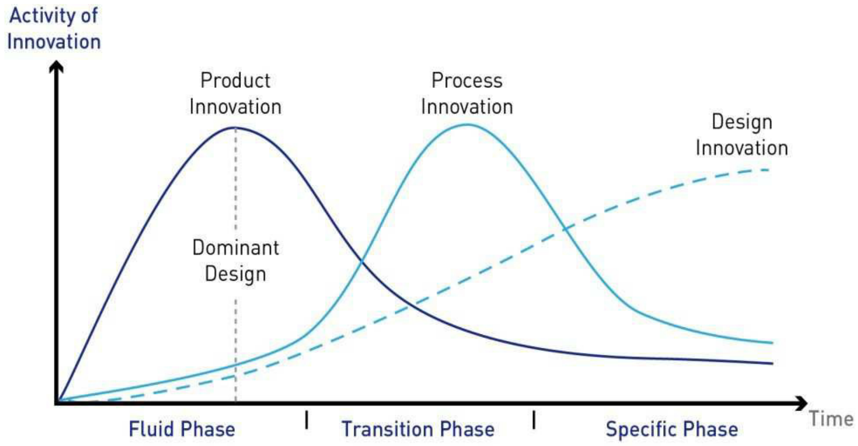

Figure 7 Development phases of technological innovations, UTTERBACK, WOHLFAHRTSTÄTTER 2010[176]

The specific phase focuses on cost optimization after establishing a dominant design. Changes in the product design are cost-intensive at this stage. The two levels are highly interdependent and the design innovation increases. This is a highly integrated process and contains both, the systemic part focusing on process development and the cost-minimizing parts focusing on the product development. The competition in the market is mainly determined by the price and therefore, the size of the market players is of importance. Frequently, the market develops to an oligopoly.[177] The technological innovations are probably followed by innovations of business models. They contain three additional categories referred to SCHUMPETER:

1. Development of new markets and new customer segments,
2. Development of new resources in the value added chain such as new suppliers and sales partner,
3. Development of new organizational structures.[178]

[176] WOHLFAHRTSTÄTTER (2010) p. 16

[177] See HÖFT (1992) pp. 117ff.; See WOHLFAHRTSTÄTTER (2010) pp. 15ff.; See ALLIANCE-CAPABILITY (2013) www.alliance-capability.com

[178] WOHLFAHRTSTÄTTER (2010) p. 16

3.3.2 Innovation Cycles in the Electricity Sector

WOHLFAHRTSTÄTTER/BOUTELLIER expanded the classical model by the category of market model innovation as illustrated in figure 8 based on the innovation development in the electricity sector in Switzerland.

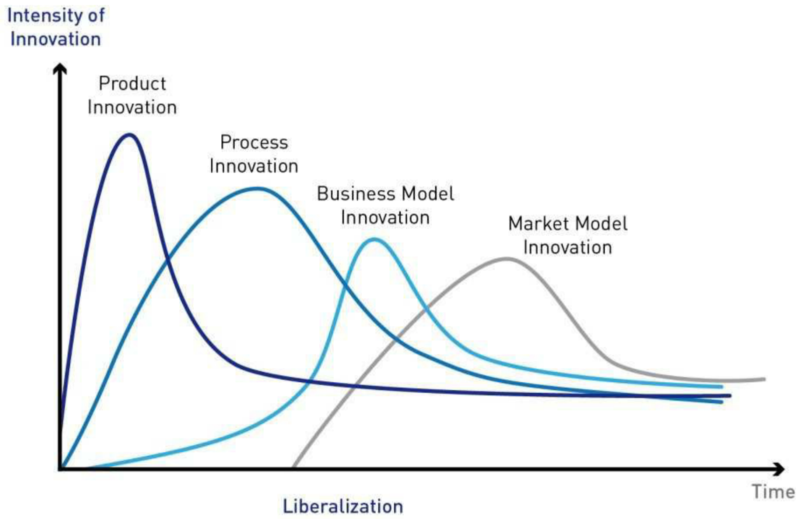

Figure 8 Innovation cycles in the electricity economics, WOHLFAHRTSTÄTTER/BOUTELLIER 2009/2010[179]

The innovation process, e.g. in the electricity sector, started with the product innovation of continuous current and alternation current. This phase was followed by the process innovation that focuses on the production, distribution and administration of the product. This has been done by the energy providing institutions. The third phase is the phase of innovations in business models. It was possible through the liberalization in the electricity market given by new regulations. The process of unbundling[180] allowed the decoupling of production, distribution and sales in many countries. New organizations and organizational structures emerged. The overall trend of sustainability

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[179] WOHLFAHRTSTÄTTER/BOUTELLIER (2009) p. 49, (2010) p. 16

[180] Unbundling contains four forms: Legal Unbundling - grid companies have to establish independant companies to separate the sales and production, Operational Unbundling - separation of tasks and independant responsibilities for results, Information Unbundling - separation of information processes between the different steps of the value added chain, Administration Unbundling - the separation of administration, accounts and the statements of profit and losses, see ROGLER (2009) pp. 2ff.

originated new customer segments.[181] Three innovations on the level of business models are relevant nowadays. They are the basis of the future scenario described under the fourth innovation:

1. New providers establish in the value added chain such as the stock market for the commerce with CO_2 certificates, new service organizations, enterprises with decentralized energy providing and provider of power out of renewables. The providers become demanders and the demanders become providers.

2. A new type of customers expanded based on the trend of sustainability and ecology. They are partly willing to pay more money for certified electricity out of renewables. This goes along with customers who invest in funds of electrical commerce of electricity and therefore, the customer expects a return of investment.

3. Due to the unbundling, new organizational structures have been composed within the energy providing system. The separation of the different steps in the process chain leads to innovations of various models of organization that are partly cost-intensive and partly cost-effective. The commercialization of the good electricity is the basis for interdisciplinary approaches e.g. finance sector that has to be adjusted to the electricity sector with different models.

4. The fourth phase is the innovation of the market model and shows a scenario after market regulation. It is an expansion of SCHUMPETER´S model by WOHLFAHRTSTÄTTER/BOUTELLIER. The market mechanism is changing from monopoly and being homogeneously and in-transparency to transparency and openness. The information policy creates the customer as an active part in the market.[182]

Within the level of market innovations, the old traditional system is replaced or expanded. In Europe the value added chain of electricity is traditionally organized and

181 WOHLFAHRTSTÄTTER/BOUTELLIER (2009) p. 48; See ibid. (2010) p. 16; See WOHLFAHRTSTÄTTER (2010) pp. 13ff.; See SPRENGER (2011) pp. 7f.

182 WOHLFAHRTSTÄTTER/BOUTELLIER (2009) pp. 49ff., (2010) pp. 16f.

has not basically changed in the last century. Market model innovations are observable on two levels:

1. The commerce with CO_2 Certificates: in 2005 the European Union implemented the European Greenhouse Gas Emission Trading Scheme. The amount of CO_2 certificates is fixed before the next period of commerce. The amount of CO_2 emissions is guided by the price in the market or leads to arrangements of avoidance. These regulations complemented the market and lead to new ways of thinking and investments. The traditional way of electricity production becomes unattractive and the green technologies can advance.

2. The risk of black-outs leads to an awareness of resources and energy efficiency: demand-response and SMART grids. The customer is connected to the grid as an active part of the whole system. Two different programs are possible. The first one is the avoidance of energy due to high prices. The second advanced level is the offer to bring the unused energy into the market. In California a saving of 15gigawatts was possible by 5,8 % minimization of the peak demand. WOHLFAHRTSTÄTTER/BOUTLLIER assess that the European energy system is traditionally organized and regulated by the providers. Energy abstinence is not rewarded and the lack of transparency is valid.[183]

3.3.3 Kondratjew Cycles

“The next Kondratjew cycle has to be green or it will not happen“.[184] New technologies are promising to start a new boom. This new cycle of growth has to be based on technologies that respect the limited natural sources of the earth.[185]

Long waves characterize historical recurrences in the development of national or political economics. They are triggered by conjunction of economical and non-economical factors and are typical in a transformation process of a society.[186] The beginning is a new technological-economical paradigm with fundamental innovations

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[183] See WOHLFAHRTSTÄTTER/BOUTELLIER (2010) pp. 17ff.

[184] WEIZSÄCKER VON ET AL. (2010) p. 25

[185] See ibid. (2010) p. 25

[186] BECKER (2004) p. 18

that carry the cyclical upturn. SCHUMPETER called the long waves `Kondratjew cycles` and made them well known.[187] He connected his terms, basis innovation and creative destruction to the long wave cycle.[188] The cycle contains a new orientation in the society. Those cycles are not exclusively economical, they are triggered by new paradigms of organizations that trigger new technologies.[189] Referring to SCHUMPETER, the Kondratjew cycle is characterized through:

- A basis innovation or a key source that is universally available and can be produced to decreasing costs
- A specific solution for an organizational-technical problem that has advantages to the previous production paradigm
- An accumulation of different sectors to strengthen the development
- A typical theory that determines the behaviour guide lines for the actors and defines generalized behaviour patterns.[190]

Figure 9 gives an overview about the known historical cycles in the past and indicates the sixth cycle to be a sustainable one. The carrying innovations of the first four cycles are determined as being hard factors such as e.g. the weaving loom or steam engines. The beginning is determined by basis innovations that require a fundamental change in machineries and human capital that drives the change to the point of replacement.

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[187] See MAIER (1993) pp. 1ff.; KONDRATJEW or KONDRATIEFF, the name is written differently, we stay in this thesis KONDRATJEW, who published the article “Long economical Cycles” in 1925 in the magazine *Woprosij Konjunkturij.* He was executed by the Stalin regime in 1938

[188] BORBELY (2008) p. 405; GRUBER (1999) p. 58

[189] See WEIZSÄCKER VON ET AL. (2010) p. 24

[190] BECKER (2004) p. 20

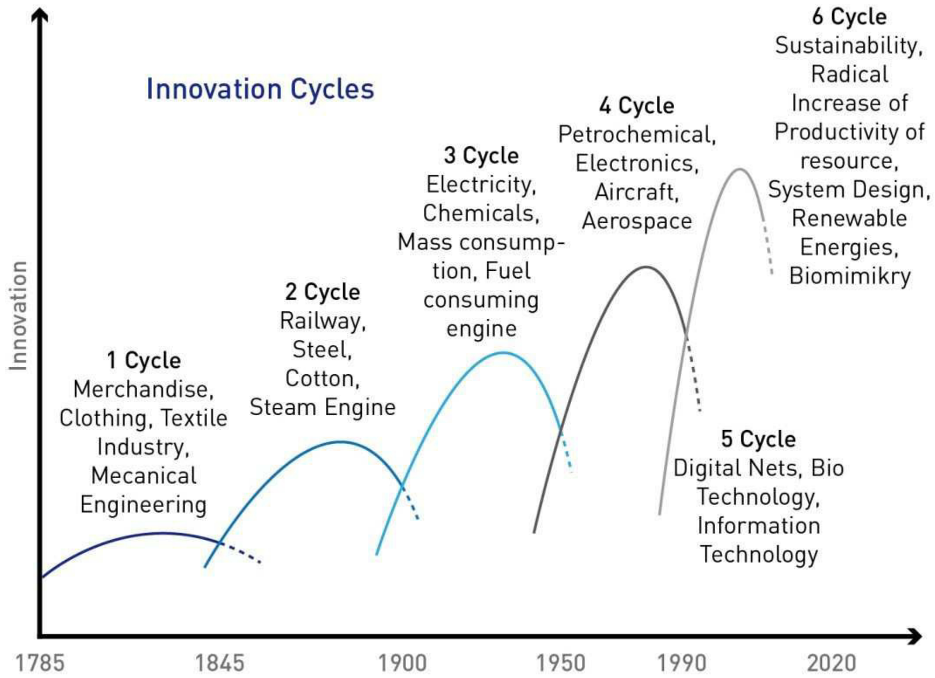

Figure 9 Five long cycles of growth and innovation and a hypothetical sixth future cycle, WEIZSÄCKER VON ET AL. 2010[191], by HARGROVES/SMITH 2005

WEIZSÄCKER VON ET AL. assess the entering of a new Kondratjew cycle by a combination of characteristics. The highest demand is given by the world population that requires food, water, space, goods and services and increased about nearly 100% since the start of the last cycle. At the same time, the resources stagnate or are on the decrease. These technological principles need to be considered in the future:

- Radical increase of productivity of resources
- Optimization on a system-based approach to develop a new system design that considers the earth as a system as well
- Bionics. This term refers to BENYUS (2000) that means designing based on the principles of nature and to take the nature as model, standard and a teacher.[192]

[191] WEIZSÄCKER VON ET AL. (2010) p. 26

[192] Ibid. (2010) pp. 30f.

3.4 Energy

Energy is one of the most important factors in economics and can be seen as the basis of economics and social life. The use of energy is not a “nice to have factor“, it is essential.

3.4.1 Energy as a Human Need

To understand the whole dimension of energy we can refer to the MASLOW`s theory of human motivation. He distinguished between different groups of human needs and put them into a hierarchy. The fundamental physiological needs of humans have to be considered, otherwise there is no interest for higher order needs. The higher levels are defined as the need for security, social needs, status, individual satisfaction or self-actualization. They will only occur if a satisfaction is reached on the level below. These needs are described as growth needs.[193]

FIETKAU states that ecological values are only relevant when the basic needs of a human being are satisfied.[194] ROSENSTIEL summarises the hierarchy in the following sentence: “first comes the food and second the moral“.[195] In terms of energy this can be described by saying if you do not have the energy to cook you do not care about environmental protection or CO_2.[196]

Energy is needed for heating, cooking, lightening, transportation and manufacturing.[197] In the near future, it will be the major part for desalination which is necessary to provide drinking water.[198]

Figure 10 shows the energy pyramid by FREI. The foundation of this pyramid means to have access to commercial energy, followed by energy security, economic efficiency,

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[193] See FIETKAU (1984) p. 46; REHN (1979) p. 197; HECKHAUSEN (1980) pp. 104f.; ROSENSTIEL (1993) p. 160; KIRCHLER ET AL. (2004) pp. 93f.

[194] FIETKAU (1984) p. 46

[195] ROSENSTIEL (1993) p. 160

[196] E.g. South Africa, despite of a low rate of inhabitants it holds a high rate of CO_2 emission/per person, see THIEL/TAMBUZZO-FERRAZ (2012) p. 23; See FIETKAU (1984) p. 46

[197] EDEN ET AL.(1981) p. 51

[198] See TRIEB/MÜLLER-STEINHAGEN (2007) pp. 23ff.; See FÜSSEL ET AL. (2012) pp. 19ff.; See MAUSER (2007) pp. 161ff.

environmental viability and social acceptability. The access to commercial energy is the essence and basis of the higher levels.[199]

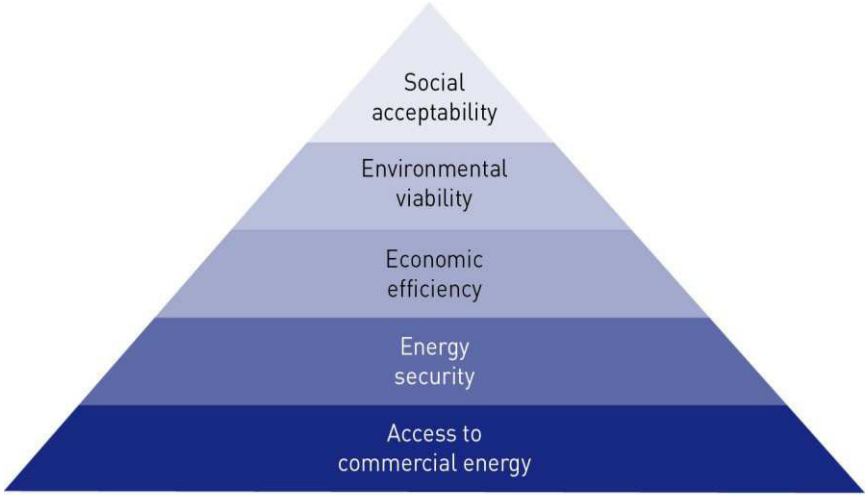

Figure 10 Energy policy Maslow pyramid, FREI 2004[200]

3.4.2 Primary Sources of Energy

Coal has been used since the 9th century but the large digging started after the technological innovations that allowed new ways of production and mobility. Today, the usage of burning wood for the daily life is still valid in a lot of regions in the development countries with tremendous negative side effects for the environment.[201]

Currently, the seven main sources of primary energy are oil (32,8 %), coal (27,2 %), natural gas (20,9 %), biomass (10 %), nuclear energy (5,8 %) hydro (2,3 %) and renewable sources (0,7 %). Therefore, 80 % of the world`s primary energy use is based on fossils.[202] 34 billion tons of CO_2 represents 81 % of the human-produced energy.[203] These primary energies are not renewable and the sources are limited. Figure 11 shows the curve of the different kinds of primary energy from 1850 to the year 2000.

[199] FREI (2004) pp. 1253ff.; See WOHLFAHRTSTÄTTER (2010) p. 22

[200] FREI (2004) p. 1254

[201] WAGNER (2008) p. 36;

[202] ARMAROLI ET AL. (2013) p. 41; See HENNICKE/FISCHERDICK (2007) pp. 20f.; See NELES ET AL. (2012) pp. 216f.

[203] ARMAROLI ET AL. (2013) pp. 55ff.; See WAGNER (2008) p. 63

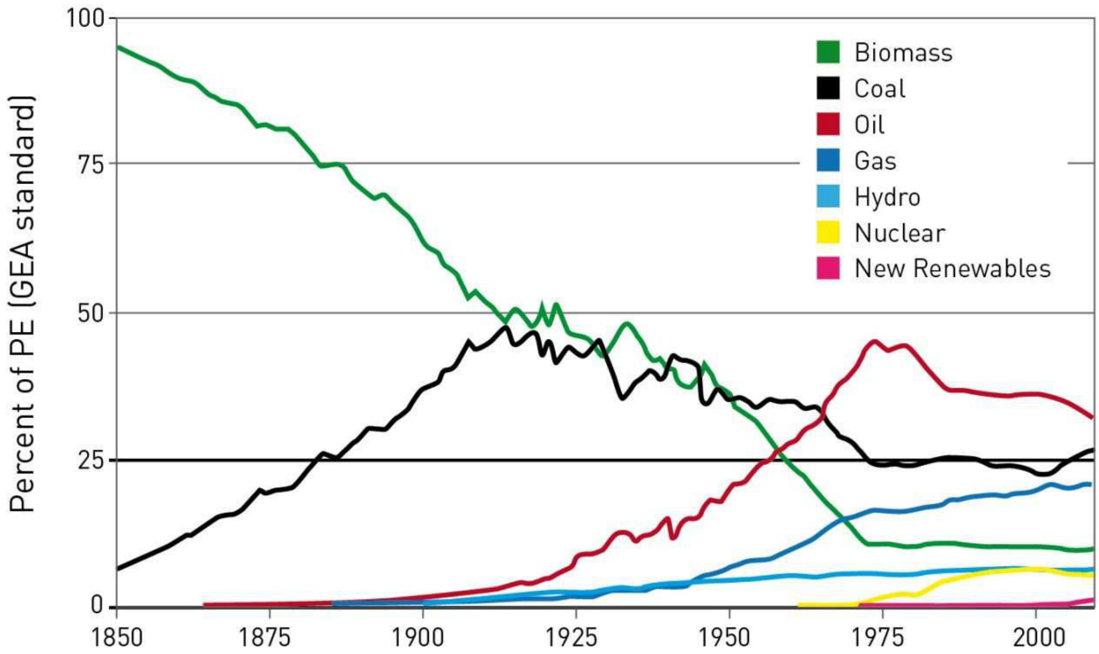

Figure 11 Structural changes in world primary energy, NAKICENOVIC ET AL. 1998, GRUBLER, 2008[204]

The lifetime of oil and gas is divided between reserves and resources. Reserves are the deposits which could be used economical whereas the resources are estimated to be uneconomical. The limit of the oil reserves is often estimated by a time of 40 years.[205] Peak oil defines the status when the highest oil production is reached and no further increase is possible. By numerous experts this is estimated to occur in the near future around the year 2020.[206]

PELTE states that under the precondition that the fossils would be used as the only primary energy in the growing world population, the worldwide deposits will reach their limits in the middle of the 21st century.[207] A lot of effort and energy is requested to convert these kinds of energy to make it usable.[208] The regions with the natural deposits are spread worldwide whereas Europe has minimal own sources except coal deposits.

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[204] GRUBLER ET AL. (2012) p. 113

[205] See WEIZSÄCKER VON (2008) pp. 55ff.; See WAGNER (2008) pp. 147ff.

[206] SCHÜTH (2008) p. 16

[207] See PELTE (2010) p. 94

[208] See WAGNER (2008) pp. 38ff.

All fossils produce CO_2 in different degrees during their burning processes that increase its concentration in the atmosphere. This is considered as the main factor for the global warming.[209]

The nuclear energy out of nuclear fission is based on the mineral fossils uranium and thorium that are limited as well. Europe has very little uranium (3%) and thorium (7%) resources. PELTE states that the accumulation of all fossil sources do not significantly extend the exhaustion of these forms of primary energy[210] whereas the nuclear energy out of the nuclear fusion could be an option for an alternative primary energy, however this form is still at the beginning and under R&D.[211] The risk of the nuclear accidents and the risk of contaminated waste are the main reasons why the nuclear energy was highly criticized by the public.[212]

All the above mentioned sources are so far produced in large power stations that need huge investments. Therefore, the refinancing of nuclear power stations is calculated up to a minimum of 20-30 years. In Germany (and worldwide) the nuclear energy gets high governmental subventions, the converted subsidy was about 2000 euro per installed kilowatt in the year 2006 against 590 euro per installed kilowatt for renewables.[213]

3.4.3 Energy as a System

Energy exists in various forms. In physics, energy is defined as the ability to do work. In practice it is used as power, heat or as electricity. It can be electrical, mechanical, chemical or thermal energy, nuclear-based or in form of radiation and can be converted or transformed from one form into another form but cannot be produced or deleted in a closed system.[214] When energy is converted, stored or transported, it minimizes its amount of usable energy.[215] Energy has a double meaning in these

[209] See WAGNER (2008) pp. 180ff.; See ALT (2010) pp. 33f.

[210] See PELTE (2010) pp. 96ff.; See WAGNER (2008) pp. 47f

[211] See PELTE (2010) p. 119; See SCHÜTH (2008) p. 27

[212] See NELES (2012) pp. 9ff.

[213] See NELES ET AL. (2012) pp. 216f.

[214] See FEDDECK (2003) pp. 1ff.; See BRUNE (1998) pp. 22ff.; See HOFER (2008) pp. 29f.

[215] FEDDECK (2003) p. 2

processes. On one hand, it is the driving force for production processes in general and, on the other hand, usable energy itself is the specific end product of the whole process.[216]

The chain of energy supply composes of different stages. In every step the rate of useable energy is less than before due to the losses of conversion and transportation. The degree of losses depends on the source and the facilities. The process chain of the oil energy from the primary to the useful energy for the customer is determined with a degree of efficiency of approximately 29%.[217]

Energy supply is embedded in a whole system. The current infrastructure is mainly developed for the transportation of energy out of fossils over long distances, nationally and internationally. This is done in combination with large, central and un-flexible power stations. One intervention in these systems could cause a lot of other effects.[218]

SORENSEN described an energy system in the early 90ies: “as a complete system for generating, supplying and using energy in a given context such as a country, a region, or another kind of domain that can be defined in terms of borders...the physical components of the energy system would typically be a number of facilities for extracting, importing or collecting energy, then for treating, e.g. refining, and successively converting the energy along a chain of steps leading to the final conversion at the end user...the plan of the historic circumstances.

According to which a given energy system is set up, have evolved a number of choices regarding energy sources, centralised or decentralised energy conversion units...one important determinant has of course been the technology at the time of decision“.[219] The social context consisting of the natural, the social and the human setting is considered as being highly influential to the energy system. “Many of the social factors are important determinants for the selection of an energy system for a particular society, and they are equally important for determining the way, that operation of the system is conducted, as well as the way, in which the society deals with

216 BRUNE (2008) p. 26

217 PELTE (2010) pp. 34f.; See WAGNER (2008) p. 60

218 SCHÜTH (2008) p. 29

219 SORENSEN (1993) p. 23

various impacts".[220] The impacts are defined as economic, environmental, social, secure and political. The natural setting is defined by the geography and demography, the human setting describes the impact of the values and attitudes of the members of a society.[221]

Energy can be provided central or decentralized. Central is related to large power stations like the nuclear power stations or the coal power stations. A decentralized system is based on a number of numerous small units spread in regions such as photovoltaics or wind energy units. It is based on renewable energies. The closeness to the end user is a precondition to get the positive effects of decentralized energy production.

The different systems have a political dimension. Decentralization is often assessed as being a value in itself and associated with several advantages that are mainly the involvement of citizens and the possibility of having more democratic control in the energy sector.[222]

KUNZE is talking about a change of paradigm from space dependent to space intensive energy production or vertical versus horizontal energy production. The horizontal space is wide-spread and more difficult to monopolize. The terms bottom-up and top-down approach are connected with the above mentioned. Bottom-up structures with participatory involvement are related to regional processes and decentralization whereas top-down is related to a centralized approach with defined hierarchies and organizational structures.[223]

3.4.4 Electricity

In an industrial society based on communication, electricity is the most important and most versatile energy carrier. A total black-out leads to an immediate breakdown of the civil life and economic activities.[224] The electricity sector is the main influencing

[220] Ibid. (1993) p. 24

[221] SORENSEN (1993) pp. 23f.

[222] See DAS RP-ENERGIE-LEXIKON (2014) www.energie-lexikon.info

[223] See KUNZE (2012) pp. 27ff.

[224] MILLES/HORENBURG (2011) p. 3

part of the energy system.[225] To make electricity affordable for the end customer, three steps are required. This represents generation, transmission and distribution. It is mainly generated in large-scale power stations with a considerable distance from the customer.

To minimize the costs for transportation within long distances it is transported by a transmission grid to high voltage transmission lines, to substations followed by medium voltage lines for regional distribution and finally in low voltage lines to the final places. The balance of the voltage is of crucial importance. The standard electricity expansion models refer to monopoly and centralization and full integration as the dominant structure.[226]

The supply and demand are an important issue because electrical energy cannot be stored so easily on a large scale. This leads to the necessity to always produce enough energy at the time when it is needed. The demand is fluctuating during the days and during the seasons. High electricity demand is called peak demand and the estimated lowest rate of demand is called base ´load demand`.

A mix of energy provided by different power stations is used to achieve a high stabilization of the grid. Inflexible power stations are used to fulfil the base load. They are to be combined with more flexible power stations to reach the higher requirements (peak) of power supply without interruption. The running costs of flexible power stations are higher than the inflexible ones.[227] The decision about the sequence of different power stations is called the ´merit order`.

The power stations are differentiated by their marginal costs. The power station with the lowest marginal costs does have the first priority, followed by the one with higher marginal costs, followed by the one with highest costs. The marginal costs are defined as the costs for providing an additional unit of electric energy.[228] All these different types of power stations are connected building the grid. The whole grid is managed, controlled and coordinated by a complex management system. The load management is

[225] HENNICKE ET AL. (1985) p. 17

[226] KALASHNIKOV (2009) pp. 5ff.

[227] See EDEN ET AL. (1981) pp. 155ff.; See MILLES/HORENBURG (2011) pp. 3f.; See HOFER (2008) p. 31

[228] BUCHAL ET AL. (2013) p. 123

the primary task. The national grid is connected internationally. This minimises the risk of failures and black-outs.[229]

HENNICKE ET AL. state that the different existing energy providers cover the extreme concentration of capital and power in the electrician market. It has been evolved through hard competition and will be secured and supported by governmental interventions. Furthermore, the monopoly is both economic and juristic.[230] The monopoly in the electricity market is also called a natural monopoly. The net operators are controlled by the state.[231] Main reasons are the inability of storage and the concurrence of production and demand.[232]

YEAGER ET AL. describe that the increasing energy demand for electricity will put pressure on the global energy resources and distribution networks that leads to the necessity of a fundamental transformation of the energy system to be sustainable.[233]

The price of electricity is composed of the price for the fuels, for the transportation in the grid, for measuring and for political motivated costs such as concession, eco taxes and costs for renewables.[234]

3.4.5 Energy and Economic Development

Access to commercial energy is needed to develop the economy, to overcome unemployment and to directly overcome poverty. It is the fundament for job creation and economic growth. Human well-being, education, healthcare, social inclusion and economic development are impossible without access to modern energy.[235]

Energy and economics evolve together and are welded together by the technology development and improvement. The fundament of the modern economy is based on

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[229] MILLES/HORENBURG (2011) p. 4

[230] HENNICKE ET AL. (1985) p. 59

[231] other natural monopolies are e.g. railways and the net for telecommunication, see BUCHAL ET AL. (2013) p. 114

[232] HENNICKE ET AL. (1985) pp. 79f.; See ORTWEIN (1996) p. 77

[233] YEAGER ET AL. (2012) p. 389

[234] See WAGNER (2008) pp. 122f.;

[235] See KAREKEZI ET AL. (2012) pp. 153f.; See MOUSSIS (2009) p. 42

energy mainly in form of electricity. The industrial revolution leads to a process of on-going urbanization and economic progress. Figure 12 illustrates the close relationship between technological progress and the access to energy. It shows that both fields complete each other by increasing the demand for energy in total.

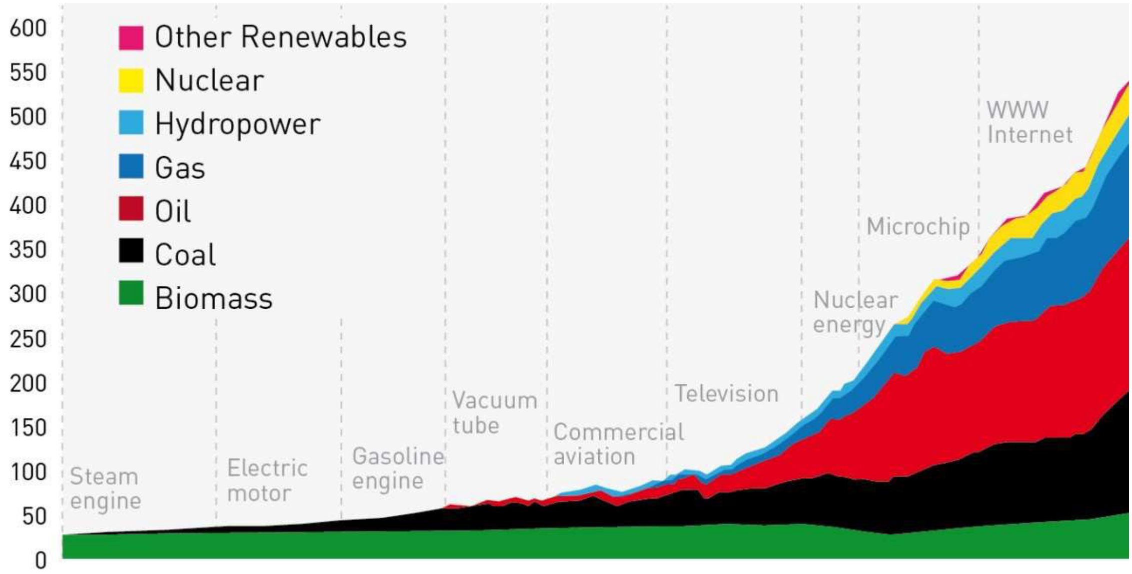

Figure 12 Evolution of primary energy shown as absolute contributions by different energy sources (EJ), Biomass (green) meant as traditional Biomass, JOHANSSON ET AL. 2012[236]

The lack of energy security, e.g. the potential risk of disruption of supply or possible black-out, is considered to be a threat for economic well-being and growth. The basic drivers of energy demand are the growth of population, economic activity including transportation and technology performance.[237]

On the other hand, the technological innovations offer the chance of efficient use of energy. BRUNE describes this in the simple formula: “less usage of electricity per application and more applications with electricity...under the conditions of new economic conditions” and furthermore, “it is the precondition for intelligent energy management systems”[238] which are necessary for a successful transformation of the

[236] JOHANSSON ET AL. (2012) p. 4

[237] See YEAGER ET AL. (2012) p. 390

[238] BRUNE (1998) p. 25

energy sector to be sustainable. ERDMANN/ZWEIFEL state that the most important origin of energy efficiency in the use of energy is the technological progress.[239]

BRUNE states: "the economics of energy is an integrated, dynamic, active and forecasting part of the economy"[240] and furthermore: "a characteristic energy is meant as the form of end energy…which has such an outstanding importance that a whole epoch is determined by this kind of energy".[241] He also saw an interconnection between electricity in the 20th century and the political economical regulations up to the centralization of energy providing and distribution with monopoly and regional protection. This is marked by total dependency and having a reliable well organized access to energy.[242]

3.4.6 Energy Economics

The ability to get energy to survive is essential for all organisms. It was reached in the biological evolution by a steady adjustment to the forces of the environment. Variety was the answer. ERDMANN sees a similarity to the sociological evolution. The necessity to find answers for the questions of how to provide, store, convert and use energy is still actual.[243]

ERDMANN evaluates the energy economics as both, a micro-economic and macro-economic topic. The micro-level concentrates on the structure of pricing and the marketability. The macro-level focuses on the regulation of price building in general and the strategy of supply and demand.

All goods of energy are a scarce resource for two reasons. First, the usage of energy is only possible through the application of scarce production factors. Second, it is a scarce good due to the limited resources. In addition to this, the balance of the market is of highest importance because energy is the backbone of society and its economics. This means that the price for energy affects other parts of the economics tremendously.

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[239] ERDMANN/ZWEIFEL (2008) p. 87

[240] BRUNE (1998) p. 38

[241] Ibid. (1998) p. 40

[242] Ibid. (1998) p. 46; See HENNICKE ET AL. (1985) p. 80

[243] See ERDMANN (1992) pp.1f.

If the money is spent for energy to run the household or business it cannot be spent for other goods. This defines the opportunity costs of energy supply.[244] These reasons could lead to a tendency for market failures. The state could be requested to find mechanisms of regulations.[245]

FRANK states that under the influence of external effects the right decisions made on a micro-level may be wrong on the macro-level. This might lead to ineffective use of resources, distribution and waste.[246] This is also described by EKINS and he states: “An economic activity may be highly successful in market terms (i.e. deliver a certain functionality at low cost, and result in profitable business), but generates environmental costs which actually exceed the market benefits...because of the existence of market failures like environmental externalities, environmental innovations may be socially desirable even if they are not eco-innovations, if their social judgement is that the environmental benefit outweighs their economic cost”.[247]

The energy market has specialities. These are described by ERDMANN in the early 90ies[248] and in an expanded version by ERDMANN/ZWEIFEL in 2008:

- Without energy providing no economic activity is possible. It is the essential good. Any disturbances in this market lead to far-reaching consequences in economics and society.

- The energy is partly used for the basic needs. In poor countries the missing access for payable energy minimises the economic progress which could reinforce the lack of a proper energy supply.

- Many investments in the energy sector are characterized by long periods of investment and planning. This leads to inflexibility of economics and society. This causes insufficient forecasts with the negative effects of over- and under-capacity.

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[244] See ibid. (1992) pp. 13f.

[245] ERDMANN (1992) pp. 17ff.; See ERDMANN/ZWEIFEL (2008) p. 153

[246] FRANK (2009) p. 85

[247] EKINS (2011) p. 67

[248] See ERDMANN (1992) pp. 17f.; See ERDMANN/ZWEIFEL (2008) p. 153

- In various countries the energy resources are in the property of the state. This reduces the interest of private investors.

- Coal, oil, natural gas and uranium are concentrated in certain regions. Within these regions they are the most important business sector. In case of changes various problems and conflicts in the macro-economics are to be expected.

- Negative side effects like emissions are not considered in the energy prices. Without the influence and correction of the state the prices are too low.

- Technical energy supply systems are risky due to the tendency for catastrophes. The costs are often shifted to the society.

- Negative side effects and technical risks are possible to be minimized by new ways of efficiency of energy, however this market does not grow with the desired speed.

- The shortage of fossil energies and the produced emissions lead to the question of social justice in the future and the question of sustainability.

- Many regenerative energy sources are not yet competitive and dependent on financial aids from the state to reach the marketability.

- Energy markets are often organised without perfect competition.[249]

External Effects

External effects can have natural costs or benefits that are not paid for or received by the subject that caused them.[250] External costs were defined by BAUMAL/OATES (1988): "...monetary values of negative impacts, imposed on society or parts of it by activities of an individual or a group that are not accounted for in the market price. Therefore not in the individual decision-making processes either. The market failure to reflect these costs in the price results in a misallocation of resources in the economy. Avoiding this misallocation involves an understanding the value of the external effects,

[249] Ibid. (2008) pp. 7f.

[250] See PASCHKE (2008) pp. 422f.

and then finding a mechanism for integrating those values into the original decision“.[251] This is illustrated in figure 13.

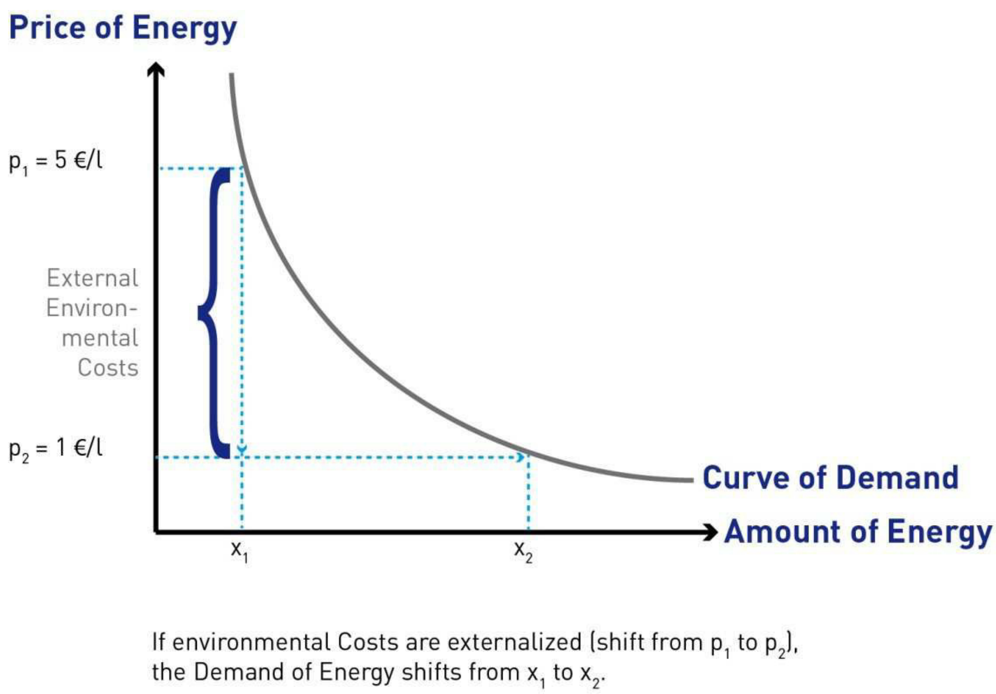

Figure 13 Demand of energy dependent on the price, ROGALL/TRESCHAU 2008[252]

PIGOU defined external effects in 1920: “that a person A gives a service against payment to person B, at the same time he gives advantages or disadvantages to other people, which are defined in such a way that there is no payment for the beneficiary and no compensation in case of damage can be forced of the other people“.[253]

He was the first one who called this an important issue and proposed a tax for these circumstances which is known as the PIGOU Tax to internalize these costs.[254] PIGOU is the reference for all those who propagate that this should be an issue of a political regulation.[255] The influence on the price by the PIGOU Tax is illustrated in figure 14.

OTTINGER states that a tax is motivating to avoid pollution: “the ultimate object of a pollution tax, in the economic sense, is to correct a failing of the marketplace in that

251 GROSCURTH ET AL. (1998) p. 30

252 ROGALL (2008) p. 61

253 FEESS (2007) p. 41

254 See ROGALL (2008) p. 55f.; See WIESMETH (2003) pp. 75ff.; See WEIMANN (1995) pp. 38ff.; See FREY (1993) pp. 83ff.

255 HAAS/SCHLESINGER (2007) p. 28

the environment is a common good the value of which is not reflected in the purchase price of the polluting good or process. The pollutant is taxed so that the price of the good or process which produces it reflects the true cost. To save money the polluter will look for ways to avoid paying the tax. Profits and fiscal self-interest will act as a motivating force to abate pollution".[256]

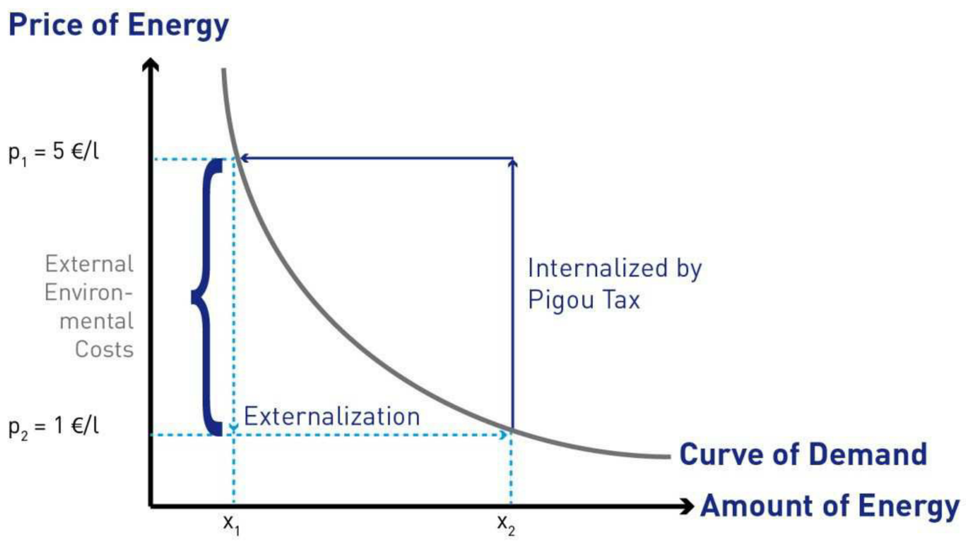

Figure 14 Internalizing of external costs by PIGOU Tax, ROGALL/TRESCHAU 2008[257]

The COASE Theorem follows another approach. COASE assumes that the external effects can be internalized by negotiations between the included parties without a major influence of the government under the precondition of not having transaction costs. SCREPANTI/ZAMAGNI state: "COASE demonstrated that - if the parties involved are really able to freely negotiate the effects of externalities, an optimal allocation can be reached independently...if, *with no costs*, an act of exchange is possible between the agents whose actions generate externalities and the agents upon whom the external effects fall, then the externalities can be ´internalized`".[258]

The origin of the problem is caused by the fact that the ownership and the rights are not clarified and therefore, it is hardly possible to identify the one who caused the environmental damage. This can be solved if the parties are able to negotiate after the

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[256] OTTINGER (1993) p. 57

[257] ROGALL (2008) p. 71

[258] SCREPANTI/ZAMAGNI (2005) p. 403

state has defined the ownership for the relevant environmental goods like air, water and soil.

The COASE Theorem is the theory behind the trade with certificates for emissions.[259] The basis of this approach is that the price is regulated by supply and demand. The trade is given by the fact that the emission reduction costs are compared with the costs of additional permissions.[260] The basic right of the property of the common good environment belongs to the state.[261] This refers to Keynes who claims for the state having a special role due to the advantage of information given by an accumulation of knowledge and being able to balance the disequilibrium of the economics. This is to be done by macro-economical interventions by the politicians.[262]

PEARCE/BANN proposed an externality adder to reflect the non-market damages or benefits of electricity-given technology. The adder should include two aspects. The first aspect is the environmental damage that is unaccounted in the price of electricity. The second are the non-environmental externalities such as subsidies.[263]

One example could be the price per kilowatt per hour produced in a nuclear power station which is much too less in comparison to the real costs like the expectation of damage for the society caused by a nuclear accident or the extremely high costs for transportation and the high funding from the government. HICKEL states that if those costs had been included, the nuclear energy would not have been economically convincing.[264] HENNICKE/WELFENS come to the conclusion that the shadow subventions of electricity out of nuclear is higher than any other aid from the state to any other industry because of its relief of the costs of assurance.[265] A study, worked out by the "Forum für ökologische soziale Marktwirtschaft" shows that conventional

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[259] See HAAS/SCHLESINGER (2007) pp. 28f.

[260] See ERDMANN (1992) p. 21; See ERDMANN/ZWEIFEL (2008) pp. 154ff.; See HAAS/ SCHLESINGER (2007) pp. 18ff.

[261] WIESMETH (2003) p. 83; See ERLEI ET AL. (2007) pp. 304ff.

[262] See PASCHKE (2007) p. 217

[263] See PEARCE/BANN (1993) p. 71

[264] See HICKEL (2011) www.iaw.uni-bremen.de

[265] See HENNICKE/WELFENS (2012) p. 27

energies are more expensive than the renewable energies but the costs are hidden in the normal taxes.[266]

3.4.7 Energy and Politics

Considering the above mentioned, ERDMANN and ERDMANN/ZWEIFEL talk about market failure in the energy supply. In this situation the governmental authorities have the responsibility to influence and organize the energy supply and demand in the interest of the whole economics. The market failures have to be corrected to reach the optimum of welfare.

Before the energy crisis of 1973, the energy politics was primarily in charge to care about sufficient infrastructures, technical security and environmental protection as well as the supervision of monopolies and cartels. Since then, the security of supply of a thrifty and efficient energy was a priority as well. The central issues expanded in the 80ies. Nuclear and renewable energies gained increasing importance. Since the 90ies the management of sustainability and the liberalization of the grid were also in the foreground. ERDMANN/ZWEIFEL state no matter which topic is actual in the foreground, it is always related to the price alignment, sustainability and security of supply.[267]

The three interdependent positions are illustrated in figure 15. The politics is confronted with different levels of interests and conflicts because the wish to achieve one goal reflects the achievement of the other goal. Some of them complement each other, others do not. Different interest groups follow different strategies and the balance is not easy to get and to maintain. This could lead to problems if some groups are able to exploit the politics for their interests. This is the reason why the correction of the market failure is called analogous failure of politics.[268]

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[266] See KÜCHLER/MEYER (2012) pp. 8ff.; See BOLCEROWIAK (2012) www.neues-deutschland.de

[267] ERDMANN/ZWEIFEL (2008) pp. 9f.; See ERDMANN (1992) pp. 17ff.; See HENNICKE/WELFENS (2012) pp. 63f.

[268] See ERDMANN/ZWEIFEL (2008) p. 11

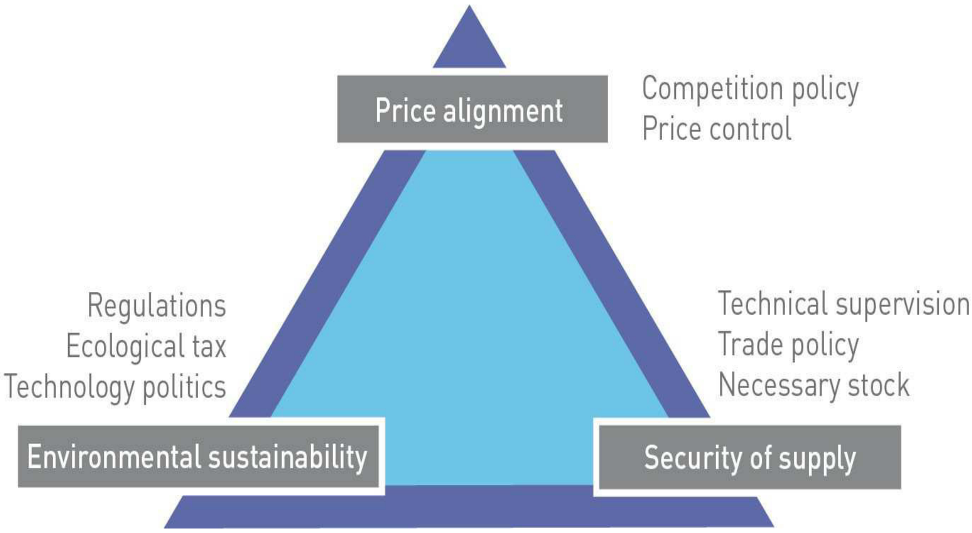

Figure 15 Magic Triangle of goals in energy politics, ERDMANN/ZWEIFEL 2008[269]

The today`s energy sector can be seen as a consequence out of the epoch of the industrial revolution. Huge investments for power stations, grid infrastructure, research and technologies set a tight frame in the society to establish alternatives to this system. The interpretation of the system reinforces the system.[270]

The political start of alternative approaches to deal with environmental protection in general and in the energy sector is described to be related to the MEADOWS Report in 1972 and the first oil crisis in 1973.[271] The system's approach became more influencing in the energy system. The traditional political paradigm of general control mechanism through the state began to relieve.[272] The weakening of the command-and-control approach happened by increasing the openness for dialogue with associations for environmental protection and the search for suitable instruments to comfort both, environment and economics.[273] WINSEMIUS opened the First International Conference on Environment and Economics (1984) with the words: "in facing the changing economic, social and technological perspectives we should not counter pose environment and economics".[274]

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[269] Ibid. (2008) p. 10

[270] SCHABBACH/WESSELAK (2012) p. 22

[271] See ERDMANN/ZWEIFEL (2008) pp. 11f.; See JÄNICKE ET AL. (2003) pp. 30f.; See SCHABBACH/WESSELAK (2012) p. 22

[272] See BRUNNENGRÄBER (2009) p. 45

[273] JÄNICKE ET AL. (2003) pp. 40ff.

[274] WINSEMIUS (1985) p. 15

FREY states that it is easy to claim for sustainable development but it is much more difficult to execute it due to the fact that new technologies are of advantage for some groups of the society but of disadvantage for others. Especially in the short-term range it can affect the economics negatively. This is related to factors such as rate of employment, social security and decrease of prosperity. The assessment of the citizens about the political actions and regulations in economy and ecology refer back to the political system and can change the government and could lead to a redirection of politics. This is why FREY is talking about the economical-ecological-political cycle as illustrated below.[275]

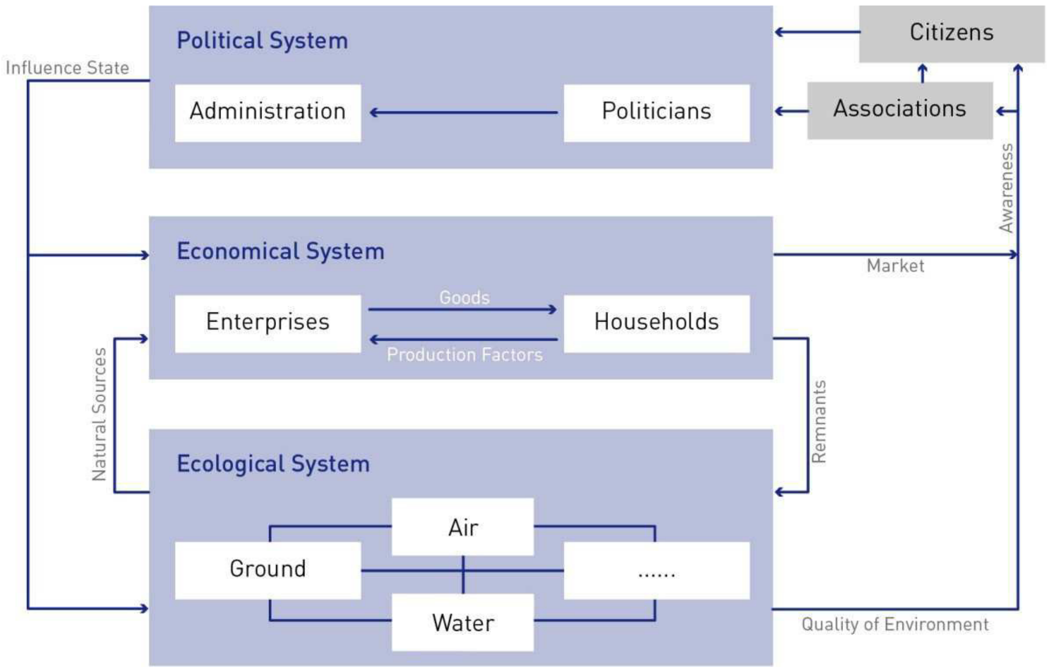

Figure 16 Economical - ecological - political - cycle, FREY 1993[276]

Referred to JÄNICKE ET AL. an analysis of the following factors described by JÄNICKE/WEIDNER (1995) and JÄNICKE (1996) has to be considered to evaluate a country`s success in environmental policy. The analysis is about:

- The structure of the problem: determined by the urgency of the environmental problem and the possibilities of available solutions

[275] See FREY (1993) pp. 19f.

[276] Ibid. (1993) p. 20

- The protagonists: the advocates of interests of the environment that are characterized by their special resources for action such as amount of people, rate of organization, competence and alliances. These advocates stand against the advocates of the interests of the causer with their resources of action
- Strategies: as a common term for the planning of action of these protagonists and their resources and methods
- Situational frame of action: this is the sum of the short-term changeable chances and barriers the actors are confronted with. They are related to steadily changing of political, economical or informational situations and events.[277]

Political Economy of Climate Change

The action field of environmental policy is related internationally. The level of prosperity has an essential meaning because it is a determining factor for the amount of problems as well as for the resources to solve the problems.[278] It is also international because all the given problems are related to each other in the system of the earth. The earth is a complex system and the human interpretation of dealing with this system has far reaching consequences.[279]

Different levels and possible reasons for the failure of state and politics are described by BRUNNENGRÄBER referred to MAYNTZ (1997):

1. Problems of implementation - lack of assertion of regulation
2. Problem of motivation - lack of readiness to obey the regulations of the government
3. Problem of knowledge - the occurrence of non-intended side effects based on the lack of knowledge about the subject of regulations and their interconnections as well as missing the target

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[277] See JÄNICKE ET AL. (2003) pp. 80f.

[278] Ibid. (2003) p. 80

[279] JÄGER (2007) pp. 80ff.

4. Problem of regulation and control - the general lack of the ability to interfere in the system with the given instruments of control and regulations.[280]

BRUNNENGRÄBER describes a general change in the definition of the role of the state with a global governance character. This is caused by the crisis of the societal natural conditions and the connected crisis of economy based on the complexity of the climate change and the need for political-economical regulations, not only on a national but also on an international level.

The change is determined by a new definition in the stress field of loosing influence and gaining influence, nationally and internationally. Loosing influence by the fact that necessary regulations are needed to be defined on the international level and in cooperation with international private or public institutions, e.g. The World Bank. Gaining influence because of the fact that those regulations could be initiated by the national governments that are representing the national actors and interests and, additionally, in executing the international regulations on a national level.

The climate politics is one example for a political economy of climate change in contradiction to the self-regulation of the economics in this field. The market exists exclusively under special conditions of authority and power. The access on resources like fossils, the private property, the rate of exchange and social as well as ecological conflicts are to be regulated and stabilized.

The relative autonomy of the state is the precondition for the ability of the function of regulation of the disputing societal conditions of nature. Without the assurance of the availability of natural sources, the economical process of reproduction would be endangered. The economy could not reach relative stability because of the precarious conditions of supply with fossil energies. The tendency of societal crisis would increase due to the externalities. The market requires a regulative frame and new instruments within this frame.[281]

[280] See BRUNNENGRÄBER (2009) p. 44

[281] See ibid. (2009) pp. 206ff.

International Commitments for Climate Protection

The awareness of the danger of the planet`s overheating by the increasing burning of fossils started already in the 50ies of the last century.[282] In the Brundtland Report (1987) the term sustainability was formulated the first time.[283] PRIDDLE gives the following working definition of sustainable development: “development that lasts and is supported by an economically profitable, socially responsive and environmentally responsible energy sector with a global, long-term vision“.[284]

The Intergovernmental Panel for Climate Change (IPCC) was founded in 1988 by the United Nations as an independent scientific committee to fight against the global warmth effectively.[285] The last IPCC report (2013) shows with different reliabilities: “Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse emissions have increased“.[286]

At the United Nations Conference on Environment and Development in Rio (1992) the IPCC produced the basis for the Kyoto Protocol.[287] Its political meaning was the interconnection between the ecological and social dimension. Sustainable development became the key word and the Agenda21 the central document. The Agenda21 gave a description of the interconnection between environment and development considering the ecological, economical and social aspects. Additionally, it includes an action plan for a sustainable development of the 21st century to support the elaboration of guidelines and mission statements and shared commitments with the involved maximum

[282] See detail description e.g. ARMAROLI ET AL. (2013) pp. 55ff.; See SCHABBACH/WESSELAK (2012) pp. 130ff.; See JÄGER (2007) pp. 35ff.; See ALT (2003) pp. 34ff.

[283] LEXIKON DER NACHHALTIGKET (2014) www.nachhaltigkeit.info

[284] PRIDDLE (2001) p. 4

[285] STUTZ/ITTERSHAGEN (2012) www.fuer-mensch-und-umwelt.de

[286] ALEXANDER ET AL. (2013) p. 2

[287] ARMAROLI ET AL. (2013) p. 57

participation of the society. It also emphasizes local activities besides the international level.[288]

The Kyoto Protocol was signed to reduce the CO_2 emissions worldwide. The reduction of CO_2 was set up with a minimization of 5,2% towards the level in 1992 until 2012. The countries of the European Union committed themselves with 8% and Germany with 21 %.[289] Additionally, the European Union decided for an increase of 20% of renewables up to the year 2020.[290] The goals of the Kyoto Protocol are to be reached by three flexible mechanisms whereas the trade of emissions is the foundation.[291] It is acknowledged as the first international binding for climate protection.[292]

EDENHOFER ET AL. state that in the following worldwide conferences in Copenhagen (2009), Cancun (2010) and Durban (2011) it became obvious that the dilemma between climate change mitigation and poverty reduction is not solved and hinders additional worldwide commitments. The limit of the global warming of two degrees above the pre-industrial level is at stake.[293]

The International Renewable Energy Agency was founded in Germany in 2009 to promote the renewables. Since then, the amount of members increased up to 157 plus the European Union. The total budget of 28,4 billion US dollar was decided to be put into research to analyze the worldwide potential of renewables for the year 2012.[294]

EDENHOFER ET AL. claim for a global agreement that requires new institutional arrangements on the regional, national and international level including financial support to consider the close relationship between climate impacts and vulnerability as

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[288] See WIESMETH (2003) pp. 8ff.; See SCHABBACH/WESSELAK (2012) pp. 135ff.

[289] LANGE/STRAUB (2009) p. 18; See ARMAROLI ET AL. (2013) pp. 57f.

[290] MIRBACH (2009) p. 2; WIESMETH (2003) p. 13; SCHABBACH/WESSELAK (2012) p. 136

[291] See LANGE/STRAUB (2009) pp. 19ff.; See WAGNER (2008) pp. 187ff.

[292] BRUNNENGRÄBER (2009) pp. 123f.; See PAEGER (2006-2013) www.oekosystem-erde.de

[293] See EDENHOFER ET AL. (2012) pp. 2ff.; the mentioned limitation of (approximately) two degrees is based on the actual knowledge about the climate. It is the critical stage to avoid the risk of climate catastrophes, See KNOPF ET AL. (2012) pp. 133f.; See THE WORLD BANK (2012) pp. 1 ff.; See MORRIS/PEHNT (2012) p. 3

[294] MUSIOL ET AL. (2012) pp. 102f.

well as the aspects of global justice and human rights. Furthermore, they state that without a combination of multi-regional and multi-level approaches all regional and bottom-up approaches are doomed to fail.[295]

The results of the RIO +20 United Nations conference regarding sustainable development are defined as settings of direction for a global execution of sustainability. At the first time, the United Nations accepted that the green economy is an important method to reach the climate goals. It is described as a paradigm shift. Especially the developing countries are interested in achieving progress and the United Nations will be in charge to coordinate the supporting systems for those countries. Additionally, a commitment was reached to define sustainable development goals until 2014.[296]

One result of the Conference of Doha (2012) was the decision about the second obligation period of the Kyoto Protocol starting on the 1st January 2013 until the year 2020. Until 2015 a new convention is to be worked out considering the reduction of the CO_2 emissions in the development countries. This is planned to become operative in 2020. The result is criticized as dissatisfying.[297]

The United Nations Environmental Programme (UNEP) put a focus on infrastructural decentralized energy in urban areas and on rural electrification by decentralized systems. This was one focus on the conference in Warzaw[298] and also was the purpose of the first energy forum of decentralization that was held in London in May 2014.[299]

Energy Politics in Europe

The program of the European Commission contains a long-lasting definition of the strategy that is defined to achieve assured, competitive and sustainable energy. Reasons for the need of the new era are resulting from the increase of import dependency, the concentration of the energy reserves in only a few countries, the worldwide increasing

[295] See EDENHOFER ET AL. (2012) pp. 5f.

[296] See BMU (2012) www.bmu.de

[297] See RÖNSBERG (2012) http://dw.de

[298] See CLIMATEACTION (2013) www.cop19.org

[299] See ibid. (2014) www.decentralisedenergy.co.uk

demand for energy and the climate change. To assure the given goals, an integrated approach of an energy mix is formulated:

- Increase of energy efficiency by achieving a minimal reduction of CO^2 emissions, at least 20% until the year 2020. Main sectors are the transportation system and the building sector.
- Advancement of the renewables through initiatives for the achievement of more marketability with focus on the security of supply at the same time. Noticeable is that the nuclear energy is included in the energy mix.[300]

The European Council set up a goal of achieving an increase of 20% of energy out of renewables until the year 2020 and giving a long-term commitment in the decarbonization path. The path is defined to reach the goal of 80-95% reduction of emissions until 2050. The long-term strategy focuses on five priorities:

1. Achieving an energy-efficient Europe
2. Building an integrated pan-European energy market
3. Empowering consumers and achieving the highest level of safety and security
4. Extending Europe`s leadership in technology and innovation
5. Strengthening the external dimension of the European energy market

In the next ten years an investment of 1 trillion euro is needed to ensure the decarbonization path.[301]

Besides the given European-wide goals, definite achievements for each country and a European-wide cooperation are considered. The member states are free to choose their own methods to achieve the given goals. National action plans have to be agreed upon and the execution of these plans have to be reported in the reports of progress. The guideline also includes a minimum of 10% renewables in the transportation system that can be fulfilled either by bio-fuels or electro-mobility. In 2010 the member states submitted National Renewable Action Plans (NREAPs) that include a trajectory showing how the governments are going to develop the wind industry every year. It is

[300] See LIEBING (2010) pp. 49ff.

[301] See EUROPEAN COMMISSION (2011) pp. 4ff.

the first time that an entire energy regulation including electricity, heating, cooling and transportation is implemented that leads to a solid foundation of investments.[302]

In 2011 the European Commission completed an energy road map 2050 that focuses on the direction after 2020 and emphasizes the urgency to provide stable conditions for investments and reliable strategies. All scenarios show a shift in the CO_2 prices, the technologies and the grid. 80% of the emissions are related to the energy sector that leads to a special pressure on the energy providing systems by a dependency on the international energy market at the same time.

The commission states ten structural changes for the transformation of the energy system that show among other things that the electricity will play the major role in the future. The increase of the demand will nearly double until 2050. Due to this, the start of the structural changes in the energy providing system is a must to reach the decarbonization by 2030 of about 57- 65% and to reach the goal of 96 - 99% in the year 2050.

This will refer to the prices of electricity because of the huge investments mainly for storage and the grid. The prices will go up till 2030 and decrease after this time. Huge investments are necessary to increase the amount of renewables. The investments would be necessary anyway because the central power stations are to be renewed.

The commission emphasizes on the critical importance of the combination of decentralization and centralization to reduce the amount of cost-intensive storage technologies and grid expansion. The implementation of intelligent management systems is a precondition to provide solutions for the demand-response considering the transmission, distribution and storage as well as international integration and to reach competitive and affordable prices. The integration of the user and innovative business models are considered to be indispensable.[303]

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[302] See MUSIOL ET AL. (2012) pp. 64f.

[303] See EUROPEAN COMMISSION (2011a) pp. 2ff.

The commission concludes: "the global energy system is entering a phase of rapid transition with potentially far-reaching implications that will unfold in the next decades. Europe has to act before the window of opportunity closes. Time is short".[304]

Energy Politics in Germany

The term Energy Transition[305] was coined in 1980. A study of the German Institute for Applied Ecology published a report to present that nuclear energy is not necessary to save the future energy requirements. KRAUSE ET AL. compared two main paths: the smooth path and the hard path. The hard path set the focus on increasing growth in energy consumption and on large central technologies to assure the supply.

The smooth path favoured the regenerative energies with a focus on energy efficiency and decentralization. The conclusion was that the decentralized solutions are faster to implement and more cost-efficient despite the economy of scale due to the minimized transmission losses and less ecological damage. SIMON states that the actual approach of the energy transition is similar to the hard path and the smooth path is deleted as being utopia or regressive.[306]

The EEG is described as the driving force for the development of renewables in Germany and the basis of the energy transition. It contains the guaranteed priority of the feed-in of green electricity into the grid. This feed-in is related to given prices for a kilowatt hour and lasts for 20 years. The EEG was the follow-up of the „Stromeinspeisegesetz" (1991). For the first time, a law contained an assured feed-in tariff for renewables. The EEG became operative on the 1st April 2000 and was amended in 2004, 2009, in January and April 2012. The EEG became a model for a lot of other countries in the world.[307] The EEG leads to a dynamic growth in the field of renewables.

The security for the investors to receive sufficient compensation increased the investments and brought down the prices. The EEG sets ambitious targets. Germany

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304 Ibid. (2011) p. 23

305 See MORRIS/PEHNT (2012) pp. 49f.

306 See SIMON (2013) pp. 125ff.

307 BEE (2013) www.bee-ev.de

plans to get at least 35% of its needed electricity out of renewables by 2020, 50% by 2030 and 80% by 2050. MORRIS/PEHNT state: "this legal requirement to switch power generation almost entirely to renewable sources is one of the main pillars of the Germany`s energy transition".[308]

Based on the energy concept of the year 2010 the German government decided a redirection of the energy politics in June 2011 that is primarily related to the phasing-out of the nuclear energy and the beginning of a new era of the renewables to ensure the economical and societal development of Germany.

The goals are to secure a reliable energy supply, to strengthen Germany as industrial location and to achieve the commitments in the climate protection and sustainability. The energy transition is seen as the chance for the future and as a chance for Germany to be a model for sustainability considering ecological, economical and social criteria. The main columns are:

- The finalization of the nuclear energy till 2022 divided in different steps defined in a graduated scheme

- The dynamic expansion of renewables through the EEG to maintain the good conditions for investments by security of abatement and a stable feed-in tariff although the tariffs for solar were adjusted and minimized

- The fast expansion and modernization of the grids, defined in the Act On Accelerating Grid Expansion with focus on the review of ultra-high voltage and high voltage lines and the implementation of SMART grids

- Strengthening the energy efficiency through new technologies in buildings, mobility and usage of electricity.[309]

3.4.8 Wind Energy as Renewable Energy

Due to the rising concerns about the global warming, environmental pollution and energy security the interest of finding alternative energy solutions to replace fossil fuels

[308] MORRIS/PEHNT (2012) p. 34

[309] MUSIOL ET AL. (2012) pp. 8 ff.

has been increasing.[310] In contradiction to the fossil energies renewables have no limited exhaustion such as the sun, wind, water, hydropower and geothermics.[311] The wind is blowing because of the temperature difference in the atmosphere.[312] The wind energy is directly connected to the sun. Annually, the sun provides a capacity of 8000-times the energy that is requested worldwide and has an assumed longevity of another 5 billion years.[313]

Frequently, the sun energy is converted into warm water or electricity through the use of photovoltaics. It is mainly installed decentralized on top of roofs. The disadvantages of the direct energy out of the sun are the low energy density, the use of a lot of space and the irregular availableness.[314]

WINTERHAGEN describes the degree of efficiency of photovoltaics with an average of approximately 10% for low cost versions and for other versions significantly below 20%.[315] PELTE states that the photovoltaics will contribute less than 1% of the total need of the primary energy until the middle of the 21st century and will not be the major solution for the energy need of the future.[316] PELTE describes the degree of efficiency of wind energy with approximately the double of efficiency in comparison to the photovoltaics. Germany has more regions that are more suitable for wind turbines than for photovoltaics and so does the world.[317]

Wind energy is a special form of kinetic energy in the flowing air that can be either converted into electrical energy or directly used for pumping water, sailing ships or grinding grain like the old versions of wind mills.[318] In the early years of the last century the modern aerodynamics started to investigate wind turbines. This was the foundation of the modern wind technology that lead to various kinds of designs and first

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310 TONG (2010) p. 3

311 WAGNER (2008) p. 49

312 FEDDECK (2003) p. 2; See SCHÜTH (2008) p. 26; See WAGNER (2008) pp. 49ff.

313 SCHÜTH (2008) p. 27

314 See PELTE (2010) pp. 138f

315 See WINTERHAGEN (2012) pp. 78f.

316 PELTE (2010) p. 165

317 See ibid. (2010) p. 187

318 See HEIER (2012) pp. 32f.; See SCHABBACH/WESSELAK (2012) p. 94

projects with large wind turbines until the middle of the century in different countries. In Germany the investigations became economically uninteresting due to the low prices of fossils until the 80ies when the modern wind technology started.[319]

PELTE assesses a contribution of 3% of wind energy for the world`s primary energy need until the middle of the 21st century.[320] TONG describes the wind energy as a principle, sufficient to feed the world`s energy need because its availability represents 20-times the rate of the present energy consumption.[321]

Characteristics of Wind

Warm air is lighter than the environment and goes up. This leads to low pressure at the surface that is balanced by high pressure. This movement in the atmosphere happens regionally and globally. The most well known are the land-sea and the mountain-valley circulations.[322] The wind in coastal regions or offshore is more consistent and the energy yield is 50-100% higher in comparison to inland locations. Locations in the mountains are frequently characterized by fluctuating wind.[323]

The roughness of the earth`s surface influences the wind speed. A reliable approximation is that the wind increases about 10% with each doubling of height.[324] This is called the HELLMANN factor.[325] The wind speed is of crucial importance because the increase of the wind speed leads to an increase of energy in the third potency. 10% increase of wind speed leads to 30% increase of energy yield.[326]

The sum of frequency of wind speeds shows how often a special wind speed occurs in a special region within a given time and is called WEIBULL distribution function.[327] The WEIBULL distribution depends on the location, local climate conditions, the

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[319] See HEIER (2012) pp. 38ff.

[320] PELTE (2010) p. 187

[321] See TONG (2010) p. 4

[322] See HEIER (2012) pp. 41f.; See PELTE (2010) pp. 180ff.

[323] See HEIER (2012) pp. 45f.; See PELTE (2013) pp. 183f.

[324] TONG (2010) p. 6

[325] See HEIER (2012) p. 43; See TONG (2010) p. 15

[326] HEIER (2012) p. 41

[327] PELTE (2010) p. 183

geography and the surface of the ground and is related to the average wind speed.[328] Additionally, the influences of wind gusts and wind direction are to be considered.[329]

TONG states: "because the power output of wind turbines strongly depends on the wind speed at the hub, modern wind turbines are built at the height greater than 80 meters, for capturing more wind energy and lowering costs per unit power output".[330]

Power out of the Wind

Modern wind turbines are energy-converting machines to convert the kinetic energy of wind into mechanical energy and in turn into electrical energy.[331] Until today the theoretical maximum of efficiency is defined by BETZ Law that was derived by LANCESTER (1915) and BETZ (1920). It says that no wind turbine could convert more than 59,2 % of the kinetic energy of wind in mechanical energy.[332]

Due to the aerodynamic losses of the wind turbine systems, the real power coefficient is lower than its theoretical limit. TONG describes a mechanical power coefficient between 30-45 %,[333] LANDWEHR describes it about 40% related to CROME. This maximum is reduced by further losses caused by the belt or the gear and by the generator. The result of the theoretical value varies from approximately 29 % (LANDWEHR) up to 32% (PELTE) of useful energy.[334] SCHAFFARCZYK states that limitations apply to the theory and that under special conditions the BETZ limitations can be beat to some extent.[335]

Every turbine system has its individual power curve depending on the technical variation.[336] The tip speed ratio is an important factor that indicates the ratio of the tangential speed at the blade tip to the actual wind. It refers to the turbine design and has

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328 BLUMENBERG/SPINNLER (2002) p. 13

329 TONG (2010) p. 14

330 Ibid. (2010) p. 15

331 Ibid. (2010) p. 15

332 Ibid. (2010) p. 21; See PELTE (2010) p. 185; LANDWEHR (2011) p. 5

333 TONG (2010) p. 20

334 See PELTE (2010) p. 187; See LANDWEHR (2011) p. 8; See TONG (2010) p. 22

335 SCHAFFARCZYK (2010) p. 92

336 TONG (2010) p. 23

many variations depending on the technical design.[337] The general possible output of a turbine system is determined by the power coefficient of each turbine system. This value has an important meaning for the calculation of the economics of the turbines.[338] The power coefficient as a function of the tip speed ratio of different designs is illustrated in figure 17.

KOMATINOVIC states: "note that the power curve of the Savonius type and the American multi-blade design were inadvertently switched in some previous publications, discouraging the studies of the Savonius design".[339]

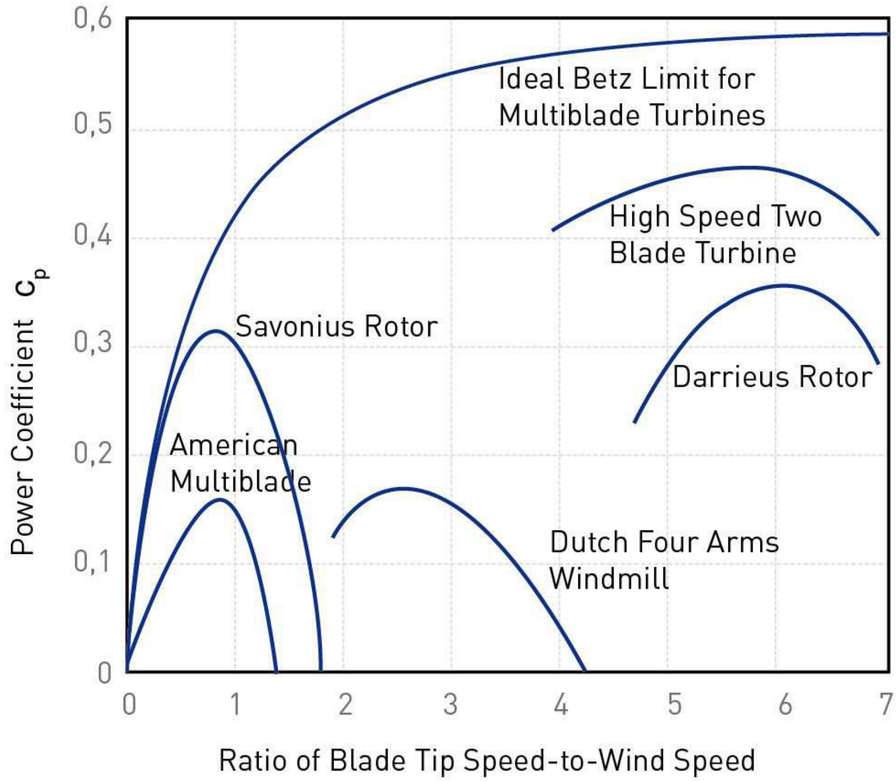

Figure 17 Performance of the conventional wind conversion systems given as efficiency versus tip speed ratio, KOMATINOVIC 2006[340]

[337] See ibid. (2010) p. 24

[338] See HEIER (2012) pp. 50f.; See TONG (2010) pp. 21f.

[339] KOMATINOVIC (2006) p.15; various illustrations with different kinds of power curves exist, mainly with differences in the American Multi-Blade version and the Savonius described by KOMATINOVIC, e.g. SCHAFFARCZYK (2010) p. 92; See PELTE (2010) p. 185; HEIER (2012) p. 50; See APPENDIX NO. 10.3

[340] KOMATINOVIC (2006) p. 15

The Standard Large Wind Turbines

The dominant design is the three-bladed horizontal-axis wind turbine that is the basis of the modern wind industry and the standard, highly elaborated version. Due to efficiency and the need to reduce the investment costs, the trend is going towards larger wind turbines and wind parks. The investment costs compose of the costs for the turbine system (wind turbine, foundations, grid-connection), operation and maintenance, electricity production, the lifetime and the discount rate.[341]

Several technical adjustments lead to the expansion of size and the optimization. The main types are turbines with a capacity of 2-3megawatts nowadays. The trend is to go up to a capacity of 7,5megawatts. The electricity produced by the turbines is fed into the grid, mainly on a low-voltage basis over transformations into the middle-voltage lines.[342]

The turbines are constructed for a lifetime of around 20-30 years. One of the main tasks for development is to cut down the maintenance costs and failure times, to optimize the manufacturing processes, to improve the performance and efficiency and to expand the production capacities. Limitations of these versions are given to environmental impacts. These are limited space, noise, shadow effect as well as disturbances of bats and birds. A lot of development was made to minimize these effects.[343]

Aerodynamic noise is caused mechanically and aerodynamically and generated by the blades passing through the air and is related to the tip speed ratio. The higher the tip speed ratio, the higher is the noise. Noises are infrasound and low and high frequency sound waves.[344]

The space is limited due to the given wind conditions and the requirements being on one hand close to the grid and residential complexes, but, on the other hand, not too close because of disturbances. Additionally, the efficiency of the turbines is minimized while standing next to each other. This is called the park effect. These aspects and the

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[341] See TONG (2010) p. 32

[342] See HEIER (2012) pp. 91ff.

[343] See TONG (2010) pp. 31f.

[344] PANTAZOPOULO (2010) p. 642

change of the typical landscape lead to potential conflicts of interest with other parties such as the tourism industry.[345]

The offshore technology started the industrial production in 2001 (in Denmark) after first demonstration units in 1991. TONG states that offshore wind has presently become the focus of the wind industry that is demonstrated in the numbers of growth rates of 75% in one year from 2009 up to 2010. A number of techniques have been developed to adjust the turbines to the conditions in seawater.[346] A lot of development is needed further to cover the offshore potential economically and to do large-scale implementations. HEIER expects this to start after 2015.[347]

The offshore sector started to seek for alternatives. QUILTER states referred to SCOTT (2013) that the momentum was with the horizontal-axis wind turbines at that moment of time. After the initial research, the view was that horizontal-axis wind turbine technology would evolve at a lower cost base than vertical-axis wind turbine technology. The distant future and the need to build upscale could change this. Vertical turbines have a lower centre of gravity and a lower turning moment that could enable the construction of bigger machines. He is talking about the 20megawatts bracket.[348]

Global Big Wind Industry

During the recent three decades wind power gained tremendous growth all over the world and is seen as the most promising renewable, clean and reliable energy source. A record breaking installation of 37gigawatts brought 157gigawatts of wind capacity to the world in 2009.[349] TONG states: “wind represents a mainstream energy source of new power generation and an important player in the world`s energy market“.[350]

Referring to the report of the Global Wind Energy Council (GWEC) in 2012, the global wind power grew by more than 10% in 2012 in comparison to the year 2011. An

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345 See PELTE (2010) pp. 186f.; See TONG (2010) pp. 28f.; See HEIER (2012) pp. 90ff.

346 TONG (2010) p. 35

347 See HEIER (2012) p. 46;

348 See QUILTER (2013) www.windpoweroffshore.com

349 TONG (2010) p. 3; See HEIER (2012) p. 10

350 TONG (2010) p. 4

investment of 56 billion euro was provided to install nearly 45 gigawatts of new windpower, the total cumulative capacity was calculated with 282,5gigawatts that represents a cumulative market growth of 19%. China is still on the first range although the number of new installations in 2012 has been higher in the USA. One reason is the limitations due to the grid capacity. The relation to China is described by increasing competition and the closing of the Chinese market for foreign companies. The American market is unstable and referred to SCHMITZ , the head of Vestas, it is threatened to break down in 2013 to about 60-90%. Worldwide over-capacities decrease the profits for the manufacturers. This leads to the trend of concentration on the own countries.[351]

Wind energy will be increasingly significant in the steady growing demand of electricity in the future. India is a key market. A high demand is also expected in the coming years in South America, Asia and Africa. Referred to the World Wind Energy Association (WWEA), the worldwide wind capacity reached 296,255megawatts in the first half of 2013, additional 22gigawatts should be installed by the end of this year. This brings a total installed capacity of 44,6gigawatts that provides 4% of the global energy demand. This result is around 9gigawatts less than in 2012 caused by the dramatic slump in the USA.[352]

In the European countries the wind energy represented 26% of all renewable capacity in 2012 with an investment between 12,8-17,2 billion euro. The rate of electricity provided by wind is now meeting 7% against the rate of 4,6% in 2009. The European Union lags behind the expected goals of the NREAP with 2gigawatts in the year 2012 and was currently suffering from the financial crisis. However, the future scenarios show that the wind energy is the leading power generation technology by 2050.[353]

GARRAD states: ”the EU policy has driven the renewable energy sector forward until now...as things currently stand, we in the wind energy business will all wake up on 1st January 2021 without any kind of framework or policy direction“.[354] The formalization of the goals for 2030 and the completion of the internal energy market as

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351 See RENTZING (2012) p. 75; See KÜHN (2013) www.tagesschau.de

352 WWEA (2013) pp. 1ff.

353 See FRIED ET AL. (2012) pp. 8ff

354 GARRAD (2013) p. 67

well as the Europe-wide power grid remain of crucial importance to stabilize the investments.[355]

The offshore sector counts new capacities of 1,296megawatts that is an increase of 33% compared to 2011. 90% of offshore installations are made in Europe being Great Britain the leading country, followed by Belgium, Denmark and Germany. The offshore is 14% behind the goals set in the NREAPs for 2012. Four billion euro was invested in 2010. The investors are mainly big energy players with 70% of the total installations. The main challenge is to bring down the costs.[356]

The market forecast by the GWEC estimates the cumulative installed capacity with 500-536gigawatts by the end of the year 2017 with a drop down in 2013. After recovery an annual increase of 61gigawatts is estimated to be achieved in 2017.[357] Given the right political signals and frame works the installation could reach 1,100gigawatts by 2020 and help to save nearly 1.7 billion tonnes of CO_2.[358] Referring to the advanced GWEC`s World Energy Outlook, the amount of investments could reach 150 billion euro and the industry could provide 2,1 million jobs worldwide in 2020.[359] By 2030, wind power could provide more than 20% of global electricity supply.[360]

The Small Wind Turbines

MAEDA ET AL. state: “actually, what is seen today as ´big wind` started in the size which is today defined as ´small wind`. Until the 1970ies and the 1980ies, most of the wind turbines had a capacity of less than 100kilowatts”.[361] MATSUMIYA says: “Small wind turbines have various long histories and yet huge market potential globally. Looking back last a couple of decades, various small wind turbines, both horizontal-axis and vertical-axis types, have emerged, however, they have kept standing behind in the

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[355] See FRIED ET AL. (2012) p. 14; See GARRAD (2013) p. 67

[356] See FRIED ET AL. (2012) p. 40

[357] GWEC (2013) www.gwec.net

[358] SHUKLA (2013) p. 25

[359] GWEC (2013a) www.gwec.net

[360] Ibid. (2012) www.gwec.net

[361] MAEDA ET AL. (2013) p. 5

shadows of large-scale turbines, as if they could not play meaningful roles in the energy production“.[362]

Historically, small turbines were used to provide power for e.g. dwellings not yet connected to the grid or water pumping, especially in rural, isolated areas. They disappeared when the grid connection was possible. The oil crisis in the 70ies was one reason for resurgence including new concepts with grid connection. Currently the interest is increasing and a lot of companies address the growing market for these applications.[363]

Although the small turbines can be easily designed and manufactured, tested and operated, technical difficulties in the past lead to lower reliability and high costs per unit. Referred to MATSUMIYA, the new technical approaches solved a lot of problems. The current obstacles are high costs and low reliability. Per definition the small wind turbines have a swept area up to 200 m^2 and a capacity up to 50kilowatts generating at a voltage below 1000 volts alteration current or 1500 volts direct current. The turbines should have a design that meet the standard of the International Electrotechnic Commission (IEC) 61400-2 and should include all safety standards similar to the requirements of the large wind turbines.[364] They can be used as island solutions with a battery system and grid-tied solutions.[365]

ZHANG ET AL. state that the definition of small wind turbines is so far not homogenous and claim for a general definition.[366] MATSUMIYA states: “today the small wind technology has evolved and is required to contribute to energy production and environment protection much more than before. Therefore, safety, performance, economics and environment are keen issues“.[367] The following figure 18 illustrates a life-cycle of small wind turbines.

[362] MATSUMIYA (2010) p. 389

[363] See STAUDT (2010) p. 257

[364] See MATSUMIYA (2010) p. 389

[365] STAUDT (2010) pp. 273.

[366] ZHANG ET AL. (2012) pp. 7f.

[367] See MATSUMIYA (2010) pp. 389f.

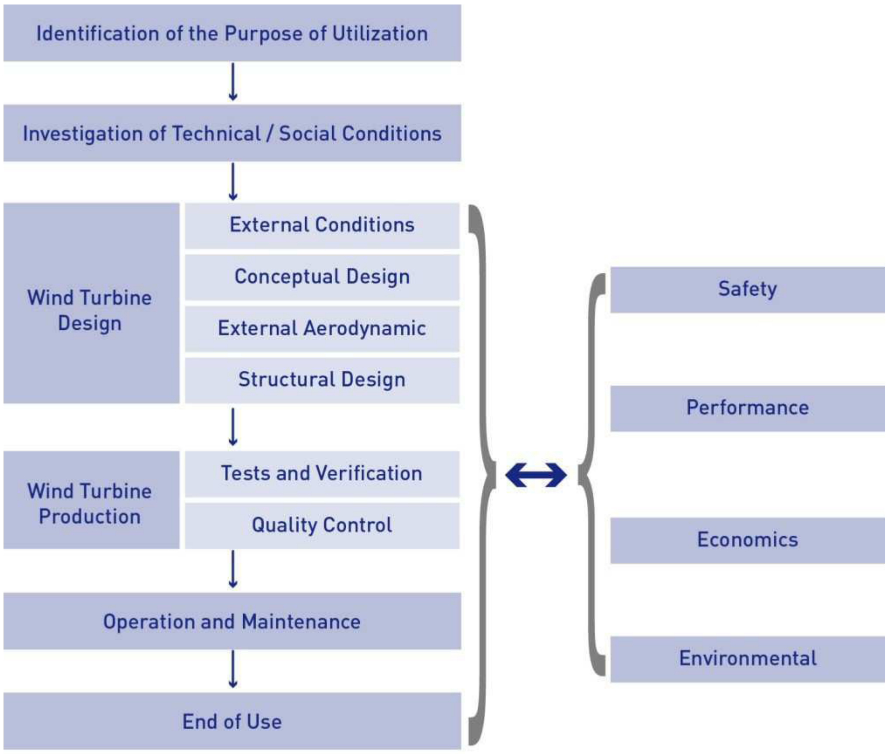

Figure 18 Life-cycle of small wind turbines, MATSUMIYA 2010[368]

The design of the small horizontal versions is in general the design of the large wind turbines. The early horizontal-axis wind turbine technology has dominated the market for over 30 years.[369] A lot of different variations are available with the basic design. Aerodynamic efficiency is sometimes sacrificed to minimize the production costs.[370] Due to their high speed, small versions can achieve high blade velocities that emit different noises including the low frequency noise.[371] The advantages are a high theoretical power coefficient, easy to reproduce and to place in development countries and an advanced technical level because of a lot of experience. The disadvantages are the need of yaw control, the shadow effect and the noise.[372]

The vertical versions have been proven to be effective to generate mechanical and electrical energy for small-scale applications as well as for large-scale electricity

[368] Ibid. (2010) p. 390

[369] MAEDA ET AL. (2013) p. 5

[370] STAUDT (2010) pp. 262ff.

[371] PANTAZOPOULO (2010) pp. 641f.;

[372] LANDWEHR (2011) p. 6; See JÜTTERMANN (2013) p. 15

production of utilities. During the time of 1970 up to 1990 a lot of those turbines were built and tested. However, they fall significantly behind the horizontal-axis wind turbines although they are proven to have advantages.[373] One of the main problems was the high rate of swinging power that can be technically reduced nowadays.[374] COOPER states: "not only were the vertical-axis wind turbines (VAWTs) the first wind turbines to be developed but they have also been built and operated at a scale matching some of the biggest wind turbines ever made. Vertical-axis wind turbines in principle can attain coefficients of performance, C_{pma}, that are comparable to those for horizontal-axis turbines (HAWTS) and they have several potentially significant advantages over the HAWTS".[375] The main versions are the Darrieus and the Savonius that lead to further design and applications.

The Savonius rotor was patented by SAVONIUS in 1929 by showing several examples for the application of water pumping.[376] It is characterized by a simple construction that leads to interest for both, self-made versions of amateurs and wind turbine developers. Due to its high solidity and the high mass, it was so far not used in large electrical production. It has a low tip speed ratio and high torque that makes it more difficult to connect with electrical devices.[377] The advantages are a robust construction, applicable in the infrastructure due to the less aerodynamic noise and the ability to work in low wind speeds. Additionally, the turbine is applicable to do co-financing by combining with advertisements.[378] A number of technical variations are currently under R&D such as stacked turbines or twin turbines.[379]

The Darrieus type has also different kinds of versions such as the H-Darrieus that is a high speed vertical-axis wind turbine. The world`s largest Darrieus is a 4megawatts machine located in Cap-Chat, Quebec. Until the energy crisis in the 1970ies it was the rotor that was close to be commercially viable.[380] One of the characteristics is the

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[373] See STAUDT (2010) pp. 257f.

[374] HEIER (2012) p. 54

[375] COOPER (2010) p. 277

[376] See ibid. (2010) p. 280; See SAVONIUS (1929) pp. 30ff.

[377] See COOPER (2010) pp. 280f.

[378] See LANDWEHR (2011) p. 6; See COOPER (2010) p. 280

[379] See HEIER (2012) p. 54; See DIRECTTECH GLOBAL (2014) www.silentrevolution.com

[380] See COOPER (2010) pp. 282f.

frequent disability of self-starting. This is the reason for applications with a combination of Savonius and Darrieus whereas the Savonius rotor is the starting rotor.[381]

Global Small Wind Industry

The importance of small wind technology is pointed out in the WWEA Small Wind Report (2012) by DEXIN. He claims for a strengthening of R&D, to establish rigorous standards and a lobby for supportive policies to guarantee the long-term growth. Besides the role of the large wind turbines he describes the main contributions of small wind turbines to secure energy supply and climate change:

- In the developing countries as key solution for power supply and electricity shortage.
- Applications in the infrastructure such as street lighting, mobile communication base stations, offshore aquaculture and sea water desalination.
- A stabilizing role in the transformation of the centralized grid to an ideal distributed network given through the SMART grid technology.[382]

The new WWEA report (2013) gave the following overview. In 2011 the total amount of 730,000 small wind turbines were installed (excl. India and Italy) with an erection of 74,000 new turbines that is an increase of 11%. China has a number of 500,000 that represents 68% of units and is far ahead regarding the USA and Great Britain. The global installed small wind capacity has reached 576megawatts at the end of 2011 whereas China as the main country holds 40% followed by the USA holding 35% of the total capacity. This means that the growth of capacity represents almost a doubling of the market size in 2011 because 120megawatts were added in this year.

The average size increased up to 1,6 kilowatts per unit. The main consumers are developing countries with off-grid and mini-grid applications. In countries without access to the national grid the competition in pricing is easily possible, especially against the expensive and environmental damaging diesel generation.

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[381] See HEIER (2012) p. 54

[382] DEXIN (2012) p. 5

Small wind manufacturers are spread over the world with the main countries China, USA, Canada and several countries in Europe. Worldwide a number of 120 new manufacturers established between the year 2000 and 2010. China has a manufacturing capacity of 180,000 units annually. The countries in Southeast Asia, Latin America and Africa with excellent wind conditions do not have any established small wind industries. In general, the industry outside China remains to be small and fragile in comparison to the huge possibilities on a global scale.[383]

Referring to the split in the basic design of being either horizontal or vertical, the producers are mainly also divided. Figure 19 illustrates the amount of manufacturers and the orientation in percentages in the field worldwide.

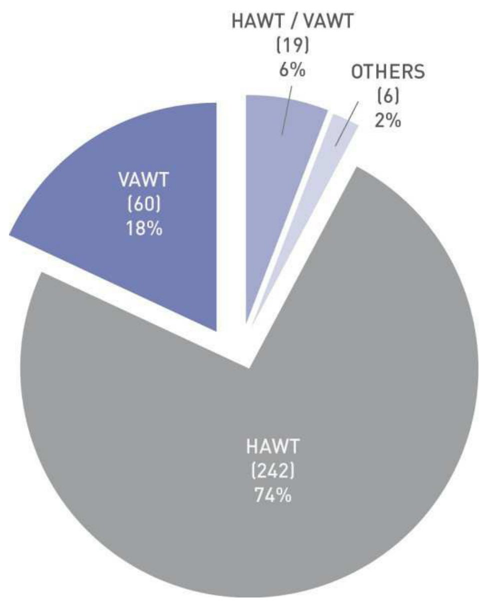

Figure 19 Small wind turbine orientation statistics, 2011, MAEDA ET AL. 2013[384]

The majority of 74 % of the preferred orientation of the early horizontal-axis wind technology is obvious. The majority of the vertical turbines have been developed in the last 5-7 years and the scale of market shares is relatively low. The average capacity provided by these versions is much smaller than the ones of the small horizontal ones.[385]

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383 MAEDA ET AL. (2013) p. 2ff.

384 Ibid. (2013) p. 5

385 See ibid. (2013) p. 5

Small Wind Turbines Global Forecast

Referring to the WWEA, the trend of the last years with an annual increase of 35 % of installed capacity is anticipated to continue in the next years, until 2015 an annual installation of 400megawatts is indicated. Until 2020 the installed annual capacity of 1,000megawatts could be reached that would achieve a cumulative installed capacity of 5gigawatts and represents a steady growth of 20%. This forecast is based on the historical growth trend of the large wind industry and the photovoltaic industry. The authors state forcefully that this dissemination can only happen under the precondition of clear policies. Figure 20 shows this trend.

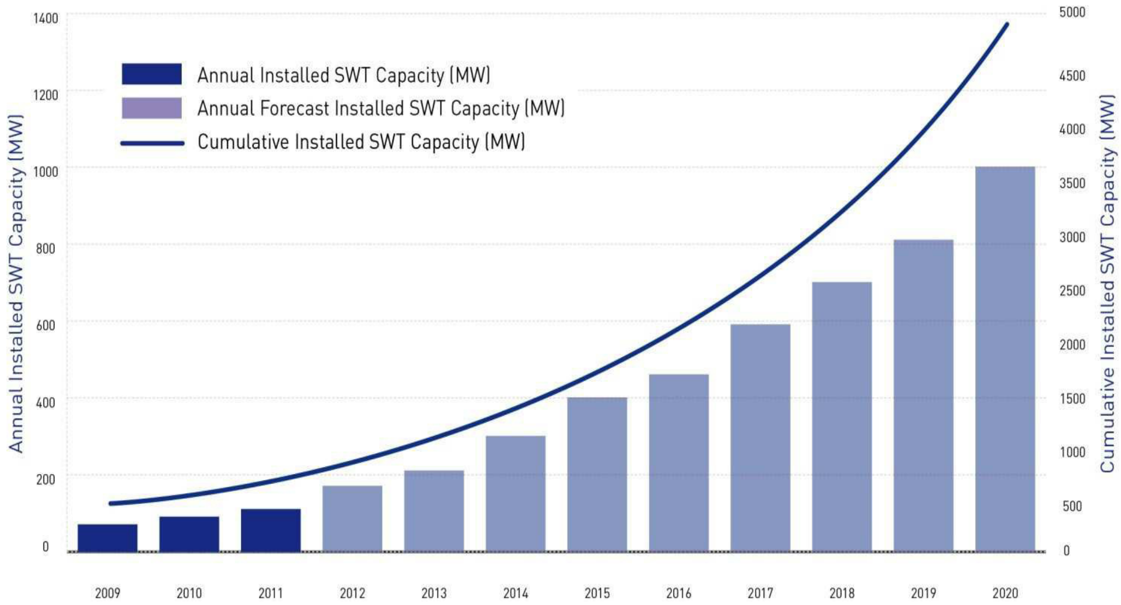

Figure 20 Small wind turbines installed capacity world market forecast 2009 - 2020, MAEDA ET AL., 2013[386]

It is of importance to establish homogenous standards for certification and to invest in further development to downsize the manufacturing costs. That can only happen when the market can rely on stable and appropriate support schemes. This is strongly related to special feed-in tariffs for small wind that are currently only available in a few countries. The two fields of application, off-grid and on-grid are both assessed to be important. The off-grid solutions will play the major role in the rural areas without grid connection (e.g. in China 2,4 million households still lack electricity). Rural residential electrification, telecommunication stations, off-shore generation and hybrid versions

[386] Ibid. (2013) p. 9

with solar and diesel are the main applications. The trend to grid-tied solutions is increasing in some industrialized countries, mainly USA, Great Britain and Denmark which use the smart-metering as incentive.[387]

3.4.9 Net Integration

The actual grid that is built on the precondition of a consistent load reaches its limit. The wind and the sun are not constant and the energy stream can change fast. The problem increases with the installation of large wind- and solar parks. At the beginning of the renewables it was not a big problem and the grid had the capacity to balance the incoming energy because of the manageable decentralized smaller applications. Due to the high amount of wind energy, the flow of loads changed and new electricity motorways are necessary to bring the electricity to the final destinations.[388]

The overload affects all lines, the low-voltage and middle-voltage lines in the regions, the high-voltage lines and the European highest voltage transmission line.[389] The European Wind Energy Association (EWEA) elaborated grid scenarios for the expansion of the European net identifying the main production and consumption areas from the current grid (2010) up to the year 2050.[390]

Referring to HULLE/FICHAUX a number of issues, both technical and institutional have to be addressed to integrate wind power successfully.[391] The actual curtailment - mandatory stopping of wind turbines - to compensate the grid problem can only be an exception because it is cost- and CO_2 intensive.[392] Flexible power stations for the back-up are needed that can ramp up and down in short time to compensate the natural fluctuations of renewables and the residual load is getting more importance.[393]

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[387] See ibid. (2013) pp. 6ff.

[388] HENNICKE/WELFENS (2012) p. 170

[389] BUCHAL ET AL. (2013) pp. 118ff.

[390] See SINNER ET AL. (2010) pp. 28ff.; See APPENDIX NO. 10.4-10.6

[391] HULLE/FICHAUX (2010) p. 13

[392] GRUET (2011) p. 14

[393] See MORRIS/PEHNT (2012) p. 26

Storage

Storage of energy is widely recognized as a key enabling technology for renewables and is now in the focus of interest. The over-capacity of wind is needed to be stored to ensure the security of supply. So far, electricity on a large-scale is mainly stored in pumped storage hydro power stations. However, this possibility is limited. A lot of research is necessary to develop further possibilities such as compressed air reservoirs, hydrogen-oxygen storages as well as storage of wind energy in methane and others.[394] The most promising storage technologies are still under R&D.[395]

Decentralized storages are currently mainly variations of accumulators and in the future the electro-mobility. HENNICKE/WELFENS state that finally the combination of central and decentralized components will lead to a tailor-made providing energy supply.[396]

LEAHY ET AL. (2010) state: “the advanced battery storage (electric vehicles (EV), flow batteries, second-life EV batteries) has the potential to reduce the need for grid infrastructure as it is not topographically, geologically and environmentally limited“.[397]

SMART Grids

Intelligent management systems for the grid are a combination of IT and grid management. The term SMART is defined by SPRENGER as: “the ability to communicate and provide ambitious functionalities based on the appropriate data processing with the environment and the humans within the environment”.[398] The technical execution requires at least one processor, a storage system, power supply and net works.[399] It includes the communication network between customer, distributor, administration and provider. The synchronization of supply and demand is to be optimized by the interaction between customers and providers.

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[394] See LEAHY ET AL (2010) pp. 661f.; See HENNICKE/WELFENS (2012) p. 172

[395] LEAHY ET AL. (2010) p. 661

[396] See HENNICKE/WELFENS (2012) pp. 172f.,

[397] LEAHY ET AL. (2010) p. 661

[398] SPRENGER (2011) p. 26

[399] See ibid. (2011) p. 26

The analysis of the data about the weather is a major issue. The goal is to minimize the amount of needed energy especially to reduce the peak demand.[400] SMART metering is required to provide SMART grids. The characteristics of SMART meters are:

1. Providing actual information about usage
2. Possibility of demand-response
3. Configuration of loads by the customer based on the tariffs of electricity and the saved decisions of the customer
4. Providing the possibility of direct access for the energy provider if requested or direct access for the customer
5. Providing the chance of new business models.[401]

SPRENGER describes a classification of different interests and interest collisions of actors in the electricity field that refer back to the implementation of SMART grids. The state and the customer have different motivations but the same interest in energy security and low costs based on a low use of electricity. The electricity provider is interested in high static demand to produce continuously at the lowest costs. The electricity traders are more interested in the fluctuating demand because dynamics in supply and demand provide the highest profit. The system operator is as well interested in deepening the peaks because of the interest to stabilize the grid.[402]

SMART grids and the SMART customer are described as the major player in the future model of the electricity system. In the German region Eifel a SMART grid was implemented as a pilot project called SMART country.[403] The Austrian support program SMART Energy Demo focuses on the development of a SMART city or SMART urban area in Austria. The goal is to develop intelligent urbanity and a controlled phasing-out

[400] See SPRENGER (2011) p. 24; See HIM (2011) p. 4; See BUCHAL ET AL. (2013) p. 158

[401] SPRENGER (2011) p. 25; See HIM (2011) pp. 1ff.

[402] See SPRENGER (2011) p. 23

[403] BUCHAL ET AL. (2013) pp. 158f.

of dependence on fossil fuels. This includes electro-mobility, public transportation systems and the infrastructure. Cities and suburban areas are of highest importance.

In the forecast (2050) the majority of 70% of the global population are concentrated in the cities. 80% of the green house emissions will be produced here because 75% of the global energy consumption will be needed in the cities.[404]

RIFKIN defines the SMART grids as the third industrial revolution. Already millions of mini grids are in place around the world. The internet will revolutionize the energy supply system and become the energy internet. Micro power plants and infrastructural applications connect the energy out of the wind and any other renewable source. Buildings become power plants. The cost for the technical devices will decrease like the costs of the internet.[405]

Merit Order Effect

The merit order is a cost optimization principle that plans with the lowest short-run marginal costs for electricity. It is the guiding principle of an electricity spot market that the lowest bids will be served first.[406] Photovoltaics and wind energy have high investment costs but low marginal costs. The total demand is related to the different types of power supply. Only those power stations are considered that are in fact required to meet the total demand.

The traditional power stations with the lowest costs are the nuclear followed by brown coal, stone coal, natural gas and oil. Due to the guaranteed priority (in Germany) and their zero fuel- and carbon costs and therefore low operational costs, the renewables enter the merit order first. The whole curve is shifted to the right that is illustrated in figure 21.

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[404] See VOGEL/HÖBARTH (2011) p. 10

[405] RIFKIN (2014) www.youtube.com

[406] GRUET (2011) p. 13

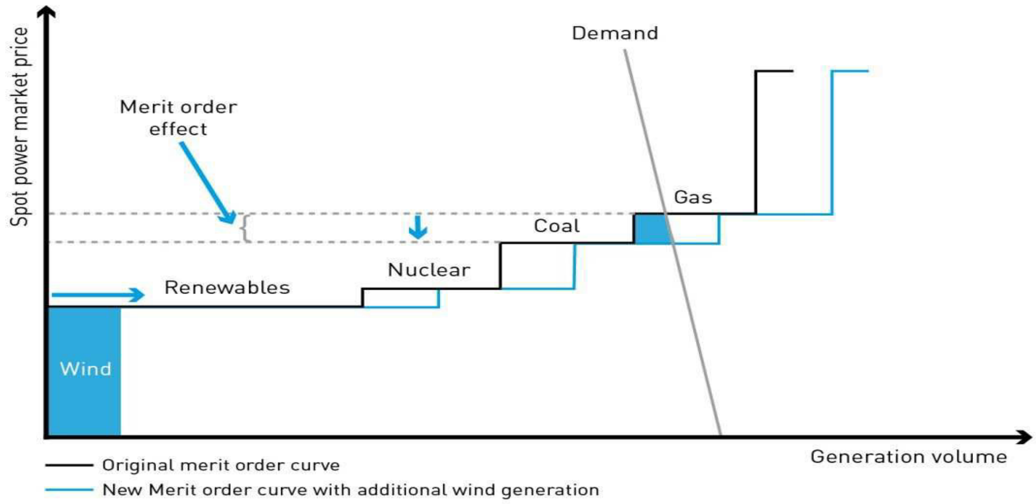

Figure 21 Merit order effect, GRUET 2011[407]

Due to the high variability of renewables, conventional power stations could be needed to solely provide the complete demand whereas they are forced to stand still during other times. Due to these variations, the prices at the spot market are defined on an hourly basis. The feed-in of renewables leads to a decrease of prices. Those prices are binding for all suppliers.

This is a positive effect for all electricity buyers that are included in the European-wide commerce and grid. It is a negative effect for the operator of the conventional power stations because they cannot produce to the low costs. Due to this, inefficient and expensive power stations are displaced from the market in a long-term run. This brings a strong impulsion to increase efficiency.[408] An unintended consequence is that the gas power stations are especially threatened to shut down.[409]

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[407] Ibid. (2011) p. 13

[408] See BUCHAL ET AL. (2013) p. 124f.; See GRUET (2011) pp. 13f.; this reason is given by the energy provider RWE who announced at the 20th of September 2013 to release 3000-3500 jobs and to close down power stations temporarily or in general, see HÖNING/REISENER (2013) p. A1

[409] See MORRIS/PEHNT (2012) pp. 26f.

Function of the Renewable Energy Compensation

Besides the feed-in guarantee, the producers of renewables in Germany get a compensation of the price independent from the spot market. In 2012 the guaranteed prices in the EEG for the producers of onshore wind were 8,93 cent per kilowatt hour for 20 years, for offshore wind 15 cent per kilowatt hour and for photovoltaics approximately 15 cent per kilowatt hour (depending on the size). A total amount of 20 billion euro annually is needed to meet these demands. This compensation is paid by the customers and is called Renewable Energy Compensation (EEC). It is fixed for one year. By the end of the year it is fixed for the following year based on the results of the last year. In 2012 it was 3,56 cent, in 2013 it was 5,277 cent [410] and in 2014 it will be 6,24 cent per kilowatt hour.[411]

Referred to BUCHAL ET AL. the consequences out of a high renewable electricity production lead to lower prices on the stock-market with the following consequences that seem to be paradox at the first glance:

- The finance need for the EEC increases because the renewable producers get a higher compensation.
- It is more expensive for the German customer due to the higher cost for renewables.
- German companies that need a lot of electricity can get a release of this payment[412] to get better conditions in the international competition.
- Foreign customers do also have a benefit because they can get cheap electricity from Germany without contributing in the EEC.

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[410] BUCHAL ET AL. (2013) pp. 125f.

[411] See TAGESSCHAU.DE (2013) www.tagesschau.de; until the year 2020 the average household in Germany will pay additionally up to 120 euro annually for electricity, see MARSCHALL/QUADBECK (2014) p. A1

[412] The European Commissioner for competion initiated an approval of this special compensation to avoid distortions in the European Single Market, see INGENRIETH (2013) p. B1; on the 18th December 2013, it was approved to be legal but the whole EEG is assessed to be a supportive instrument, see BWE (2013a) www.wind-energie.de

- Foreign power stations have disadvantages because the commerce can buy cheaper in Germany.

- It is suspected that the low spot market leads to the minimization of other attractive renewables in other countries, e.g. the hydropower in Switzerland.

- The foreign producers are strained whereas the foreign customers have benefits. The exported electricity is completely compensated by the German customers.

These circumstances lead to the following effect. The more renewables are produced, the higher is the increase of the price compensation. The complexity is enriched by the daily fluctuations in pricing given through the auctions that are competing with long-term contracts. Additionally, the temporary curtailment to stabilize the overloaded grid is also to be compensated. BUCHAL ET AL. conclude that the renewable electricity is actually an expensive good in the national economy.[413]

A study investigated national subsidies in the long-term run and compared the prices for nuclear, stone coal, brown coal and the renewable energies. The main difference is that the EEC is transparent whereas the other subsidies are hidden in the national finances. All direct and indirect subventions for electricity were compared during the time starting 1972 until 2012. The subventions include the national subsidies of financial support, tax benefits and further benefits of frame conditions. The negative external costs of the fossil- and the nuclear energy for environmental and climate damages were also considered. The EEC was calculated with a status of the year 2012.[414]

The result shows accumulated subsidies for nuclear electricity (real) in total of 187 billion euro, for stone coal of 177 billion euro, followed by brown coal with an amount of 65 billion euro and for natural gas with 1 billion euro. The renewables have so far been supported with an amount of 54 billion euro.[415]

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[413] BUCHAL ET AL. (2013) pp. 126ff.

[414] See KÜCHLER/MEYER (2012) pp. 3ff.

[415] See ibid. (2012) p. 5; See ZIMMERMANN (2012) p. 26

4. METHODOLOGY

The methodology of the dissertation is aimed on reaching the defined objectives based on the literature survey.

4.1 Qualitative Research

Firstly, the different structures, i.e. the broader social structures, the face-to-face structures and the deeper individual structures were analyzed by literature, observation and qualitative interview survey. Based on the knowledge and context information gained by the literature survey, the author was able to perform interviews that revealed the deeper mental structures, e.g. by confronting with certain decisions, actions, success or failure and record their patterns of explanation.[416] This enabled the author to illustrate their impact on the interpersonal behaviour and thereby on the broader social structures.

Using qualitative interviews was the most reasonable approach to the mental models because the investigation focuses on special knowledge of involved people about situations and experience. The social contexts and processes are reconstructed.[417]

Based on the results of the analysis of the literature, the author prepared expert interviews with key persons in different positions and different levels of the determined field. The experts were evaluated as experts based on their special experience in their special position in the special context and situation.[418] The aim was to get an insight and an understanding of the thinking behind the actions and decisions of the persons and to open up the values and mental models as part of the deep belief systems.

This approach includes an open communication process to explore the personnel and professional experience and to elaborate the professional culture and the thinking

[416] Related to the field theory isolated, fragmented elements of the situations are to be elaborated and evaluated under the influence of the characteristics of the emergent situation, see LEWIN (2012) pp. 104ff.

[417] See GLÄSER/LAUDEL (2010) p. 13; See STRAUSS (1998) pp. 12ff.; See STRAUSS/CORBIN (1996) p. 83

[418] See GLÄSER/LAUDEL (2010) p. 12

patterns. These aspects of biographical research include the individual construction of reality as well as patterns provided by the society.[419]

STARK states: “biographical aspects, individual resources and abilities are always to be seen as part of collective history“.[420] For this process experts are not meant as specific technical or scientific experts, although they can be. However, they are used as experts for their specific role as an interview partner to describe original special knowledge about the requested social issues.[421] This special knowledge is in mind of every person, it is knowledge about social contexts in which one is acting in, about the companies or organizations in which one is working and about processes of work.[422]

The interviews started after the first overview and the analysis of the broader social structures in literature. The information was placed in the different levels of the KANTOR model.

For the macro-environment analysis the PESTLE[423] analysis was used to cover political, economical, social, technical, legislative and environmental issues. First results lead to first criteria for the persons to be interviewed, the organizations and institutions to look for and the guidelines for the interviews.

The process of interviewing started with two pre-interviews to do a pre-exploration of the field and approve the own approach. The following figure illustrates the consideration of the different levels that surround the wind energy.

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[419] See ROSENTHAL (1995) pp. 12f.

[420] STARK (1996) p. 39

[421] GLÄSER/LAUDEL (2010) p. 12

[422] Ibid. (2010) p. 11

[423] See SCHEUCHER (2002) pp.199 ff.

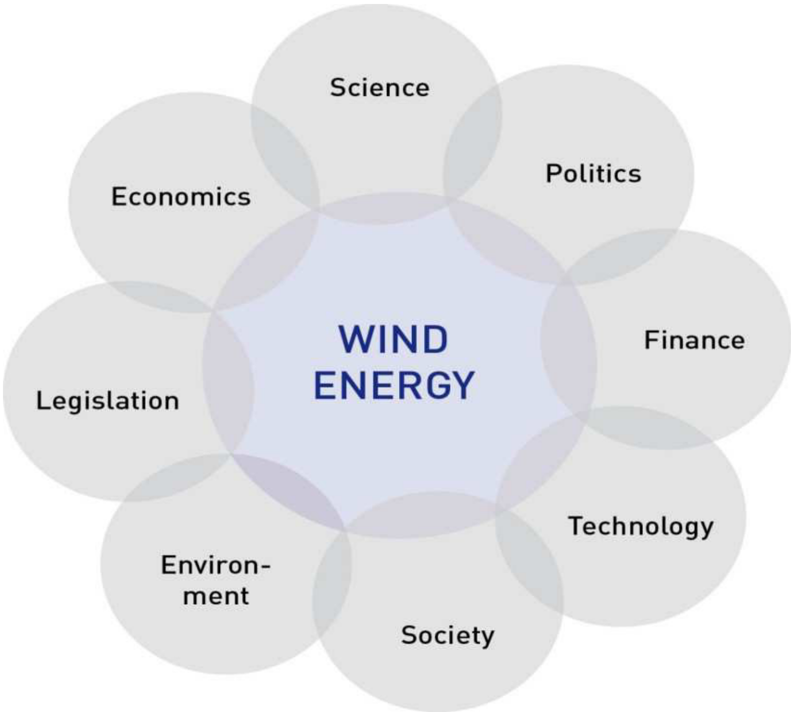

Figure 22 Levels considered in the survey

4.2 Observation of the Ongoing Process

The ongoing process of the energy transformation and the governmental discussions and decisions given by this actual topic are important to follow and were put into the context of wind energy. This is also one of the references used for the preparation and the content of the interviews. This part of the survey refers to the level of obvious behaviour, the face-to-face level in the KANTOR model. Referred to DOUGLAS and SCHATZMANN/STRAUSS, the observation focuses on the relationships and interactions in the energy field.[424]

Referred to SCHNELL ET AL., the observation of documentaries, talk shows or the news was indirect, hidden and non-participating. It is semi-systematic because it was done for this thesis; systematic on one hand because it will be planned and scripted as much as possible. It is non-systematic on the other hand because it is only possible to refer to a limited amount of documentaries.[425] The observation will be structured as follows:

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[424] See DOUGLAS (1976) pp.17ff.; See SCHATZMANN/STRAUSS (1973) pp.7ff.

[425] SCHNELL ET AL. (2005) pp. 391f.

- Interest of the observer for the research
- TV moderator and date
- Topic of the talk show/ discussion
- Actual background of context
- Composition of the group - organization and position of each member
- Flow of conversation or discussion
- Filling in information into context of whole survey.

4.3 Preparation of the Interviews

The focus of the interviews was put on the practitioners in their different fields and roles. The goal is to get insights from different angles. These are representatives of the big wind industry, the small wind sector, finance and project planning, ministries, customers and scientists. The author oriented herself to the recommendation of LUKENSMEYER to collect data of the minimum of five levels.[426]

The main focus was to collect data about experiences of the actors related to the founders of the field in the early years to explore the mental models. Thus, besides others, the author focused on people who grew up professionally with the development of the whole field.

Those persons are called the ´direct actors`, being close related to the wind energy. These are engineers, customers and representatives of wind associations. The ´indirect actors` deal with wind on a more distant level and are not exclusively professionally related to wind energy. They are politicians or working in governmental institutions, consultants or investors. They frequently depend on evaluation and basic assumptions of the direct actors. The difference is illustrated in figure 23.

[426] LUKENSMEYER (1999) seminar

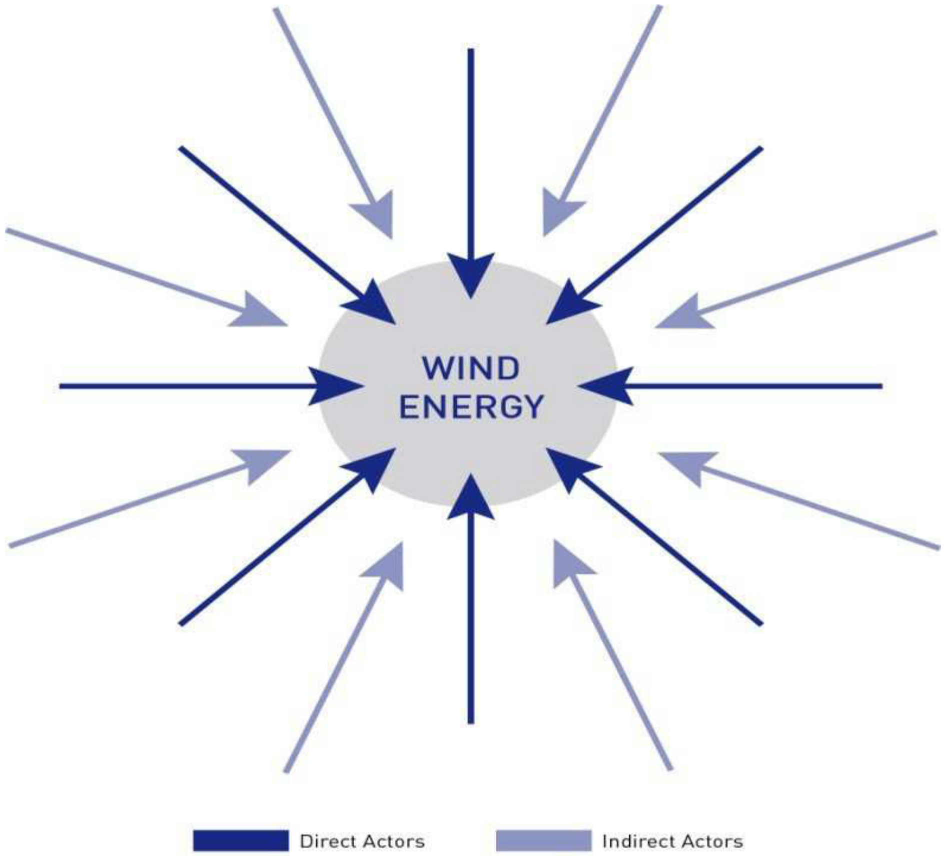

Figure 23 Difference in distance of actors to the research topic

The following institutions and professionals were approached:

- Engineers in the wind industry
- Scientists
- Investors and politicians
- German Association for Small Wind Turbines (BVKW)
- German Wind Energy Association (BWE)
- Funding institutions/consultants
- Energy providers
- Big wind companies (e.g. Vestas, Fuhrländer)
- Customers and private energy associations
- Farmer`s association.

The persons were invited by a letter[427] and by telephone. The invitation letter was sent to the chief executive officer of three large energy providers and the companies FUHRLÄNDER and ENERCON and to the BWE. Additionally, engineers of ENERCON were approached. The author could not get access to the heads of the energy providers, the approached engineers of ENERCON answered but thought that they are not the right persons to be interviewed. Through the pre-interviews and the first interviews with pioneers in the field, the author got access to the pioneer network that she focused on in the following process. Within the whole course of interviewing, a steady adaption and refinement of the interview strategy took place. The research process is illustrated in the following figure.

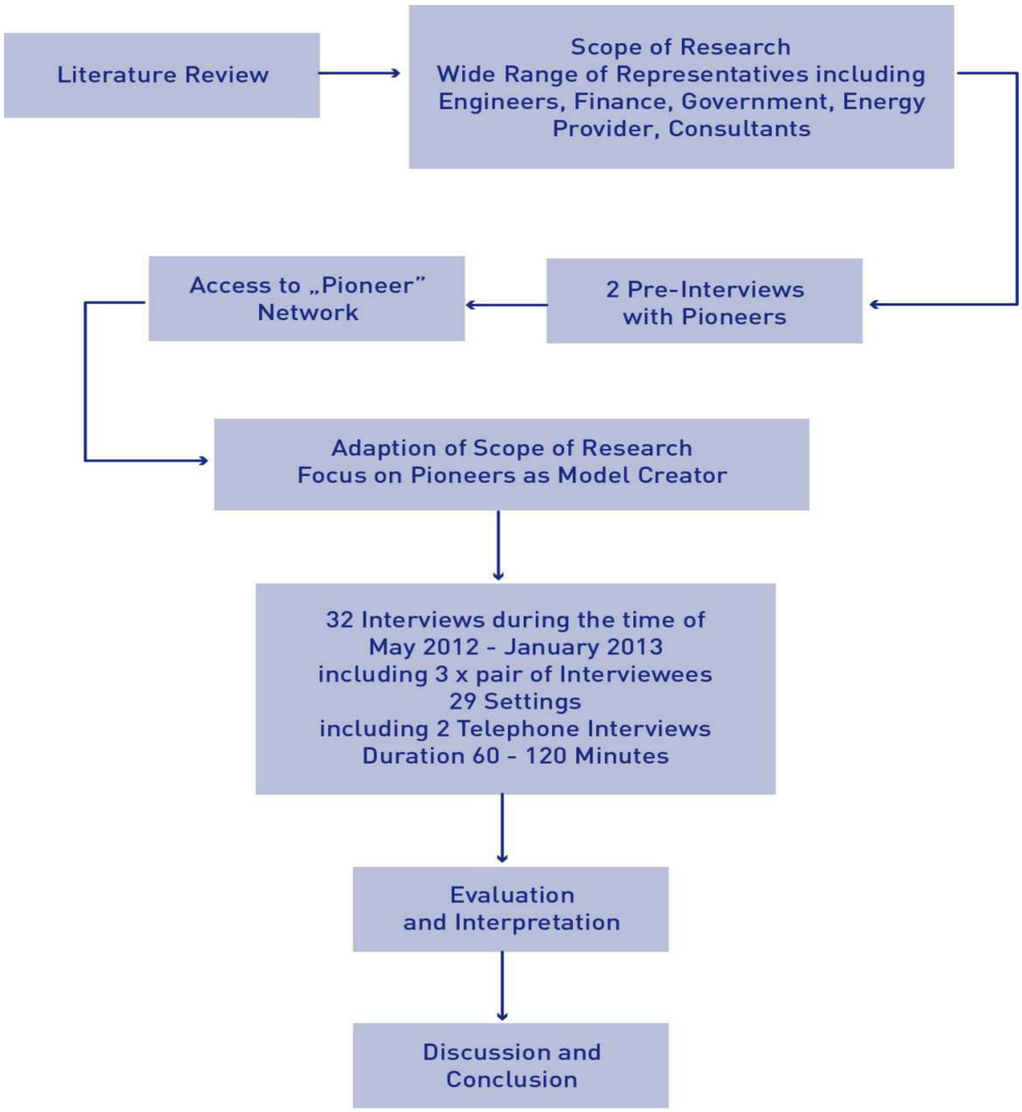

Figure 24 Flow diagram of research process

[427] See APPENDIX NO. 10.7

4.4 Interviews as Diagnostic Conversations

The personal history of the researcher is determined by the fact being a professional consultant in the field of change management and being active in the field of R&D for small wind turbines that includes personal experience in this field as well. This context knowledge is of importance for the quality of the research because conceptual interrelations based on the given data are to be formulated to represent the complexity of the researched phenomena.[428]

Besides attaining information, the interview sessions contain processes of mutual exploring. The interventions lead to learning sequences and new insights on both sides. Therefore, the sequences will partly be diagnostic conversations. Related to WOHLFAHRTSTAETTER, the relationship of the actors and the interviewer helps to ask the questions accordingly that is an added value for the outcome of the sessions.[429]

During the interviews, the persons will mainly be asked for their personal experience and the individual conclusions they can draw, thanks to their experience in specific situations and conditions during the different stages of the development of the field. The author will ask questions for getting information about facts, explorative questions and confronting questions depending on the situation and will leave enough room for the stories of the actors.[430] The following guidelines represent the topics that are mainly to be covered:

- Relation to wind - personal motivation to work in this field
- Personal experience - critical incidents in own professional history
- Confrontation with results of analysis of broader structures
- Confrontation with decisions and actions
- Description and comparison of the small wind sector and the big wind industry
- Focus on the thinking behind the action, conclusions and decisions.

[428] See STRAUSS (1998) pp. 35ff.

[429] See WOHLFAHRTSTAETTER (2010) p. 23

[430] See SCHEIN (2000) pp. 68ff., (2010) pp. 94ff.

- Additional questions: satisfactions - weaknesses - opportunities - threats of the field in connection to the governmental activities in the energetic transformation, most important challenge and possible solutions.

4.5 Evaluation of the Interviews

The content of the interviews are the data to be evaluated to be able to elaborate the mental models. These data are the core data for the analysis. The opinions and conclusions represented by sentences and stories of the actors build the core content of this survey and represent the specific experience of the actors in specific situations in the development of the field. They are the reconstruction of the social situation as mentioned above and are related to the original conditions.[431]

The qualitative analysis of the content will be done exclusively based on the data of the actors. Referring to the method of codification, the author will select similarities and other insights focusing on the importance for the research topic.[432] Based on the content the clusters will be defined. Core explanations and core stories as well as their interpretations of the actors will be visible. The stories and the sayings of the direct actors and the pioneer network will be in the focus of the interest for the elaboration of the mental models. Quotations of core sentences of the actors will be used to represent the thinking with high distinctness.

Based on the results, the author will formulate first theories about the stages of model building related to the three stages of KANTOR that is shown in figure 25.

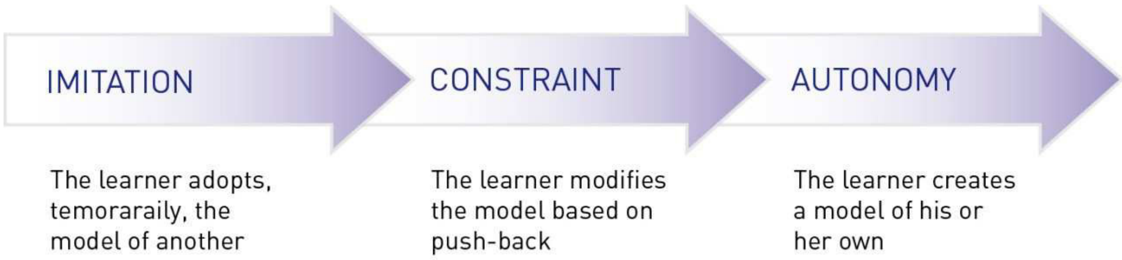

Figure 25 Three stages of model building, KANTOR 2012[433]

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[431] See STRAUSS/CORBIN (1996) pp. 78ff.

[432] See FLICK (1998) pp. 197ff.

[433] KANTOR (2012) p. 290

Stage one is the confrontation of the implicit model by other models. The possibility of learning is given. A proactive exploration starts going along with adjustment and imitation of the other models.

Stage two is the stage of testing and constraining the other models. KANTOR states that all models occasionally fail while being tested. If the process of constraining is reflected and incorporated, the own model can expand by an internal cross-model conversation that leads to an enrichment of the own model by parts of the other model.

The third stage, the autonomy, is the new model in practice and the new model integrated in the former model by reflected incorporation of the experience with the other model.[434]

4.6 Interpretation of the Results of the Team Learning Model

The sections of structures of the Team Learning Model are separated in the broader social structures that is done by literature, the face-to-face level that is done by observation and using the actual press and the deeper individual structures that are done by the interviews. After each section of survey, a short summary and an interpretation of the findings will be formulated and will be visualized in models using the terms of KANTOR.

Based on the findings, the author will draw interconnections to the other levels of the KANTOR model to elaborate the possible influence on the economical situation and future perspectives. Therefore, the results will be split in listing of the findings and in the way the author makes a meaning of the data for the whole case based on the findings. The Theory of Change and the Theory of Practice of this case will be formulated based on these results.

4.7 Summary of Methodology

The scope of research is illustrated in figure 26. The author calls the model the Case Learning Meta Model. This model is a combination of the Team Learning Model (figure 1) and of the Structural Sources of Verbal Interaction.[435]. It is adjusted to the

[434] See ibid. (2012) pp. 289ff.

[435] See ibid. (2012) p. 286

topic of research and combined the research process with the KANTOR model. The headline of the catalytic structures and the professional stories in the deeper individual structures were added.[436] Additionally, besides the mental models, the author put in the moral models. The professional stories are either stories about the group or individual stories in a professional environment. The main stream in the wind energy was put into the face-to-face level. At the same time, the main stream is evaluated by the author as a result of the whole process.

The adjustment of the model is an example for KANTOR`s statement: "whatever is relevant and shows more clarity, you can put in the different levels, also the boundaries of the levels and between the levels are to be defined from case to case, a model is living".[437]

Here are the different steps and dimensions of using the KANTOR model illustrated in figure 26:

1. Context information about change to explore the Theory of Change and of energy related topics as the first dimension of the Theory of Thing done by a survey of literature.

2. The focus of the second dimension of the Theory of Thing was the analysis of broader social structures of the Case Learning Meta Model and the Team Learning Model in Germany.

3. The third dimension of the Theory of Thing was the analysis of actual activities related to the face-to-face level.

4. Based on the knowledge we gained by the literature survey, we were able to perform interviews revealing the deeper individual structures which represent the fourth dimension of the Theory of Thing.

5. The evaluation of the interviews provided additional data of e.g. stories or images. From there on, we elaborated the mental models or hypothesis of the mental models. These results were interconnected with the other levels.

[436] KANTOR (2013) www.kantorinstitue.com

[437] Ibid. (2012b) interview

Consecutively, the KANTOR model was applied to investigate the interconnections of these structures with a focus on the mental models that are the least visible and therefore until now the least investigated.

6. Based on the completed Theory of Thing, the author was able to elaborate the Theory of Change for the case.

7. The Theory of Practice will provide possible change strategies on different levels.

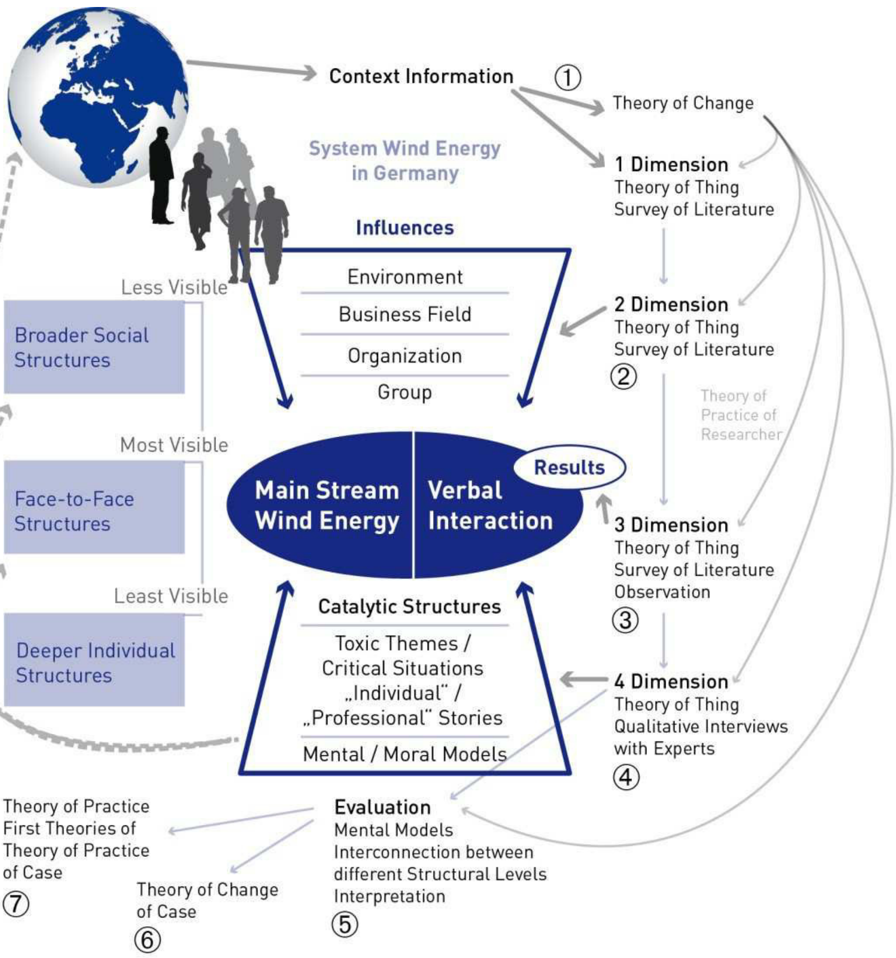

Figure 26 Case Learning Meta Model, based on KANTOR 1995/2012

5. RESULTS

The goal of the change process is the transformation of the energy sector to reach the goals of the energy concept that defines Germany`s path to reach a payable, reliable and environmentally friendly energy supply without nuclear energy. The concept includes, besides an energy supply mainly without fossils, the minimization of energy consumption and the shut-down of all nuclear power stations terminated until 2022. It also includes the assurance that energy remains payable for every person and company, the security of employment, the increase of economic wealth and the social security. The phasing-out of the nuclear energy is the core element of the extrapolation of the energy concept and not discussible. No further nuclear energy will be used after the deadline in 2022.[438]

ALTMAIER states: "with this energy transformation our country will be the worldwide trailblazer for an energy supply without oil and coal. 2022 the last nuclear power station will be cut off the grid. The era of nuclear energy will be definitely finalized in Germany".[439] He states additionally: "the energy transformation is Germany`s response to climate change and the challenges of a modern energy supply...we are also enduring a successful transformation of the German economy to a low-carbon economy which continues to promote growth and employment".[440]

5.1 Results of the Analysis of the Broader Social Structures

5.1.1 Big Wind Industry

Level of Environment

The natural source wind is related to the typical wind conditions within the regions and the available ground in this region. Germany has 4 wind zones (figure 27) defined by their main average wind speeds.[441] The coastal area is defined with the highest wind

[438] See BUNDESREGIERUNG (2013) www.bundesregierung.de; See ALTMAIER (2013) p. 10

[439] Ibid. (2013) p. 10

[440] Ibid. (2013a) p. 69

[441] Definition by the DIN 1055-4 that defines the different wind classes given by the wind loads and the topographical environment, measured 10meter above ground, see HERAS-ADRONIT (2013) www.heras-adronit.de

speed that is wind zone 4. Some regions have wind zone 3, the main regions are wind zone 2 and wind zone 1. The regions with high wind conditions are very limited in the northern part especially the coastal regions. Schleswig-Holstein is the federal state with the best wind conditions because of its geographical situation being between the North- and the Baltic Sea. It is called Germany`s Wind land No.1.

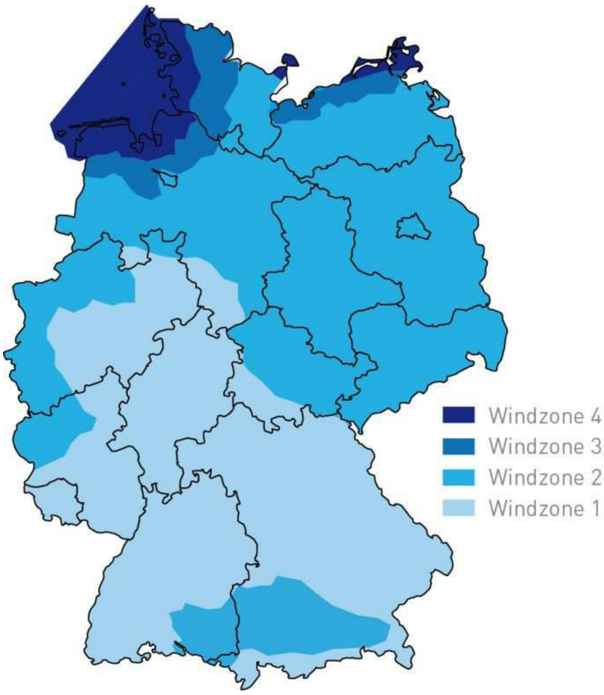

Figure 27 Wind chart of Germany 2011, HERAS-ADRONIT[442]

A lot of this industry started in Schleswig-Holstein. RAVE states: "the history goes back to the 80ies, three success factors were leading, the geographical situation, economical development and political decisions".[443] The industry in this region focused on the maritime business with people who were experienced to deal with the natural strength of the wind and water. The maritime industry was looking for new opportunities after the oil crisis. The farmers were pioneers in both, farming and energy providing, due to the force to produce partly their energy by wind-mills (mechanical).

This was also common in Denmark and by the Frisians. These traditions and neighbourhoods were supporting factors. Additionally, the farmers were trustworthy because of their fruitful ground. RAVE is talking about the multiple source ground that can be used for farming, wind mills and as security for loans from the bank. The close

[442] Ibid. (2013) www.heras-adronit.de

[443] RAVE (2007) p. 41

relationship to Denmark influenced the process further due to the clear denial of the nuclear energy that swept over to the Social Party. The pictures of the anti-nuclear-movement and the demonstrations about Brokdorf are historical. This opened new paths for political decisions to support energy alternatives in Schleswig-Holstein.[444]

Regulations of the concentration fields were established in the 90ies, to ease the process of planning and installation and additionally, the natural regions and the settlements should be protected.[445] Especially in the second half of the 90ies, the traditional coastal regions in the northern part were already occupied that lead to more stress on the development of larger turbines to use the scarce ground for more output and to be able to expand more in the inland.[446]

Due to the ongoing technical expansion in size, additional regions are now seen in the middle mountains, the woods and low wind regions in general. The Fraunhofer Institute for Wind Energy and Energy System Technology (IWES) built up a 200meters wind measurement pole to explore the options close to woods in the middle mountains.[447]

BOFINGER ET AL. did a study for the BWE (2011) about the suitable space in Germany. The study was elaborated considering the frame conditions for the big wind industry such as regulations for distance in settled areas, infrastructure and others. The energy yield was based on a standard turbine capacity with 3megawatts with a hub height of 100meters and a rotor diameter of 100meters. The results show that 2% of all regions can be used due to the criteria. If the woods are included, 12,3% - 22,4% of all regions can be used that bring an estimated energy yield of 390terawatt hours that is 65% of the energy consumption of Germany in 2010. The study shows further that currently 57,3% of turbines are erected in areas that are non-usable areas due to the criteria in the study.[448] A concrete planning to integrate the woods already exists in North Rhine-Westphalia, Bavaria and Rhineland-Palatinate.[449]

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[444] See ibid. (2007) pp. 41ff.

[445] See OHLHORST (2009) pp. 141ff.

[446] See BRUNS ET AL. (2008) pp. 62f.

[447] See KÜHN (2013) www.tagesschau.de

[448] BOFINGER ET AL. (2011) pp. 5ff.; See BWE (2013) p. 11

[449] See WEINHOLD (2012b) pp. 30ff.

BISCHOF states that the potential of land that can be used for wind energy is mainly related to the political opinion making, not to the given environmental conditions.[450] The scarce available ground is the main reason for the basic conflict of interests on the macro-ecological level (climate protection) and the micro-ecological level (biodiversity, protection of natural environment).[451]

The wind in Germany avoided 35,2million tons of Green House Gas emissions in the electricity production. This is the main part of the total renewable amount of 86,5million tons. Due to the BWE, the wind turbines have a positive CO_2 balance. After 3-9 month they save the CO_2 that was used for their production.[452]

Level of Business Field

Economical

Referring to the BWE industrial sector report (2013), the German wind market is a growing market.[453] Germany is still the unchallenged number one in the European wind market with an overall installed capacity of 32,4gigawatts and new installations of 1,1gigawatts in the first half of 2013.[454] The total amount of wind power in the electricity production was 6% in 2010 and 7,8% in 2011. Up to 2020 this amount is planned to triple considering the on- and offshore. The total turnover of the German wind industry in the year 2010 covered 6 billion euro of the total amount of 33 billion in the renewable industries.[455] Germany is, besides China and the USA, a global leader in wind.[456]
The mass market began in the year 1991 due to the new governmental regulations (Stromeinspeisegesetz). Main technical developments were made during this decade.[457]

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[450] See BISCHOF (2007) p. 19ff.

[451] See RAVE (2007) p. 53

[452] See BWE (2013) p. 27

[453] See ibid. (2013) p. 15

[454] See WWEA (2013) www.wwindea.org

[455] See AG BILANZEN (2011)

[456] MORRIS/PEHNT (2012) p. 16

[457] See WEINHOLD (2012) p. 48; See BRUNS ET AL. (2008) p. 48

Export

The export was a growing factor due to the limited space in Germany since the mid 90ies. The market shares were divided and a saturation of the market lead to more focus on the export including governmental support. The export focus is accompanied by an increasing concentration of companies.[458] The export rate of the wind industry was about 66% in 2012. Internationally, Germany is losing influence due to the increasing competition.[459] Recently, the uncertainties in the international market and the unsolved offshore problems lead to a return in the own onshore market that is the most plannable mass market.[460]

Onshore Capacity

Due to the BWE report (2013), the onshore wind industry has achieved the highest increase of installations since 10 years. A total number of 23.040 turbines with a cumulated capacity of 31,33gigawatts with an average capacity of 2,42megawatts were grid-connected by the end of 2012. 1008 turbines with a capacity of 2.439megawatts have newly been erected. This is an increase of 20% in comparison to 2011 and the highest accession rate since 2003. The installed capacity reached the highest level per turbine.

The status of the development of the market is different in the federal states.[461] The main installations are still in the northern part of Germany. Due to the redirection of the federal politics, Rhineland-Palatinate and Bavaria are the most advanced federal states in the south. The highest turbines were erected in Bavaria with an average hub height of 133,9meters. Turbines of this size are now technical feasible. Due to this, the possibility of expansion in regions with lower winds is more economical. The average hub height is 109,8 m in whole Germany.[462]

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[458] See ibid. (2008) pp. 93f.

[459] BWE (2013) p. 11

[460] See RENTZING (2012) p. 75; See KÜHN (2013) www.tagesschau.de

[461] See APPENDIX NO. 10.8

[462] BWE (2013) p. 15

Repowering

The first turbines and wind farms that received feed-in tariffs reached the end of their service. This leads to the significance of repowering. The output of an average turbine installed today is about ten times greater than the output of a turbine installed in the mid-90ies.[463] 161 repowering turbines with a total capacity of 432megawatts were installed, 252 turbines with a capacity of 179megawatts were uninstalled in 2012.[464]

Offshore Capacity

The offshore is influenced by offshore activities in Great Britain and Denmark. It was mainly initiated by the government (2002) to achieve the goals for the climate protection, the security of supply and the stabilization of employment.[465] Germany holds 6% (50megawatts) of the total installed capacity of Europe in 2010.[466] In 2012 the offshore wind has reached a total output into the grid of 280megawatts produced by sixty-eight turbines. Sixteen turbines with an average capacity of 5megawatts (the European average is 4megawatts) have newly been installed that is 3,3% of the new installed capacity in Germany. Six offshore wind parks are currently under construction.[467]

The expansion of turbines is delayed. Obstacles are assessed in difficulties to find investors and the missing grid expansion.[468] KÜHN states that the take-over of risks and the finance of the connections were not clarified until January 2013 this is why the projects get stuck. The decisions for investments depend on the security on subsidies. Especially the very long planning times are to be considered. Additionally, a lot of research is necessary for the German deep water applications and therefore the finance has to be assured. KÜHN sees drastic negative consequences for the job security in the middle-term if Germany plans to minimize the subsidies.[469]

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463 MORRIS/PEHNT (2012) p. 17

464 BWE (2013) p. 15

465 See BRUNS ET AL. (2008) pp. 215ff; See OHLHORST (2009) pp. 96ff.

466 See ARAPOGIANNI/MOCCIA (2011) p. 13

467 See BWE (2013) p. 16; See APPENDIX NO. 10.9

468 See BWE (2013) p. 16

469 See KÜHN (2013) www.tagesschau.de

Employment

The increasing rate of employment was already a main factor in the 90ies.[470] In the year 2009, the total number of employees was about 140.000 including the employees of the suppliers. The number of direct employees in the wind industry increased from 64.000 up to 101.000 from the year 2004 until 2011. This is approximately one fourth of the total employment in the renewable industry. The employment is wide-spread over Germany. It includes the maintenance and component suppliers due to the supply chain. This brings additional jobs for approximately 140.000 people, also in regions which are not well developed in wind industry such as North Rhine-Westphalia.[471]

Finance

50% of the German onshore energy are owned by private investors, only 7,4% are in the hands of the big energy providers, the rest is in hands of banks, project-planers and funds. The onshore investments are assessed with low risks and high return of investment and reached the point of being main-stream nowadays.

The finance of offshore is more complicated because the banks refuse to take the risks although the feed-in tariff was increased in 2012. The wind park Global Tech 1 in the North Sea was financed by a consortium of 16 banks that invested a maximum of 50 million euro each.[472] Normally a percentage of 35-40% of own capital is requested that the banks start to invest (onshore 20-25% or less).[473] The three large energy providers (EON, RWE, Vattenfall) and others invested billions in the offshore industry.[474]

Technical

The technical development started with small wind turbines developed by engaged engineers and mechanists who were motivated by the idea of decentralized energy supply and to search for alternatives of the nuclear energy. Those turbines were mainly

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[470] See BRUNS ET AL. (2008) p. 49

[471] See BWE (2013) p. 24; See EE-NEWS (2011) www.ee-news.ch

[472] See BWE (2013) p. 23

[473] See BUNDESVERBAND DEUTSCHER BANKEN (2012) p. 4

[474] See WAZ (2013b) www.derwesten.de

sold to farmers for their own energy need during the time of mid-70ies until the mid-80ies.

The first and only large turbine project was the Growian that was initiated by the government, the industry and energy providers. The Growian with a capacity of 3megawatts was supposed to achieve the goal of central energy supply by wind and to assure the security of supply due to the political conditions in these days. The Growian was installed in 1983 and uninstalled in 1987 because this project was assessed to have failed. This project is described as one of the deepest disappointments in the history of the wind energy but it lead to further steps. Later on, it was assumed that the Growian was built to fail because of possible conflicts of interest of the large energy providers.[475]

From the beginning on, the focus of the technical development was set on the expansion of size starting with robust small turbines. The Danish Design of a three-bladed horizontal-axis turbine that was already successful connected to the grid in Denmark became the dominant technical design.[476] Surveys of vertical designs were done but this path was stopped.[477]

The size and the capacity of the horizontal turbines grew tremendously (average of 40 m in 1990) as described above. The motivation was to be more economically by size. The scarce of land was one driving factor. MORRIS/PEHNT state that the wind energy is the cheapest source of renewable power nowadays.[478] Main contributions in the progress of the development of the technical devices were achieved in the decade of the starting mass production in the 90ies and were mainly done by the companies themselves.[479] Nowadays, the largest turbines achieve a rotor diameter of 154meters with a hub height of 160meters that brings a total height above 200 m.[480] KÜHN states

[475] See BRUNS ET AL. (2008) pp. 27ff.; See OHLHORST (2006) pp. 104ff., (2009) pp. 95ff.; See WEINHOLD (2012) p. 48; See RAVE (2007) p. 43

[476] See MAUTZ/BYZIO (2005) p. 27

[477] See BRUNS ET AL. (2008) pp. 36f.

[478] See MORRIS/PEHNT (2012) p. 16

[479] See WEINHOLD (2012) p. 48; See BRUNS ET AL. (2008) p. 48

[480] See BWE (2013) pp. 20f.; See MORRIS/PEHNT (2012) p. 16

that this is a certainty for German companies to be competitive in the international market.[481]

The 5megawatts turbine was mainly developed for offshore. Due to its dimensions and technical specifications, it is limited for onshore applications. Hindering factors are transportation, cranes, corrosion protection and maintenance.[482]

WEINHOLD states: “over decades the developers had the goal to achieve the highest capacity per unit. Prototypes of 10-20megawatts machines are announced, the turbine with the highest capacity is the 7,5megawatts Enercon turbine E 126. More than twenty prototypes are announced with a capacity between 5-10megawatts and the diameter of 126 m was exceeded, a size that was not functionally in the 80ies with the Growian”.[483] WEINHOLD states further: “already another trend in the race of the ´super-turbine` is on the way”[484] and quotes KÜHN: “in the last years the turbine grew less in power than in size...one has recognized that megawatt hours are more than just megawatts”.[485]

The path of increasing size leads to increasing problems with the weight. HÖHMANN quotes CHENG (2012): “a generalized formula says that the power output increases in a square but the weight increases cubically...a rotor with a double weight produces 4-times more but it is 8-times heavier”.[486]

Referred to CHENG, it does not work just to build larger turbines. A technology leap is necessary. Besides developments based on the horizontal design the vertical design is of interest. This problem could be solved easier by vertical turbines because the stress will be at the bottom and not in the height.[487]

Investment Costs

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[481] SEE KÜHN (2013) www.tagesschau.de

[482] See OHLHORST (2009) pp. 229f.

[483] WEINHOLD (2012) p. 50

[484] Ibid. (2012) p. 50

[485] Ibid. (2012) p. 50, citation of KÜHN

[486] HÖHMANN (2012) p. 2 www.handelsblatt.com, citation of CHENG

[487] See ibid. (2012) p. 2 www.handelsblatt.com; See HAUTMANN (2013) pp. 40ff.; See ibid. (2013a) pp. 44ff.

The investment costs for onshore wind turbines in good wind conditions are described with1000-1800 euro per kilowatt, the production costs are between 0,045 und 0,107 euro per kilowatt hour. The investment costs for offshore turbines are described by 3000-4599 euro per kilowatt hour and the production costs per unit 0,119 -0,194 euro per kilowatt hour although they have more hours of full load. [488]

The total investment costs of a turbine or a wind park are always related to the conditions and can vary. A wind turbine project in Bavaria (2011) with a turbine capacity of 3megawatts that is estimated theoretically to produce 7000megawatt hours annually and should provide electricity for 2000 households has planned investment costs of 5,6 million euro.[489] Graszpow is the largest wind park in Mecklenburg-Vorpommern with an investment of 220 million euro that is supposed to generate electricity for 125.000 households.[490]

Table 1 The Agrarian Chamber of Farming Schleswig-Holstein gives the following example: investment costs in euro of a turbine with a capacity of 2megawatts - 90meters - 105meters hub height [491],

Turbine/ transportation and installation	2.500,000
Foundation	120.000
Transfer station	50.000
Electrical installation in the wind park	35.000
Net connection	350.000
Streets, space for cranes, in the wind park	50.000
Planning costs (2% of the investment costs)	62.100
Survey	25.000
Compensation	25.000
Others	17.900
IC per turbine	3.235.000

488 KOST ET AL. (2013) p. 2; price of brown coal production 0,038-0.053 euro/kW, stone coal 0,063-0,080 euro/kW and of natural gas power stations 0,075-0,098 euro/kW depending on the cost of fuels, the cost of CO_2 certificates and the assumed hours of full load.

489 See KNOOP (2012) p. 12

490 See NDR (2013) www.ndr.de

491 EGGERSGLÜß (2012) p. 9

The economical calculation of a project in Gailingen of 10.500,000 euro that is based on the installation of three turbines of 2,3megawatts capacity each shows that a return of investment is possible in the minimum of 17 years.[492]

Related Technical Level - Net Integration

One of the major problems of this business is how to bring the produced electricity from regions with high wind speeds but limited population to the places where the power is needed. The grid reaches its capacity. Due to the fact that the large wind turbines need grid connection, the grid is the needle-eye of the expanding wind energy.[493] This problem exists already in the 90ies when the net operators were allowed to shut down the turbines to deal with possible overloads.[494]

Referring to the Federal Network Agency, the curtailment had an amount of 421gigawatt hours, this is 3-times the amount of 2010 (127gigawatt hours) in 2011.[495] Whole wind parks are temporarily closed, 118.000 households could have been supplied one year with the amount of the lost electricity. The compensation payment had an amount of up to 35 million euro that was paid by the consumer.[496] The expansion of the grid is delayed. 214kilometers are finalized by the end of 2012. An amount of 1.834kilometers were planned and decided on by the German Parliament in 2009.[497]

Referring to the study of the German Energy Agency (Deutsche Energie Agentur DENA), a suitable expansion of the transmission lines will cost up to 42 billion euro until the year 2030 depending on the scenario. Besides more electrician motorways and the European super grid, an amount of 193.000kilometers of additional distributing transmission lines is necessary. The grid is to be changed in the contradiction as before, so far the electricity flows from the high-voltage lines into the lower voltage lines.[498]

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[492] BÜRGERINITIATIVE FÜR EINEN VERANTWORTUNGSVOLLEN UMGANG MIT WINDENERGIE (2012) pp. 3ff.

[493] BWE (2013) p. 28

[494] See OHLHORST (2009) pp. 182f.

[495] BWE (2013) pp. 28f.; See FINANCESCOUT24 (2012) www.financescout24.de

[496] See ibid. (2012) www.financescout24.de

[497] BWE (2013) p. 29

[498] See WETZEL (2012) www.welt.de; See DENA (2012) pp. 2ff.

Related Technical Level - Storage

Except the hydro pump stations, the large-scale storage solutions are under R&D. Special ideas are pump stations in the salt caverns and old coal mines due to the geographical conditions. The access to storage facilities in Norway and the usage of the net as partial storage are related to the grid expansion.[499] A pilot project with hydrogen storage is carried out in the wind park Graszpow.[500]

Social

The multiple crisis in the 70ies consisting of nuclear energy, of the environment and the crisis of security of energy supply was the social and political context for the pioneer phase of the wind energy. The anti-nuclear movement expanded fast. The conviction to find alternative energies was growing after the Chernobyl accident.[501] The ecological movement challenged the industrial establishment. The main features were the decentralization with focus on mini power stations, pluralism of actors and ecology of the electricity sector that lead to social dynamics of technical development integrated in networks.[502]

The conflict of interests between the climate protection and the nature protection is long-lasting and carries on with the main focus on offshore wind parks nowadays. The missions are competing.[503] During the 90ies, the nature conservation associations were assessed as the brake in the expansion of the wind energy by the public perception. They seem to be partly exploited.[504]

This was also one reason for a phase of consolidation since 2002. Further conflicts of interests with competing industries like the tourism arose. This was more profound due to the increasing lack of usable space.[505] In 2013 the citizens in Münster, located in

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[499] See BISCHOF (2007) p. 32; See KRUCKOW (2012) p. 36

[500] See NDR (2013) www.ndr.de

[501] See BRUNS ET AL. (2008) p. 39

[502] See MAUTZ/BYZIO (2005) pp. 6ff.

[503] See OHLHORST (2009) p. 227; See RAVE (2007) pp. 50ff.

[504] BRUNS ET AL. (2008) pp. 54ff.

[505] See ibid. (2008) pp. 129ff.

North-Rhine Westphalia, refused the implementation of a big new wind park by a petition, against the decision of the local government.[506]

The number of private owned wind farms started in the early 90ies because the turbines became larger and the minimization of personal risks was a driving factor as well as to earn money in contradiction to the mainly ideal orientation before this decade.[507] This is of highest importance to consider for the professional project developer.[508] The path of participation leads to more acceptance of the wind energy[509] and is also applicable for the expansion in the woods. The communities share the leasehold.[510] Nearly 600 energy associations guided by citizens[511] have been found that is seen as democratizing of the energy sector. ALTMAIER states that this way of success could be transferred to other parts of the energy system such as grid expansion and storage. He is talking about a dividend for citizens to let them participate economically.[512]

The social disparity became discussable due to the increasing costs for electricity of the normal households.[513] The sceptical scientists complain about the inequity and the disadvantages for people who do not have any kind of land and the privileges for a small group of only 1% of the German households.[514]

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506 VOOGT (2014) p. A2

507 See OHLHORST (2009) pp. 137ff.

508 See MORRIS/PEHNT (2012) p. 29

509 See BWE (2013) p. 19; See WIEG ET AL. (2013) pp. 18f.

510 See LEMKE (2012) p. 33; referred to a study of the “Unabhängiges Institut für Umweltfragen” UfU in general the people agree to the energy transformation but they tend to oppose to wind parks, especially if they are affected directly. This is related to the assessment of strains, individually (health, economical) and for the municipalities (strategy of municipality, consequences for the region, view of landscape, plants and animals). The other influencing side are the beneficiaries (economical, sense for the whole society). The perception of strains is considered to be less due to the range of participation of the citizens in projects, see SCHMID/ZIMMER (2012) p. 7

511 BWE (2013) pp. 22f.

512 See ALTMAIER (2013) pp. 20f.

513 See BUCHAL ET AL. (2013) pp. 125f.

514 See SCIENCESCEPTICALBLOG (2013) www.science-sceptical.de

Legislation and Politics

The term energy transition was born in the 70ies strongly related to the oil crisis and strengthening of the anti-nuclear movement and goes back to the publication of the MEADOWS (1972) report as described above.[515] The new established Green Party was elected in the German Federal Parliament (1983) with their central topic of the energy transition against nuclear energy. The party was the major actor to bring the discussion further. The conflict between ecology and economy was escalating. The main anti-capitalism attitude of the ecologic side was contra the part of industrial interests represented by the big companies and energy providers.[516]

The BMU was founded but the energy politics remained in the hand of the BMWi.[517] First programs of subsidies supported the development of large wind turbines such as the Growian. The Growian failed but after the Chernobyl accident the new established wind energy got a push. The first 100megawatts program (1989) was established and expanded to the 250megawatts program (1991).[518] The main legislative steps for wind was the "Stromeinspeisegesetz" (1991) followed by the EEG.[519] The preconditions were:

- the increasing awareness of nuclear energy caused by the Chernobyl accident
- the Brundtland report (1987) as trigger for the sustainability discussion and the goals to minimize the CO_2 emissions
- the growing European integration including the energy sector
- an achievement of a technical status that allowed the market entry.[520]

Due to the increasing certainty of the technology, the political initiatives turned the interest towards the repowering and export that stabilized the field. To reach the climate

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515 See MORRIS/PEHNT p. 51

516 See OHLHORST (2009) pp. 90ff.; See MAUTZ/BYZIO (2005) p. 5

517 See OHLHORST (2006) p. 106

518 See ibid. (2009) p. 76, pp. 97ff.

519 See MORRIS/PEHNT (2012) p. 33

520 See OHLHORST (2006) pp. 108f

goals, the offshore became of highest interest for the government.[521] KÜHN states that the high dependence on the legislation of the wind energy, especially offshore, has a high potential of risks for the employment.[522]

The decentralized approach from the beginning of the modern wind energy was completely released towards the centralized large production offshore.[523] The political focus is actually more related to the strategies of dealing with the integration in the whole energy supply system (net integration) and to ensure the security of supply for the future as well as to minimize the long-term effects such as security of employment and affordable prices. The amendment of the EEG in 2012 strengthens the integration in the electricity market by direct sales. A bonus per kilowatt is provided that is calculated based on the difference of the EEG compensation and the achieved price due to the electricity exchange.[524]

Level of Organization

The growing business and the developments in this field were accompanied by steady adjustments and building new forms of organizations. This evolution carries on. New trends are to be seen in the direct marketing and new constellations of projects due to the repowering, the international competition and the offshore industry. The sector expects a structural change through mergers and acquisitions in the coming years.[525] The offshore built up a new alliance consisting of big technology concerns, energy providers, manufacturer and specialized project-planers as well as the actor government.[526]

The pioneers were lone warriors with idealism and practical mechanical knowledge. They started in a niche to develop alternatives of energy supply by wind. One example

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[521] See ibid. (2009) pp. 231f.

[522] See KÜHN (2013) www.tagesschau.de

[523] See OHLHORST (2009) p. 232

[524] See LEGLER (2012) p. 14; also the compensation by the „Quotenmodell“ is discussed again, it defines a defined quote of green energy for every provider, if they produce themselves or buy-in is an internal decision, if an overload is available they could sell as allowances to others, see HÖNING (2013) p. B1

[525] See BWE (2013) p. 19

[526] See OHLHORST (2008) p. 240

is the founder of Enercon. WOBBEN started in his own garage. A few of the pioneers achieved a growth of their companies due to the described environmental, political and social conditions.[527]

In the 90ies Enercon, Micon, Vestas, Tacke and AN Windenergie were the biggest players in the market. Due to the increasing competition and the necessity to develop larger turbines, time was the most advantageous factor. The market entry for new companies became difficult. In 2002 nine main manufacturers remained, the others hold a market share of 0,2%.[528] Due to the maturity of the products, the process innovation came in the foreground. Several revised versions of the EEG followed and have been the ongoing back-up of the industry.[529]

The increasing influence of the German wind industry was possible through a combination of business and science. Associations and scientific institutes were founded to establish this industry in the society and to expand the knowledge as one major export factor.

The risk of cancelling the "Stromeinspeisegesetz" changed the focus of the associations. Political lobbyism and public relations became the relevant issues. Furthermore, the scientific Institute for Solar Energy Technical Supply (ISET) is a supportive mechanism on a high level for the wind energy. The analysis of data about meteorological conditions, predictability of the expected power, reliability, failures and costs are transferred as informational basis of decisions to the political level. These are the references for further strategies for both, onshore and offshore.

OHLHORST states: "for the lobby of the wind energy this work has a high meaning, it underlines the argumentation with technical data."[530] Additionally, reports, journals and magazines were established and contributed to the strengthening of the sector.[531] The BWE as the binding association describes itself as the speaking tube of the wind

[527] See MAUTZ/BYZIO (2005) p. 28

[528] See OHLHORST (2009) p. 188

[529] See BRUNS ET AL. (2008) pp. 27ff.; See OHLHORST (2009) p. 140

[530] Ibid. (2009) p. 146

[531] Ibid. (2009) p. 146

energy. The advisory board consists of the large companies such as Enercon, Vestas, Repower, Fuhrländer and Nordex that are 97% of the main manufacturers.[532]

A special trust for the development of the offshore wind energy was found in 2005. The trust consists of wind associations, federal and national ministries (e.g. BMU, BMWi), energy providers (e.g. E.ON, RWE, Vattenfall), banks (e.g. Commerzbank) and financial services (PricewaterhouseCoopers).[533]

The field has achieved an advanced level of professionalism. Technical standards for the dominant turbine design and for the production are set. Special technical degree programs focusing on renewable energy and wind energy present the scientific part at universities.[534] The main teachers belong to the group of pioneers of the wind energy. The pupils of these teachers are found in scientific- or in leading positions in the companies.[535]

5.1.2 Small Wind Industry

Level of Environment

In general the protection of the nature, the acoustic emissions, the light and shadow effects and the disturbance of neighbourhood are to be considered. Basically, turbines below 30-35meters are no influencing factor for the landscape, therefore the land use planning is not the suitable instrument.[536]

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[532] BWE (2013) p. 17

[533] See LOBBYPEDIA (2014) www.lobbypedia.de; the trust is critisized because of the close relationship of politics and the large energy providers (subsidies of 5billion euro were paid initiated by the Green Party) this is described in the article „Dangerous Closeness“, it is stated that the citizens have to pay besides the compensation of the feed-in tariff the public relations of the trust, see FRÖHLINGSDORF (2012) www.spiegel.de

[534] See RABE (2013) p. 4

[535] See WEINHOLD (2012a) pp. 52ff.

[536] See SCHETTLER (2012) pp. 8f.; See EGGERSGLÜß ET AL. (2012) pp. 27f.; See FEST (2013) pp. 160f.

Level of Business Field

Economical

Referred to the BVKW, the demand for small wind turbines is increasing. Private households, companies and mainly farmers are searching for solutions to integrate own energy production into their total consumption by small wind turbines.[537]

EISELT assesses a high economic growth rate due to decentralized capabilities and states: "...decentralized structures replace the old structures, mobile photovoltaics, applications in houses and balconies and vertical turbines with sufficient capacities are the start of a new era...with complete new locations of energy providing in transportation, lorry and trains".[538] He states further that the usage of a high amount of decentralized versions can save the expansion of the grid and minimize the black-outs. The summation of energy by multiple small units is probably more than the production of the large wind turbines.[539]

At the end of 2011, a number of 10.000 units of the total 730.000 small wind turbines worldwide were installed in Germany. The average capacity is 1,5kilowatts in Germany.[540] The HANDELSBLATT (2010) gave an overview about installed capacities worldwide starting in 2007 up to 2013. It was done before the Fukushima accident. It showed a forecast of 113megawatts installed capacity in the year 2013 as it is to be seen in figure 28.

The real figures reached 576megawatts installed capacity at the end of 2011 that is at least 4-times more as expected.[541] The BVKW states that a number of 700.000 small

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[537] See BVKW (2014) www.bundesverband-kleinwindanlagen.com; See JÜTTERMANN (2014) www.kleinwindkraftanlagen.com

[538] EISELT (2012) p. 134

[539] See ibid. (2012) p. 13; he refers to the year 2010, more energy was produced by photovoltaics than by the power stations of all large energy providers, see p. 11

[540] MAEDA ET AL. (2013) p. 2; See FRANKEN/TRECHOW (2013) pp. 60f.

[541] See HANDELSBLATT (2010); See MAEDA ET AL. (2013) p. 2

wind turbines could be installed in Germany until 2020.[542] In 2010, Germany had a market share of only 3% in the small wind sector worldwide.[543]

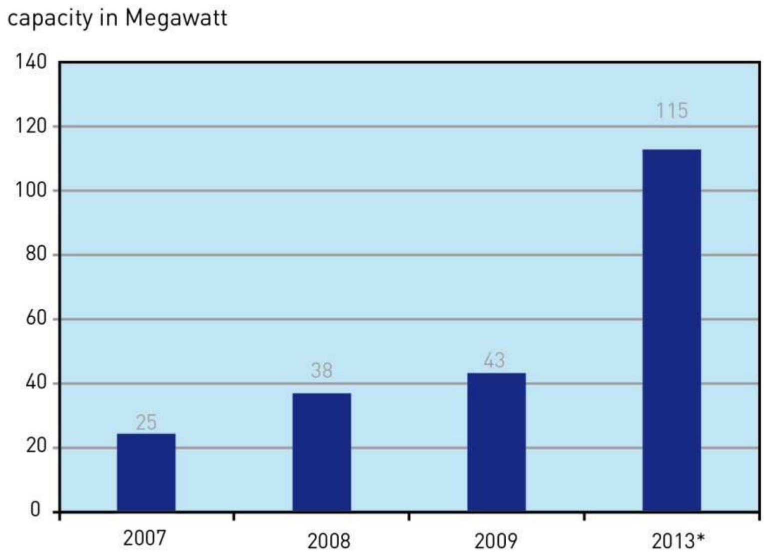

Figure 28 Trend and forecast of small wind turbines worldwide 2007 - 2013, HANDELSBLATT 2010[544]

Technical

Numerous variations of technical designs are offered. Referred to a survey of the Institute IWES, the horizontal version is most spread with 88% of the 112 analyzed units, mainly with three blades. Vertical versions have a share of 12%. Applications in the infrastructure often show the vertical version due to their advantages of having no or low noise and no shadow-effect. EISELT assesses the vertical turbines as being the future turbine because it can be put in the infrastructure and has the defined advantages.

Small wind turbines can be applied grid-connected and as island solution. A combination with storage and heating based on electricity storage capabilities, e-mobility, in combination with cell towers and other infrastructural buildings are possible. Hybrid versions in combination with photovoltaics are already available.[545]

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542 GRIESER ET AL. (2013) p. 13

543 HANDELSBLATT (2010)

544 Ibid. (2010)

545 See EISELT (2012) pp. 52ff.

The infrastructural wind applications are the basis for the energy internet and SMART grids. The buildings are the power plants that produce and distribute combined with storage facilities on demand-response.[546]

The BVKW defines small wind turbines with a nominal capacity of 100 kilowatts, the most ones are smaller and have a capacity below 5 kilowatts with a rotor area below 20squaremeters. The farmers are normally interested in turbines with more than 5 kilowatts. In this segment the turbines have a size between 10-30meters. The DIN EN 61 400-2 defines the technical standards.

Only single versions are certified due to the high costs and the intensive work load. This is the reason why the German Technical Control Board (TÜV) has done a plausibility check.[547] Every type that is installed has to have a confirmation aligned to the German Institute for Building Law that includes safety checks and load management.[548] Table 2 shows an overview about classes defined by the BVKW.

Table 2 Small wind turbine classification according to the BVKW, LANDWEHR (2011)[549]

According to IEC 61400-2 (2006-03)	Safety specification of small wind turbines with an area exposed to wind up to 200 m² and a max. voltage of 1.000 V AC or 1.500 V DC
Micro-Turbines	Rotor area up to 5 m² and 30 m construction height (including on-roof-turbines)
Lower-small wind turbines	More than 5 m² rotor area, but max. 10 m construction height
“normal” small wind turbines	On- or off-grid solutions up to 30 m construction

A market analysis and a field test with vertical- and horizontal-axis wind turbines done in 2009 showed that a lot of applications have not reached their marketability and

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546 RIFKIN (2014) www.youtube.com

547 See FRANKEN /TRECHOW (2013) pp. 189ff.

548 See EGGERSGLÜß ET AL. (2012) pp. 6ff.

549 LANDWEHR (2011) p. 4; Other tables divide in other categories such as micro version up to 5kilowatts, mini version up to 30kilowatts, and the middle-class version up to 100kilowatts, see EGGERSGLÜß ET AL. (2012) p. 6; See TWELE (2013) p. 171

are still under R&D. Technical problems arise mainly in the connection of the generator and the electronics. The optimal adjustment to the given regional conditions is an important issue as well.[550]

Investment Costs

The following table shows examples of the investment costs for three small wind turbines with different sizes.

Table 3 Investment costs of three small wind turbines in euro, EGGERSGLÜß 2012[551]

Types	Nominal Capacity	Euro	kW in Euro
$28m^2$ Rotor Hub Height 15 m	7,5	33.750	4.500
$65m^2$ Rotor Hub Height 19,5 m	15	56.250	3.750
$126m^2$ Rotor Hub Height 21,6 m	25	81.250	3.250

The investment costs depend on the regional conditions and the wind speeds. EGGERSGLÜß states that in average a small turbine can be economically feasible in good wind regions. They could be partly economical in regions with middle strong winds under the precondition of self-usage of the electricity of 45%.[552]

OTTER/PEHNT elaborated average investment costs for vertical-axis wind turbines of 4.600 euro per kilowatt and for horizontal-axis wind turbines about 4.150 euro per kilowatt.[553] Other examples are given by FRANKEN/TRECHOW.[554] Due to the feed-in tariff, being lower than the costs of electricity, it is more worth to use the energy yield for the own consumption. The higher the price for electricity, the more economical is a small wind turbine.[555]

[550] See OTTER/PEHNT (2009) p. 26

[551] EGGERSGLÜß (2012) p. 39

[552] See EGGERSGLÜß ET AL. (2012) pp. 40f.

[553] See OTTER/PEHNT (2009) p. 11

[554] FRANKEN/TRECHOW (2013) p. 56

[555] See LANDWEHR (2011) p. 18

Social

The underestimation of the effort that is to be done and the overestimation of the wind as well as the wrong positioning turn out to be points of disappointment after installation. Although numerous products are offered, they often do not pervade their obligation. This leads to disappointments and reduces the trust of the customers in the technology.[556]

Politics and Legislation

The regulations for building permissions are complicated and the process is cost-intensive and long-lasting. The BVKW argues for unified regulations.[557] The land use planning and the concentration fields that were done to ease and control the expansion of the large turbines are contra productive for the small wind turbines. FEST states that the basic assumption of these regulations in the German law is that wind energy has to be controlled by the communities because it is a dominant piece of land. This is in contradiction to the usage of the small wind approach that installations should be close to the houses. This leads to a hindering of any kind of decentralized wind energy providing and in fact, a juristically not acceptable planning avoidance.[558] Additionally, administrative requirements on the level of the federal states and the communities have to be considered.[559]

The possible argument for a denial of the building permission for small wind turbines with the argument that small wind turbines are not working economically is juristically not possible and is construed as a sign of the young sector.[560] The minimum of 60% of the turbine`s yield has to be used for the own consumption to get an approval as a privileged facility.[561]

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[556] See JÜTTERMANN (2013) pp. 138ff.

[557] BVKW (2014) www.bundesverband-kleinwindanlagen.de; OTTER/PEHNT (2009) p. 4

[558] FEST (2013) p. 165

[559] See RICHTER (2010) pp. 11ff.

[560] See LEGLER (2014) www.klein-windkraftanlagen.com

[561] See LANDWEHR (2011) p. 18

The feed-in tariff is the same as for the large wind turbines. In other countries the feed-in tariff is split for smaller versions to influence the market positively.[562] ALTMAIER is talking about an Energy Internet with multiple decentralized operators also in individual households. Small wind is not included in this idea.[563] Decentralized more accepted applications are the photovoltaics and the decentralized combined heat and power stations.[564] Political and financial support for small wind turbines is partly available in the scheme of the export initiatives.[565]

Level of Organization

The small wind technology is mainly represented by small- and middle-sized companies that are mainly resellers. The BVKW was founded to grasp ground and to gain more political influence in 2009.[566] Referred to the co-founder KROEGER, it was necessary to found an extra association because the BWE was not interested to integrate and represent the small wind turbines.[567]

In July 2011 the BVKW had about 106 members. The numbers are non-reliable due to the lack of data administration. The BVKW is suffering from money and people (only one person was employed partly). At the end of 2012, the BVKW started a new positioning with a new management. The restructuring process is obvious through a new location and better public relations. Regional groups have been founded to establish the small wind approach in Germany. The main represented version is the horizontal-axis wind turbine.[568] JÜTTERMANN calls it the normal turbine.[569] Currently, the BWE offers seminars, publications and an annually market overview.

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[562] See FRANKEN/TRECHOW 2013) p. 63

[563] See ALTMAIER (2013b) pp. 23f.

[564] See EISELT (2012) p. 114

[565] See OTTER/PEHNT (2009) p. 9

[566] See ibid.(2009) pp. 4ff.

[567] KROEGER (2010) telephone conference

[568] See BVKW (2014) www.bundesverband-kleinwindanlagen.de

[569] JÜTTERMANN (2013) p.15

5.1.3 Changing Models in the German Wind Energy Field

The field started with motivated people who were motivated to find alternative solutions for the energy supply. Their start was small. The orientation was decentralization of energy supply and autonomy. The perspective of a nuclear-based system was no option. This model was in contradiction to the traditional model of the energy supply system and the political strategy. The author assesses a general model clash. Figure 29 illustrates the two different models.

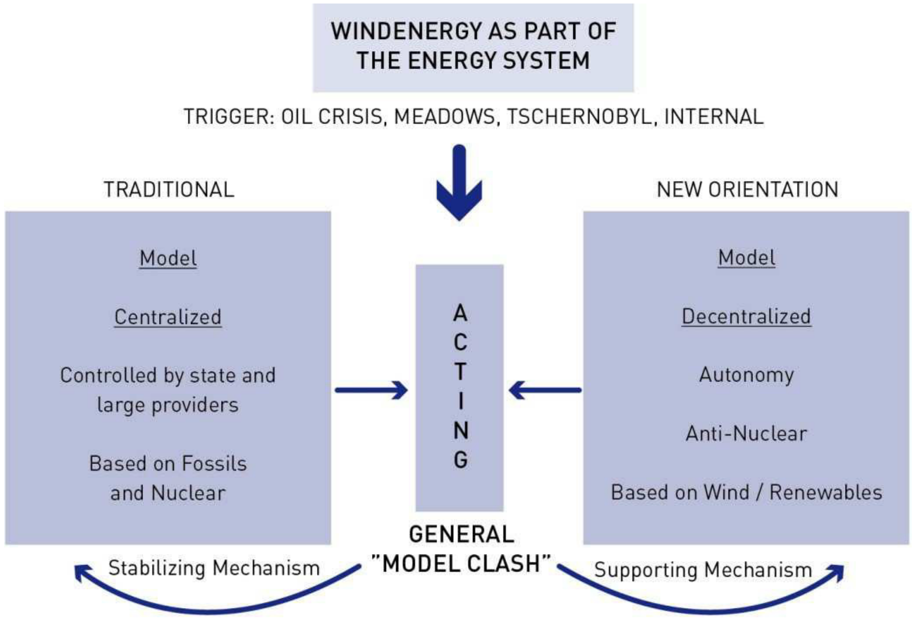

Figure 29 General model clash in difference of orientation[570]

The small, purely decentralized model was adjusted step by step. The orientation changed to larger applications due to the technical development of the dominant design. The direction of moving is exclusively towards the orientation of ´being big`. This includes the size of the turbines, the size of projects onshore and especially offshore. The wind parks guided by citizens can be seen as a part of the decentralized model. The path of increasing the size is backed up by the political level.

The representatives of the traditional system partly adopted the wind energy. A process of creeping adjustment of the decentralized model is illustrated by the movement arrow. The results based on this acting are increasing acceptance and gaining

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570 See BÖCKER-KAMRADT (2001) pp. 66ff., DESIGN ALIGNED

more influence. The wind energy became an important industry based on the technical design that is the ´normal turbine`.

The upcoming regulations are related to this design. The further development of small or middle-sized versions or the vertical-axis wind turbines were not of interest. The model clash between the traditional system and the wind energy became relative. The models do have important differences but the fundamental orientation towards centralization is given. The dominant design and the related processes became main stream. Figure 30 illustrates the ongoing process in the next decades.

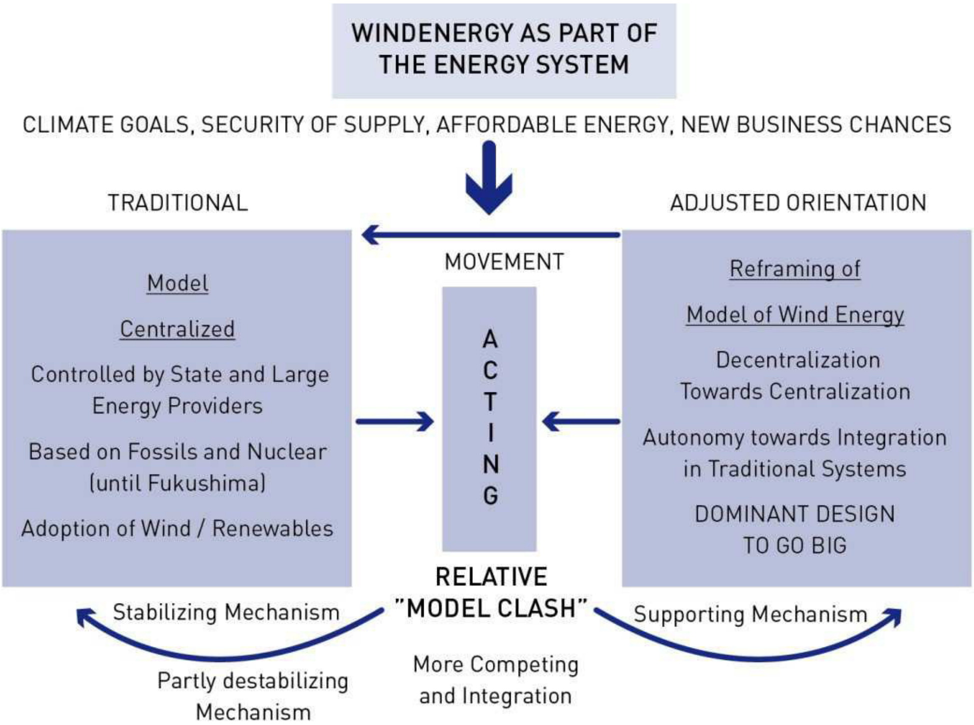

Figure 30 Relative model clash in adjustment of orientation[571]

The next figure 31 illustrates the step into the field of the small wind approach that happened when the big wind industry has reached a level of high adoption. The orientation of each turbine is still to be larger in size and in concentration of fields. Limitations are given externally due to the increasing international competition and problems with the related technical systems such as net integration and storage.

The dominant design is applied in other environments (offshore) with very high risks and costs. This part is mainly in the hands of the traditional system and the government.

[571] See ibid. (2001) pp. 66ff., DESIGN ALIGNED

The further expansion of size of each turbine offers new market chances (low wind and woods). The efficiency of the increasing size starts to be questioned by some experts. Signs for a limit of growth can be recognized.

The orientation of decentralization is coming up again. The dimensions of the model clash have shifted from wind energy against the traditional system to big wind against small wind integrated in the traditional system. The difference in the model is related to the general orientation such as centralization versus decentralization and additionally, on the process level - high advanced in technology versus newcomer. The technology of the vertical-axis wind turbines gets some attention but is in the minority.

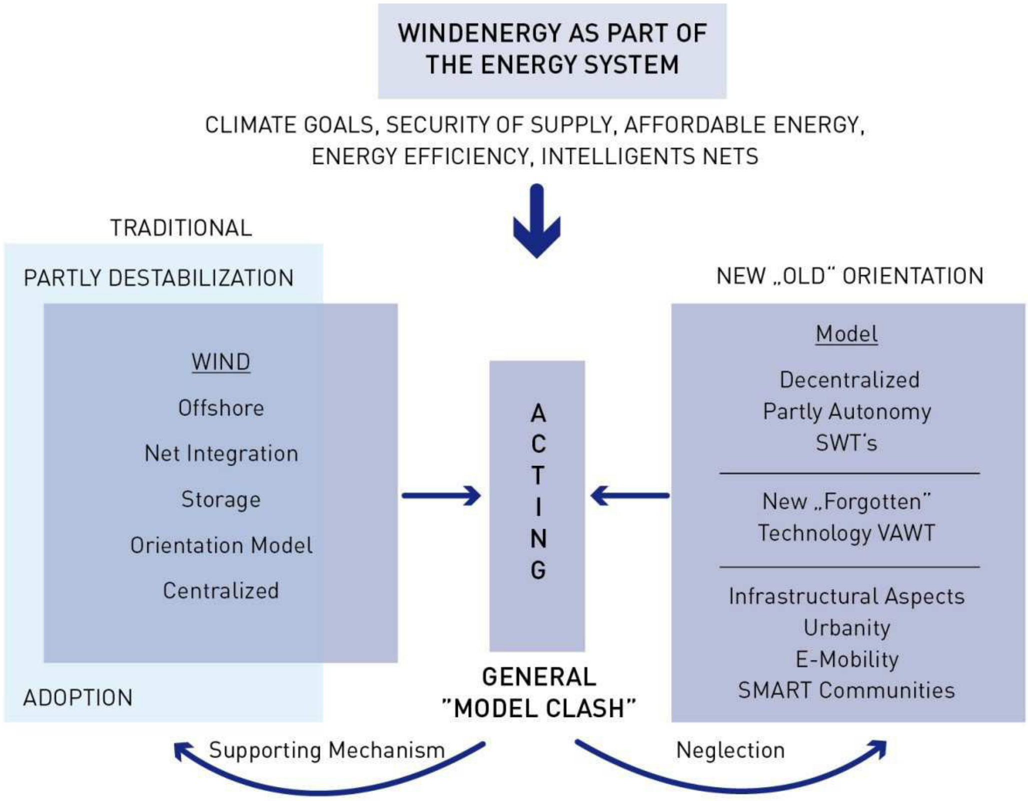

Figure 31 General model clash between big wind industry and small wind sector

The technical related systems (inverter, generator) have not yet been fine-tuned for applications in turbulent winds and are still under R&D. This aggravates the acceptance and therefore the market entry. The interested customer is lost in a field of numerous but not reliable products, other products are not yet available.

The chance to use the decentralized wind sources for applications that ease the energy transformation is not discussed politically although decentralization is an often mentioned term. Infrastructural aspects and SMART communities are mentioned. These applications are mainly connected to photovoltaics and combined heat and power. The German independent electricity provider "Lichtblick" has developed a swarm conductor to control decentralized energy production. They are interested to combine the applications with small wind turbines.[572]

5.2 Results of observations - Face-to-Face Level

5.2.1 Observation of the Newspaper

Main topics of actual discussions and the process of the energy transition are observed in the newspaper. They are related to the face-to-face level in the Team Learning Model and the Case Learning Meta Model. The discussions are short-term temporary results. Main topics are the speed of the energy transition, the increasing price of electricity, the threat of unemployment, the threat of black-outs and the threat of increasing CO_2 emissions. One year after Fukushima, chancellor MERKEL complained about the missing concepts of the federal states.[573] Others complain about the low speed and the missing decisions and concepts.[574] ALTMAIER announces the costs of 1 trillion euro for the energy transition until 2030 and claims for cost-saving solutions.[575]

The issues are related to different conflict levels:

- Level of conflict: German government versus citizens. Increase of prices for electricity due to the EEA in the EEG in the last years from 0,2 cent in the year 2000 up to 6,3 cent per kilowatt in 2014. A minimization of the social disparity is requested.[576]

  Initiatives of citizens slow down the energy transformation process. They demonstrate against the plans if they are affected locally, e.g. the stop of the

[572] BARGEL (2014) conversation; See LICHTBLICK (2014) www.lichtblick.de

[573] See DERWESTEN (2012b) www.derwesten.de

[574] See ibid. (2012) www.derwesten.de; See ibid. (2012a) www.derwesten.de

[575] See WAZ (2013) www.waz.de

[576] See MARSCHALL (2013) p. B1; See MARCHALL/QUADBECK (2014) p. A1; See HÖNING ET AL. (2014) p. B1

hydro-power station at the Rurtalsperre[577] and the lawsuit against the transmission lines and the central node in Meerbusch.[578]

- Level of conflict: German government and the European Union. As mentioned before, the extra saving for the energy-intensive companies is questioned. 900.000 jobs are at stake and a high payback of the companies is possible. The conflict also includes the level of the national independence of the energy politics.[579] The new European guidelines for subsidies that will be implemented in the summer 2014 question the secured feed-in tariffs and therefore the EEG in general. It is planned to introduce a bonus on top of the exchange price of electricity for mature technologies.[580]

- Level of conflict: climate strategy versus security of supply. Due to the merit order effect, the traditional energy providers and municipal utilities are threatened. Governmental subsidies for non-profitable power stations are requested to ensure the security of supply and to avoid black-outs.[581] Additionally, approximately 30.000 employees are pronounced to get released.

- Level of conflict: climate goals and economy. The percentage of burning coal is increasing due to the actual low price of the CO_2 certificates, the European Union and the German government plan a reduction of the certificates, the back-loading.[582]

- Level of conflict: Federal state versus national state. Different stages in the expansion of the renewables in the federal states (wind[583] and photovoltaics) lead to a disparity of the burden in the different federal states.

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[577] See WAZ (2013a) www.waz.de

[578] See HANNEMANN (2013) p. C1; See RÖSE (2013) p. A1

[579] See MARSCHALL ET AL. (2014) p. A1

[580] INGENRIETH (2013a) p. B1

[581] See INGENRIETH (2013) p. B3; See HÖNING/REISENER (2013) p. A1; See MARSCHALL (2013) p. B1; 28 applications for laying-in of power stations were placed till October 2013, if they are determined as a relevant system to ensure the security of supply their costs will be compensated, see REISENER/RÖSE (2013) p. B1

[582] See HÖNING ET AL. (2014) p. B1

[583] See APPENDIX NO. 10.8

> Different interests have to be fulfilled. North Rhine-Westphalia pays for Bavaria, Schleswig-Holstein and Brandenburg whereas those federal states have an increasing income. On the other hand, Schleswig-Holstein refuses the plans of subsidies for the struggling coal power stations.[584]

The doubts about the actual strategy[585] of the energy transition become obvious. New adjustments are requested.[586] Obvious results are the proposals for the new regulations announced by the new Ministry of Economics and Energy that was founded after the election (2013). The ambition is to set the conditions for a non-subsidized green energy that is governed by the market in the long-term. New feed-in tariffs are intended to start for all new requests in 2014.[587]

In the actual press the problems and consequences of the political supporting mechanism for the renewable energies are in the foreground of awareness. High electricity prices for the customers and the herewith connected complaints about the social disparity are main topics. Due to the merit order effect, the threat of a shut-down of fossil-based power stations and the risk of unemployment as well as the risk of black-outs are announced partially. The solutions discussed on the governmental levels such as reduction of the onshore feed-in tariff and the minimization of the expanding capacity onshore focus on a strengthening of the offshore sector.

5.2.2 Observation of Discussions

The described topics in the newspaper are also the ones that are of interest for moderated discussions in the television. The topics are e.g. "Electricity without nuclear, cheap promises, expensive receipt (Strom ohne Atom, billige Versprechen, teure

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[584] See HÖNING/MICHELS (2014) p. B1

[585] The Industrial Trade Union of Coal Mining, Chemistry and Energy and the Industrial Trade Union of Metalworking set up an alliance with the German Association of Industry to strain the government to formulate a master plan to minimize the burden of the EEG by introduction of an energy tax, they also claimed for a new ministry of energy to stop the competing interests of the BMU and the BMWi, see PLÜCK (2013) p. B1,

[586] See KOWALEWSKY/VOOGT (2013) p. B1; See HÖNING/KOWALEWSKY (2013) p. B1

[587] See HÖNING/MARSCHALL (2014) p. A2

Quittung) [588] or "Status of the energy transition" (Stand der Energiewende)[589] or "Energy transition" (Energiewende).[590] Prices, employment, delays of the transmission lines, centralization versus decentralization (always related to large wind turbines) are discussed with competing arguments depending on positions, parties or other interest groups. The topic of decentralization considering small wind turbines was not mentioned within the discussions. Attention will be paid to the analysis of the communication structures in the discussions analogous to ´Reading the Room` according to KANTOR[591] as illustrated in the following figure.

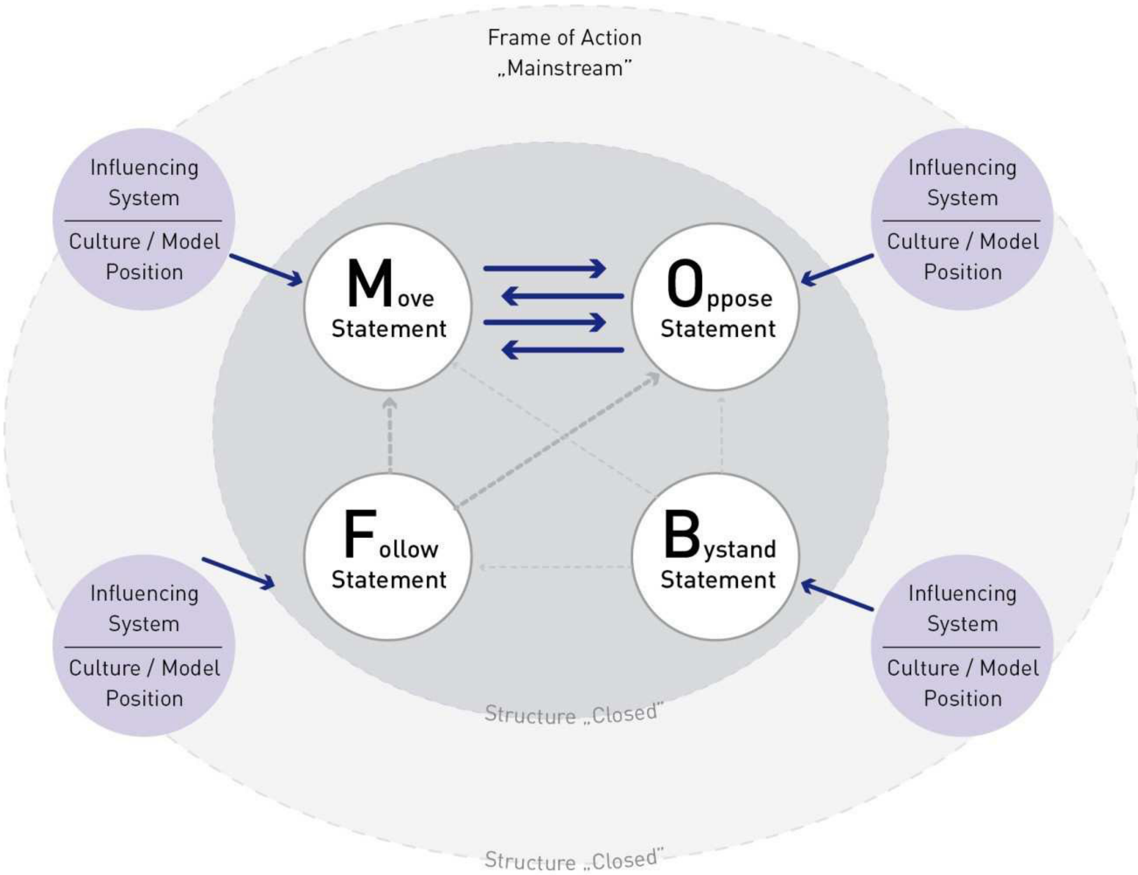

Figure 32 Point-counterpoint speech act in the discussions, related to KANTOR 1996/2012[592]

588 ILLNER (2012) ZDF

589 Ibid. (2012a) ZDF

590 WISSEN AKTUELL (2012) 3 SAT

591 See chapter 3.1.4

592 KANTOR (1996) seminar script, (2012) p. 39

The speech acts are characterized by polarization of the different positions. The aim is to present and bring through the own position that is most probably also a representation of an interest group.

On the action level we observe mainly the position of move and oppose which is referred to KANTOR, the behaviour archetype of point-counterpoint. The position of the Follower is denoted because it is not as much as dominant as the move-oppose positions. The moderator role represents a formal Bystander. The communication domain of Meaning is the most obvious one. The speech act has recurring redundancies. This is defined as a closed structure by the author. Additionally, the participants are representatives of a system and the author hypothesizes that the behaviour and the argumentation is aligned to the strategy of the organization or party that the participant is representing.

The flow of the observed sessions reminds of the flow of political discussions or debates in general. The author assumes that this flow of communication is common in political working groups as well. Furthermore, it is evaluated as data that no topics were discussed or mentioned about small wind approaches which leads to the hypothesis by the author that the mainstream mental model indicates the ´frame of action`.

5.3 Evaluation of the Interviews - Deeper Individual Structures

The interviews were executed on different levels and started with the pre-interviews in 2011. The main interviews took place during the time of summer 2012 until spring of 2013. The author arranged 29 settings with 32 interviewees[593], two of them were done by telephone. Three interviews were executed with two persons at the same time. The two persons who did the pre-interviews were interviewed twice. The duration of the interviews was between 90-120 minutes. The author monitored and transcribed data of 21 interviews whereas the evaluation and the results are based on the content of all 32 interviews. The author took notes during every setting. Personal data of the interviewees within the transcribed interviews are deleted for the sake of anonymity. The transcribed

[593] See APPENDIX NO. 10.10

interviews are attached.[594] Personal notes were not transcribed upon explicit request of the interviewees.

5.3.1 Definition of Groups of Interviewees

The goal is to get an insight in the field from different angles that are related to the wind energy field. The interviewees are divided into seven groups. The percentage of representatives of each group is shown in figure 33. The seven groups are:

- Large wind turbine experts (LWT experts) consisting of experts grown up with the field of wind energy, engineers and other experts. One representative of the GWEC was a strongly influencing person who built up the industry from the beginning on. Due to their professional background, the representatives have insight in various companies and the whole field, national and international. They are still in the wind energy sector in high expert positions.

- Scientists consisting of electrical specialists, specialists of energy technology, one physician and one fluid scientists plus a scientist who is originally from the United States. They are working either on university level or in their own institutes.

- Customers consisting of customers from the beginning of the field and owners of the first wind turbines in the late 80ies and large wind turbines in the 90ies.

- Project developers consisting of specialists for project development of large wind turbines and wind parks. Project developers are specialized in the coordination of initiating, planning, organization of financing and implementation of large wind turbine (windpark) projects. One representative of the finance/assurance sector was included in this group.

[594] See DVD APPENDIX NO. 1

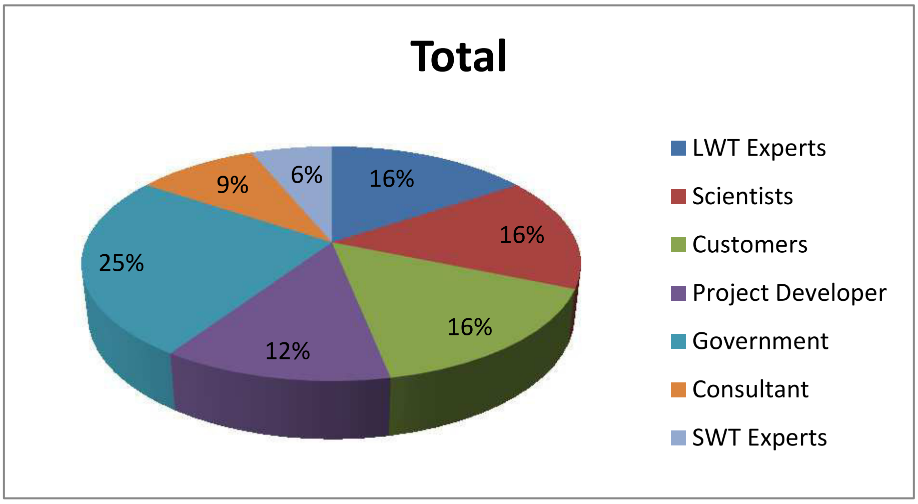

Figure 33 Background of representatives in percentage

- Governmental institutions consisting of representatives of the community level, the regional level of North-Rhine Westphalia and of the national level. It contains representatives of ministries such as the Ministry of Environmental Protection, the Agrarian Chamber of North Rhine-Westphalia and an expert of sustainability (community) as well as the Ministry of Economics (Germany). Ministers of the Green Party represent the federal level (North-Rhine Westphalia) and the national level.

- Consultants consisting of one consultant who is specialized in providing applications for the funding institutions focusing on renewable projects on a German level and other consultants who are closely related to the development of the whole wind energy field since the end of the 90ies and have insight in different companies and work closely together with federal ministries.

- Small wind turbine experts (SWT Experts) consisting of representatives that are exclusively active in the small wind turbine business field in contradiction to the other representatives.

Besides the different professional background of the representatives of the interviewee group, the author divided the interviewees in direct and indirect actors as described earlier. Some representatives are put in the group of direct actors although their professional background assumes being an indirect actor. This was done because of their long-term close relationship to the wind energy field or based on their main activities. As it is seen in the table below this was executed by the author with two of the consultants, one governmental representative and four of the scientists. The following table shows the amount of interviews and groups of representatives divided in direct and indirect actors. It is a majority of direct actors. Due to the topic of the research this is suitable. The main group is originally from North Rhine-Westphalia.

Table 4 Representatives of different fields divided in direct and indirect actors

Representatives	Total	Direct	Indirect
LWT Experts	5	5	0
Scientists	5	4	1
Customers	5	5	0
Project Developer	4	2	2
Government	8	1	7
Consultant	3	2	1
SWT Experts	2	2	0
Total	32	21	11

Additionally, the author defines the group of the pioneers with an amount of 18 of all 32 interviewees. Related to KANTOR and SCHEIN, these persons are of special importance for the development of the mental models. As already said, the author got access to the pioneer network that is represented by people who were in the development of the field from the beginning on. This period lasts until the end of the 90ies and covers the beginning (early pioneers) with small wind turbines (end of 80ies) and the first years of the large wind turbine industry. 14 persons of the whole group mentioned that they are members of the Green Party and 20 of the whole group indicated that they are associated to the anti-nuclear movement. This result mirrors the common origin that will be described later.

The following figure gives an overview about the final composition of the different groups of representatives covering the direct and indirect actors, pioneers, members of the Green Party and associates of the anti-nuclear movement. The graph shows that the total amount of 18 pioneers, 14 green members and 20 associates to the anti-nuclear movement are over-lapping towards the groups of representatives whereas the large wind turbine experts, customers and the governmental group show the strongest alliance. The ´Total` indicates the total of each group of representatives.

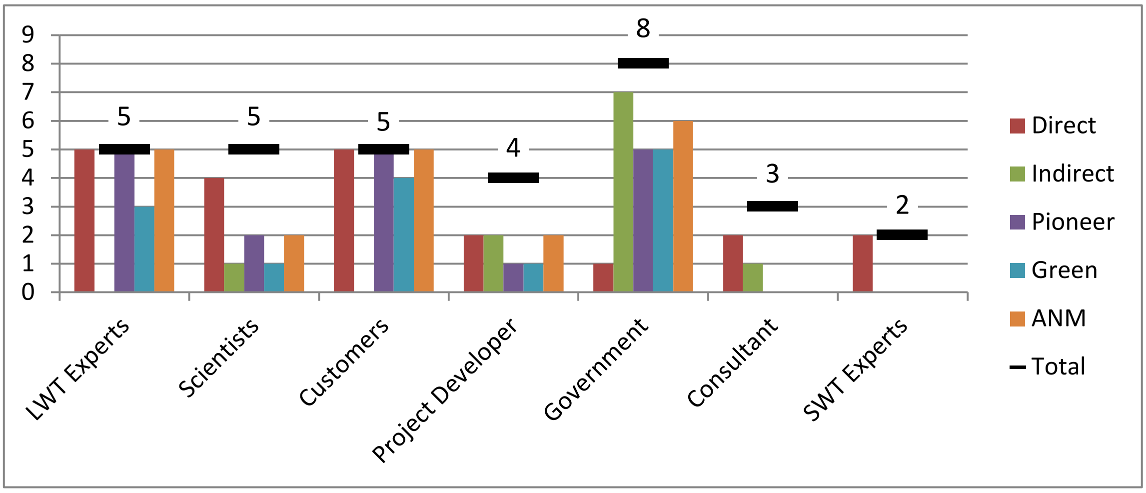

Figure 34 Overview about composition of groups related to direct and indirect actors, pioneers, members of the Green Party and associates to the anti-nuclear movement (ANM)

Furthermore, the author defines the collection of interviewees as belonging to the different groups. Eleven interviewees belong to four groups. Nine of them are direct actors, pioneers, members of the Green Party and they are related to the anti-nuclear movement. This is the largest group of the whole group. Two of the eleven persons are indirect actors with the same affiliation. Five persons have the same affiliation but they are not a member of the Green Party. The group of the indirect actors, being green and anti-nuclear, consists of five interviewees including two persons that are also pioneers. Three persons are affiliated to two categories and ten persons have one affiliation being either indirect actors (5) or direct actors (5).

Table 5 Overview of affiliations of the interviewees

Number	Group	Direct Actors	Pioneer	GreenParty	ANM	Indirect Actors
1	Customer	x	x	x	x	
2	Customer	x	x	x	x	
3	Customer	x	x	x	x	
4	Customer	x	x		x	
5	Customer	x	x	x	x	
6	LWT Expert	x	x	x	x	
7	LWT Expert	x	x	x	x	
8	LWT Expert	x	x	x	x	
9	LWT Expert	x	x		x	
10	LWT Expert	x	x		x	
11	Project Developer					x
12	Project Developer				x	x
13	Project Developer	x	x	x	x	
14	Project Developer	x				
15	Government	x	x		x	
16	Government			x	x	x
17	Government			x	x	x
18	Government			x	x	x
19	Government		x	x	x	x
20	Government		x	x	x	x
21	Government					x
22	Government					x
23	Consultant	x	x			
24	Consultant	x	x			
25	Consultant					x
26	Scientist					x
27	Scientist	x				
28	Scientist	x	x		x	
29	Scientist	x	x	x	x	
30	Scientist	x				
31	SWT Expert	x				
32	SWT Expert	x				

Four features	Three features	Two features	One feature

This specific composition of the group is a result of both, intention from the beginning on and the ongoing exploration process. It was achieved to gain a mixture of interviewees who are having a high relevance for the topic of the mental models. This composition of the group allows a first description of the social reconstruction of the historical situation that reflects the mental models and the further development of the field.

5.3.2 Procedure of Content Analysis

Due to the fact that the analysis is based on a qualitative approach and open conversations, it is of importance to relate to the individual descriptions as data. Personal data provided by the interviewees are not questioned nor need to be approved. The personal experience, feelings and insights are the value of this kind of research. This part corresponds to the least visible part of the KANTOR model that are the mental models and the identity forming stories. They are based on the experience of the actors and their personal conclusions. These personal data are the basis to explore and define the fourth dimension of the Theory of Thing that is the non-visible part of the current state of the wind energy field. The data need to be taken as presented for further elaboration. Further questioning is useful in order to get a deeper understanding of what the interviewees are saying. In this term, the interviewees are the experts of the situation as described earlier and the goal is to explore what they are thinking.

The analysis of content was made in different steps and is related to the codification:

1. Marking of parts that are of most importance for the topic[595]
2. Extracting of the marked passages of each interview[596]
3. Summarizing of most important sayings of all interviews
4. Elaborating the similarities that are the main sayings[597]
5. Elaborating additional important sayings related to the topic
6. Forming main groups
7. Forming clusters based on the main sayings within the groups
8. Naming the clusters related to the main content that is the summary of the sayings of the interviewees that gave information to this special part
9. Defining typical codes that summarize the explanations
10. Defining sub-clusters if requested
11. Defining critical sentences if possible

[595] See DVD APPENDIX NO. 2, transcribed interviews

[596] See DVD APPENDIX NO. 3, transcribed interviews

[597] See DVD APPENDIX NO.4

12. Adding a quotation for the distinctness of the sayings or as a summary of the description of the situation if suitable.

Due to the fact that the content of the data is related to representatives with their special assessment of the situation, the data presented by a small number of interviewees or even a single person may also include main aspects for the survey. Those findings are summarized in sub-clusters within the main clusters to visualize that this is a special meaning of a few persons. They are as well the basis of the further interpretation. The thinking and interpretations of those people that have a deep insight in the field based on their position are of importance for the research topic. Quotations are used to specify the sayings and, if suitable, as a summary of the situation. They are highly informative for the elaboration of the mental models due to their representation of the thinking of the actors.

Thus, the evaluation is based on similarities of main topics and on special content independent from the number of sayings. The author would like to emphasize that the data provided are assessed as a mirror of the thinking of the actors and their analysis of the wind energy at this moment of time. The social reconstruction of the path of the wind energy business field is based on the special experience of the actors as well as their actual insight.

Based on the analysis of the content, the author formed two main groups. The first group is the big wind industry. The second group is concentrated on the small wind sector. The main contents are summarized to clusters with a special headline. The statements of direct actors and indirect actors are put together. The codes represent the main contents of the clusters. It also contains the definition of sub-clusters within a main cluster to specify some sayings of importance that are not mentioned by all members of the main cluster. The amount of persons who were giving information about this special topic is indicated. In some of the clusters the author adds the critical sentences. Critical sentences are partly expressed as such and are either sentences the actors were facing or they are expressed generalized and therefore, those sentences have an important meaning for the elaboration of the mental models.[598]

[598] See JOHNSON-LAIRD (2005) p. 179

5.3.3 Contents and Clusters of the Big Wind Industry

Within this first group of the big wind industry, the author defines eight clusters that represent the main content. In the next table the amount of representatives for the clusters is indicated and the typical codes are defined for each cluster. Additionally, the author describes the sub-clusters.

Table 6 Clusters and sub-clusters as well as typical codes for the first group[599]

Cluster	Definition of Cluster	Amount	Typical Codes
1	**Origin of the wind industry**	**19**	**Anti-nuclear movement, green decentralized energy concepts**
2	**Growian**	**12**	**It was intended to fail**
2.1	New start of small	5	The beginning of the new upscaling
3	**Identity forming stories**	**18**	**Critical sentences, no acceptance, attacks**
4	**Network structure**	**11**	**Pressure from outside, one family**
4.1	Husum	8	Meeting point and identity, visible changes
4.1	Concept of enemy	5	Against the "big 4"
4.3	Lack of communication	4	Less talking about problems
5	**Trend of "getting large"**	**27**	**Large is economical, centralization**
5.1	Limitations	4	Lack of solutions
5.2	Visible symbol	4	Symbol of Green Politics
6	**Professionalism**	**8**	**High level**
6.1	Status of puberty	2	Professionalism is in the status of puberty
7	**Political aspects**	**29**	**EEG, Green Party**
8	**Technical related aspects**	**10**	**Storage, net expansion**

The following figure illustrates the percentage of data related to the representatives that formed the clusters.

[599] The number of representatives in the sub-clusters is part of the full amount of representatives within the main cluster, e.g. the sub-cluster 2.1 consists of 5 sayings of the main cluster 2 being 12 interviewees.

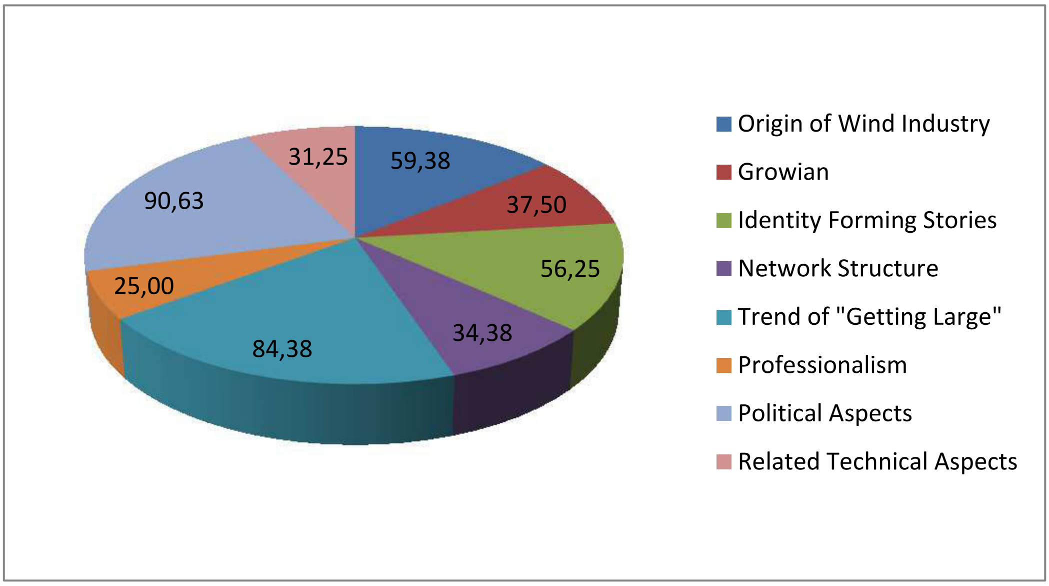

Figure 35 Percentage of data provided for this topic related to the whole group

Cluster 1: Origin of the wind industry

Codes: Anti-nuclear movement, green decentralized concepts

The anti-nuclear movement is described as the origin of the wind energy field. The motivation was to find alternatives to replace the nuclear energy and to produce own energy. This went along with the decentralization and democratization of the energy sector and the wealth of the society. The decentralization included the autonomy and the independency of the established energy sector. Chernobyl was a trigger.

The interviewees show a close relation to the Green Party that was founded 1980. The alternative green decentralized concept that describes the approach is the Total Energy Module (TOTEM) concept. It contained a house, a combined heat and power as well as wind units up to 100kilowatts. Small units based on wind energy were the idea of the actors to replace the central nuclear and fossil based energy system. This was aligned to the Green-Grass-Root-Revolution (Grüne Graswurzelrevolution).

Cluster 2: The Growian

Code: It was intended to fail

The Growian project[600] was mentioned specifically without asking for it. It is assessed that it was intended to fail to show that wind energy is no alternative energy option in a large scale. One quotation as an example is: "*it lay damaged in the landscape to show wind energy in large dimensions is not possible*".

Sub-cluster: New start of small

Code: The beginning of the new up-scaling

The failing of the Growian is also described as the beginning of the new start of the wind energy with small turbines and therefore, as the start of the trend of the new up-scaling of the wind turbines.

Cluster 3: Identity-forming stories

Codes: Non-acceptance, irony, attacks

Critical Sentences: It does not work, it is too small

The first small units based on a cross-border thinking (Netherlands/Denmark) were installed grid-connected. Laughing and irony are the described reactions the actors were facing from the established side at the beginning.

The cooperation with the traditional energy providers was also described as being very difficult from the beginning on. The necessity of grid-connection was taken as a possibility to hinder the wind energy. The costs were pushed and used as weapon (up to 300.000 German Mark for a 50kilowatts turbine). The interested customer had to threaten with television and press. The boycott carried on over a long period of time. The procedures were slowed down.

Many additional people were interested to install wind turbines, however it is told that they did not get an approval and as a consequence they gave up their intention to build their own turbine. For those who sustained the pressure, the support of the first wind association was of crucial importance. The following quotation describes the situation distinctly: "*At the beginning the energy system was based on coal and nuclear*

[600] The first and only large turbine project with a capacity of 3megawatts capacity was installed in 1983 and deinstalled in 1987 because this project was assessed to have failed

in the hands of monopolies that have the electricity and the power about the processes how to produce. Nuclear was modern and cheap and only questioned by the alternative eco-freaks“. The comments from the established side about first concepts is described in the sentences: “*when you will stop nuclear and coal - you need big concepts and large technical systems and not small garden politics*“ or “*it is 10.000 times too small and does not work and will never work*“.

The high professional electrical energy supply system did not provide a market for decentralized grid-independent versions. Despite the green romantic (in the 90ies), the companies gained ground and went internationally and brought back their success. The actors are saying that the monopoly of the traditional energy providers felt disturbed due to the more serious competition at this stage and the negative reactions carried on. The resistance of the energy providers changed to active organized disturbances which seemed to be systemized and to include associations of environment protection.

Cluster 4: Network structure

Codes: Idealism, pressure from outside, one family

Critical Sentences: We stand together against the outside

The driving force of the community was the similar thinking and the high idealism. The network committed against nuclear and consisted of people with different professional backgrounds and knowledge. The network is also called the *wind family*. The consortium worked concentrated in the same direction like an arrow against the nuclear and reached a proof of concept locally.

The working style in the 90ies is described as being creative with highest motivation. A full workload was combined with low salaries. It is named a Robin Hood mentality that is good for the people and the society. The pressure from outside welded the community together. Quotations to illustrate the atmosphere within the network are: “*We knew that we were always standing on the right side*“ or “*it was all one scene and we met on events. It was a family including scientific contacts, e.g. the IFEU*[601] *institute*“.

[601] Institut für Energie und Umweltforschung Heidelberg GmbH

Due to the assured feed-in tariff, the interest of earning money started to be in the focus of interest of all involved parties in the ongoing process. Additionally, the soaring growth and the increasing competition partly lead to a change in the network. Nevertheless, the feeling of being part of the *wind family* is still actual.

Sub-cluster 4.1: Husum

Code: Meeting point and identity, visible changes

The exhibition in HUSUM is the main event of the community and the visualization of the huge development in this industry. It started in cattle stables and developed to an event with more than 2000 exhibitors worldwide. The style of the people of the first years is described as "*eco style*". The HUSUM exhibition is still assessed as the main event of the community and its origin.

Sub-cluster 4.2: Concept of the enemy

Code: Against "the big 4"

The concept of the enemy against the big energy providers was of importance to stand together. It is assessed that it lasts until today. A representative who is very often talking with the new generation of representatives of the large energy providers on exhibitions says that they feel still treated like "*enemies*" although they were grown up with the renewables. The fact that the "*big 4*" energy providers took over parts of the wind energy is seen with mixed feelings.

Sub-cluster 4.3: Lack of communication

Code: Less talk about problems

Nowadays a cross-company conversation is missing to solve common technical problems. This is mentioned as a risk of minimization of the quality in the long-term and may weaken the position of the wind energy in general. A missing communication within projects is described as one reason that additional problems in the execution of the projects are caused and main problems are not solved.

Cluster 5: Concentration on large horizontal-axis wind turbines

Code: Large is economical, trend of centralization

Critical Sentences: Large is economical

The basis of success is being large to be economical

The best engineers brought the technical issues further. The up-scaling is not questioned and assessed as being the step in the right direction. The design of the first larger horizontal three-bladed turbines (500-800kilowatts capacity) answered the need of the market and increased the output. Other technical versions like the vertical-axis wind turbines were not mentioned anymore.

The idea of small was cut. To be large was construed as being economical. Being more competitive and economical was the driving force for increasing the size further. It is said that the size of the turbines defines the efficiency that means the higher and larger the turbines are, the more economical is the technology. The scarce good ´space` is also mentioned as one main reason. The technical developments of bigger turbines lead to bigger projects and the first citizen-guided wind parks that replaced the stand-alone versions. One quotation illustrates the drive to work economically: "*The basis of success was always to work economical*."

The trend of centralization is seen onshore and offshore. Onshore wind parks are international investment projects nowadays. The following quotation describes this: "*Today, the big wind parks are turn-key projects. After finalization they are sold to international investors with the highest bids, the citizens are left out*". Offshore is described as still being in children`s shoes. It is seen separated and partly questioned because of the high costs. One quotation is: "*when it was not possible to stop the wind onshore, the renewables were made more expensive by the offshore wind*".

The Green Party changed the orientation to centralization as well. The reason is seen in the necessity to bring a real alternative. One quotation is suitable to demonstrate this: "*Big was more imposant and it was necessary to show something relevant that is more economical. You need to bring something in megawatts to provide a real alternative*".

Sub-cluster 5.1: Limitation of being large

Code: Lack of solutions and identity

Due to the fact that wind is a natural source for free, the exclusive orientation of being large to be economical is assessed to be a limitation for the wind energy as well. The lack of space is a big issue. The solutions that could be provided by the wind energy are minimized and chances and necessities for a system optimization of the energy system cannot be fully provided.

The following quotation is presented to illustrate this: "*the wind people entered the market to save the world. And then they did one mistake - they brought all down to money. Large is imposing and impressive but basically the efficiency is not of importance. Wind is a natural source and it brings solutions".* The focus on large applications leads to a lack of other applications. This is described as a missing part of the identity of the wind industry that needs to include all sizes. It is said: "*it is quite obvious that the big wind industry lost an important part in their way of success which is the smaller brother*".

Sub-cluster 5.2: Symbol of the Green Party

Code: Large as a visible symbol

The large wind turbines are described as visible symbols for the energy transition and the Green Party similar to the sunflower. A quotation herewith: "*Nobody could have believed that turbines of such big dimensions are possible, they are the visible proof of the energy transition and green politics*".

Cluster 6: Professionalism

Code: Professionalism against pioneer status

Being professional is pointed out very specifically. The figure of the lonesome entrepreneur was described by the later pioneers as ´Daniel Düsentrieb` type who is very innovative but chaotic. This image was started to be replaced by the trend of professionalism that is described as major step to compete in the field of energy and to be more economical. The trend of professionalism was related to the growing concentration of the companies.

Sub-cluster 6.1: Status of puberty

Code: Professionalism is in the status of puberty

The high level of standardization and professionalism is questioned by others. They are saying that the industry is running behind the processes of their own development because the development of getting large has run fast. They describe the status of industrial professionalism as still being in the "*puberty*".

Cluster 7: Political aspects

Code: EEG, Green Party, secured investments

The governmental influence is mentioned as the main important factor for reaching the growth. The laws provided the frame for the needed security of the investors. The Green Party gained more influence and acceptance. The Green Party is seen as the representative of the common ideas in the government. The first supporting regulations have been brought through in the government that provided a secure investment climate for the wind energy. The EEG is described as the most supporting influence for reaching the growth of the wind industry.

Cluster 8: Technical related aspects

Code: It was well known that storage is needed

The storage is described as a well-known relevant topic of the renewables from the start on. It was discussed at the universities and within the network already in the 80ies. It was always clear that suitable storage capabilities have to be developed but there was no funding for this. For the wind people it was an overload also to care for the storage. Some assumed that the missing storage was the last joker in the hands of the traditional system against the renewables. The expansion of the transmission lines is assessed being necessary but the dimensions are partly questioned.

5.3.4 Contents and Clusters of the Small Wind Industry

The data related to the small wind turbines provide insights of the actors about the current situation of this special field within the wind energy and especially reactions of the actors of the big wind industry to the new decentralized approach. The following table gives an overview about the main clusters and the sub-clusters, the number of representatives on which the clusters are based and the typical codes.

Table 7 Clusters and sub-clusters and typical codes for the small wind sector

Cluster	Definition of Cluster	Amount	Typical Codes
1	**Reaction of big wind industry**	**11**	**Reminder of the past, pioneer status**
2	**Mainstream stances**	**18**	**Small wind is not politically recognized**
2.1	Depending on scientists	3	No different actions without scientific back-up
2.2	Conflict of ministries	3	Competing interests of ministries
2.3	Less R&D for small wind turbines	4	Small wind is excluded
3	**Association**	**9**	**Lack of lobby**
4	**Marketability**	**14**	**No reliability, no quality**
5	**Resentments**	**8**	**Large versus small, small versus large**
5.1	Conflict of associations	4	BWE against BVKW
6	**Opportunities**	**14**	**Value of decentralization**

The following figure gives an overview about the percentage of the given data in relation to the whole group of interviewees.

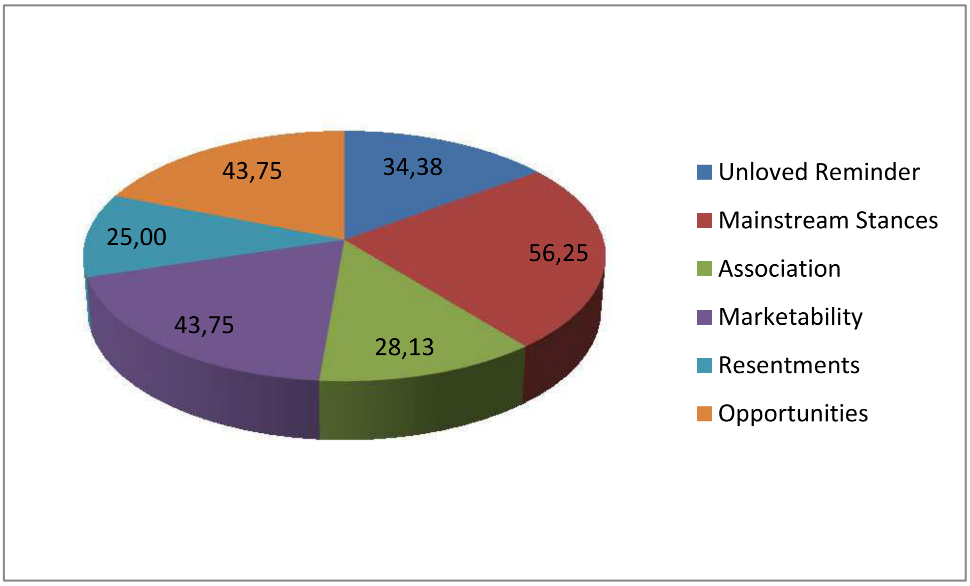

Figure 36 Percentage of data provided for this topic related to the whole group

Cluster 1: Reaction of representatives of the big wind industry

Codes: Reminder of the past, pioneer status

Critical Sentences: It is chaotic and does not work, it is too small

The decentralized wind energy concept provided by small wind turbines is similar to the ideas of the actors of the beginning of the field and they are facing similar reactions. The small wind technology is associated with the pioneer status of the big wind industry and is seen negatively from their representatives. Main presented sentences to demonstrate this are: "*it does not work, it is too small, it is not economical.*" The small wind sector is described as being in a stage of development that the large wind turbine representatives already left behind themselves.

Small wind turbines are associated with the experienced difficulties in the early years and a stage of professional status with which the large wind representatives do not want to be associated with nowadays. Quotations as examples are: "*nobody wants to go back to the children`s shoes*" or "*something that we already left behind*" or "*they are not professional*" or "*they are lonesome amateurs*" or "*we do not want dark spots on our white shirts*".

Cluster 2: Mainstream stances and political orientation

Code: Small wind turbines are not recognized politically, non-acceptance

A general concern about the small technology is described as main stream. The administration side is difficult because the regulations and the feed-in tariffs are related to the large wind turbines. Small wind technology is described as being non-economical and it is no issue that small wind technology could be a contribution to solve the energy supply problem. The reason for not being economical is seen in the legislation. The EEG does not mention small wind as a topic in special and it is assessed as not being wished politically.

Applications close to settlements and integrated within the infrastructure that are the potential of small wind technology are not discussed politically. A difference to the photovoltaics is mentioned. The missing availability of a mass production to reduce the costs of the small wind turbines is assessed as one reason. Also the successful up-scaling after the failing of the Growian is evaluated as being an important issue to hinder the acceptance of the possible down-scaling of the turbines. New regulations for small wind technology with a special feed-in tariff or any other governmental support are mentioned of crucial importance to change the situation. Without stable investment conditions it is seen as difficult for the whole small wind sector. The chance to change the situation for the small wind technology is evaluated as minimal because of the mainstream being not aware of this part of a possible solution.

A quotation of a minister illustrates this: "*Politically, the train has gone and small wind was not on board. All regulations are associated to large wind turbines. No studies or examples have been available. We did not even think about the small wind turbines in the amendment of the EEG in 2012 and we did not know that we had not thought about it*".

Sub-cluster: Dependence on scientists

Code: No different action without scientific back-up

The dependence of the politicians on the evaluation of the scientists is mentioned as a reason not to be able to act differently. So far, no studies about small wind technology or projects with small wind technology are available to refer to. The following quotation illustrates this: "in our decisions *we depend on the technicians and the scientists. When we start questioning the current strategy, we need to have something in our hands. But we do not have anything*".

Sub-cluster: Conflict of ministries

Code: Competing interests of ministries

The structure of the BMU being responsible for the environmental protection and the BMWi being in charge of the energy system are mentioned as a structural problem.

Sub-cluster: Less R&D for small wind turbines

Code: Small wind is excluded

The current funding situation is mentioned as to be questioned. New, not approved technologies should have more attention. Less funding has been required for R&D of small wind technology in the last years. If it had been asked for, it would not have been approved by the funding organizations although the BMWi and the Ministry for Education and Research set the focus on self-produced energy and energy efficiency. Small wind is excluded in practice. The typical applicant is an individual or a small company with other core businesses nowadays. The main professional background lays in mechanics. The applicants are highly motivated with high idealism and suffering from a lack of money to bring the products on the market. Special fields for R&D are the generators and the electronics. One quotation is: "*the politicians are talking about it - nobody is doing it. They are saying that it is needed - but we do not get finance for projects. Concerning the small wind turbines - it is expected that they perform from zero to hundred all at a sudden*".

Cluster 3: Association

Code: Lack of lobby

The lack of professional representation by a decent association is assessed to be a reason for not being recognized. The association of the BVKW is nearly unknown and described by having no lobby. A lack of money is described as the main reason.

Cluster 4: Marketability

Codes: Products of low quality, non-reliable products

The small wind technology is assessed as being non-reliable with low quality. It is also questioned that the customers have the choice between numerous variations and that the delivery times are too long. The market is evaluated to be confusing for the customers. The promises that are given to the customer are often not held that minimizes the trust into the products. Also the missing standards in the production and the status of product development are major topics that question the small wind technology.

The quotations are: "*it is non-calculable for the customer"* and *"it looks like a catalogue of toys"*. The delivery times are too long although the product is announced on the market. A lot of resellers from China are in the market and the quality is questionable. This is minimizing the trust of the customer and brings a bad reputation. It is described as a vicious circle. The products are mainly in the phase of product development and a mass production has not been achieved that could reduce the investment costs.

Cluster 5: Resentments

Codes: Large versus small, small versus large

The large wind turbine representatives assess the small wind turbines on a low level of quality with no or less standards, no associations of interest and lobby behind them. The small wind representatives are described as the ones who steadily compare themselves with the large wind turbine sector. They do not define themselves as an own energy form with other customers and other markets. It is said that small wind turbines have their own purpose and that the own identity has to be defined similar to solar. It is not enough to be in the market by claiming that the small wind technology is the same as the large wind turbine technology. The described reactions correspond to the resentments of the small wind actors against the large wind actors. A quotation of a large wind representative illustrates this: "*all of a sudden I feel being on the other side and I am attacked as the bad guy*".

Sub-cluster: Conflict between the associations

Code: BWE against BVKW

Both representing associations BVKW and BWE are separated. It is said that the BVKW was founded due to the fact that the BWE had no interest to represent the small wind turbines. Representatives of the BVKW suspect the BWE to present a stigmatized negative picture of small wind turbines to the interested customers. Small wind turbines are described as not being economic in general by the representatives of the BWE. The feedback of the customers refers back to the BVKW. It is described as being a vicious circle that detains the investors.

Cluster 6: Opportunities

Code: Demands of small wind turbines cannot be fulfilled

Demands for small wind applications are seen in the e-mobility and in the private sector similar to the photovoltaics. Infrastructural applications in combination with storage are seen as an option as part of the future energy supply system if reliable products are available. In this case, chances are assessed as possible that small wind turbines could contribute to a system optimization that could also lead to a saving of grid expansion.

Off-grid solutions are mainly requested by other countries where people do not have access to energy and grid connection. The infrastructure for installations is minimal in comparison to the transportation of the large wind turbines. The following quotation illustrates this: "*We have to think about this in the future because small wind does have many advantages, especially in the threshold countries. For the large wind turbines we need a complete infrastructure to do the transportation and installation. We also need a grid. Millions of people do not have access to energy - they just have the right to get a solution, not in 20 years, they have the right now*".[602]

5.3.5 Difference of first and second Generation of Large Wind Representatives

The author defines another group based on the content of the interviews. She discovered a difference between the first and the second generation of the representatives in the wind energy field. The first generation is the generation of the pioneers who went through the obstacles by themselves. The second generation is of younger age and stepped into the wind field when the industry was already well accepted. They were grown up in the cultural climate of the temporarily finalized mainstream model but were not directly affected by all the obstacles of the beginning of the field.

[602] This refers to the international dimension of the wind industry and the high export rate of the wind industry as described before. Furthermore, small wind turbines can be installed without grid and can be transported easily with simple transportation methods

The small wind turbine experts belong to this group as well. Two persons of the second generation represent the large wind turbines whereas the author considers this group of importance to present an additional perspective. Despite the fact that the large versions are not doubted at all, the representatives of the second generation expressed openness to the approach of decentralization and other technical versions.

One of them tried to bring the small wind approach into the political discussion and was highly attacked. Also the minimal potential for the decentralized versions that is assessed by the local energy providers leads to doubts. The wind potential is seen as a value in itself besides the current foundation of economical calculation.

The following quotation illustrates this: "*Large wind is the potential bringer, but small wind is attractive because of the localization of energy. I cannot really believe the minimal potential that is assessed by the local EVU(energy provider). Wind is a natural source and the efficiency does not matter. It matters that we can use it. We need to set on renewables. Therefore, the market has to be adjusted and not everything has to be adjusted to the market. A new system with new regulations has to be established - however an open discussion about this topic is not possible right now*".

The other large wind turbine representative mentioned his basic interest in additional wind concepts and said: "*I know the large wind turbines from my childhood and I am very fond of working in the wind family field, but I have heard about other concepts that might be also efficient or even more efficient - I am interested but in the daily life it is forgotten*".

5.3.6 Interpretation of the Results of the Interviews

Due to the provided data, the author elaborates a hypothesis of a process of model building that is related to the circumstances the interviewees described as their perceived reality. The formulation of the stages refers to KANTOR that is described earlier in this thesis.[603]

[603] See chapter 3.1.6

The Stages of Model Building

Based on the data provided by the interviewees, the author defines the following steps of model building in the German wind industry.

1. Under the influence of the anti-nuclear movement the wind people entered the energy field with the idea of decentralization and democratization of energy. Small independent units should replace the large central power stations especially the nuclear power stations. The Growian that was initiated by a large power provider failed. It was construed by the actors that this was done by intention to approve that energy out of wind in large dimensions is not possible. The actors are described as idealists and started as individuals or in small companies belonging to a network of people with different professional background but with the same motivation.

2. The first mall units that were successfully installed were horizontal, three-bladed and grid-connected that was the basis of the dominant design.

3. The self-identifying stories are enriched with constraints the actors are facing. Different variations of non-acceptance are described starting from irony and not taking serious up to attacking. Critical sentences with the following message can be summarized: “small is not enough, you have to get bigger and bring megawatts“.

4. The model was constrained over time and seriously pushed back. The challenges were:

- Caused by nature, due to the lack of space with good wind conditions
- The big energy providers with their standards of economics as well as their technical standards
- The larger context of the energy system being centralized
- The necessity to provide an alternative for the nuclear energy due to the motivation of the actors.

5. Related to KANTOR, the actors had three choices to cope with the constraints that produce mere noise: to dismiss the model, to realize that the model has failed in some way and to fill the gaps or to find a new concept to be added to the former model. The actors of the wind industry did not dismiss the idea of wind energy. They adjusted the former model of single small units to develop larger, grid-connected versions. The orientation changed towards centralization. The goal was to achieve ´to be economical` that went along with more professional standards.

6. The horizontal large wind turbine is the adjusted expressed model with the tendency to centralization.

The following figure illustrates the model building process summarized in three steps starting with the decentralized concepts followed by the adjustment of the model aligned to the established system. The ideas of the origin of small decentralized units were discarded completely. The actors restore possession of themselves by adjusting the traditional model. The stage of autonomy is characterized by a strong adoption of the former traditional system with the main focus on centralization in wind parks onshore and offshore.

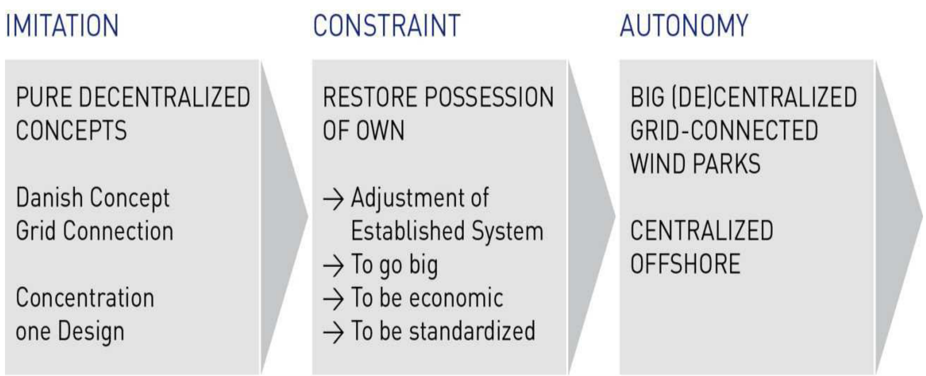

Figure 37 Three stages of model building in the German wind energy, based on KANTOR 2012[604]

[604] See KANTOR (2012) p. 290

The Mental Model spread in other Rooms

The author hypothesizes that the sentences of non-acceptance the actors were confronted with and the situations told in the self-identifying stories are the basis of the mental models. Those situations and sentences lead to a positive incorporation and generalization of these sentences as described by JOHNSON-LAIRD.[605]

The conclusion of the actors that ´to be large is to be economical` is assessed as a translation of the processes into words that is functioning as a model for the wind energy. These special sentences are the truth the persons believe in and constitute the exclusive orientation. They are not questioned and accepted as a common value. The drive to provide the proof of concept of ´big is possible` after the Growian failed is likely a hidden influence as well.

The network is described as being an important factor in the development of the field. The members are described as being idealists with a high motivation. People with different professional background with similar thinking were in the network and met on events such as Husum and welded together against the outside. This was an important factor to get over the difficult described situations.

The wind energy actors and the new established Green Party show a close relationship. The political regulations are described as the main factor for the growth of the field due to the fact that the politics provided the frame for the secured investments. The network was represented in the political scene by the Green Party.

It is assumed by the author that the special codes and sentences are the foundation of the mental models within the network and that they were spread in all relevant sectors due to the fact that the network consists of representatives of various professional backgrounds. This process is illustrated in the following figure.

[605] See JOHNSON-LAIRD (2005) p. 182

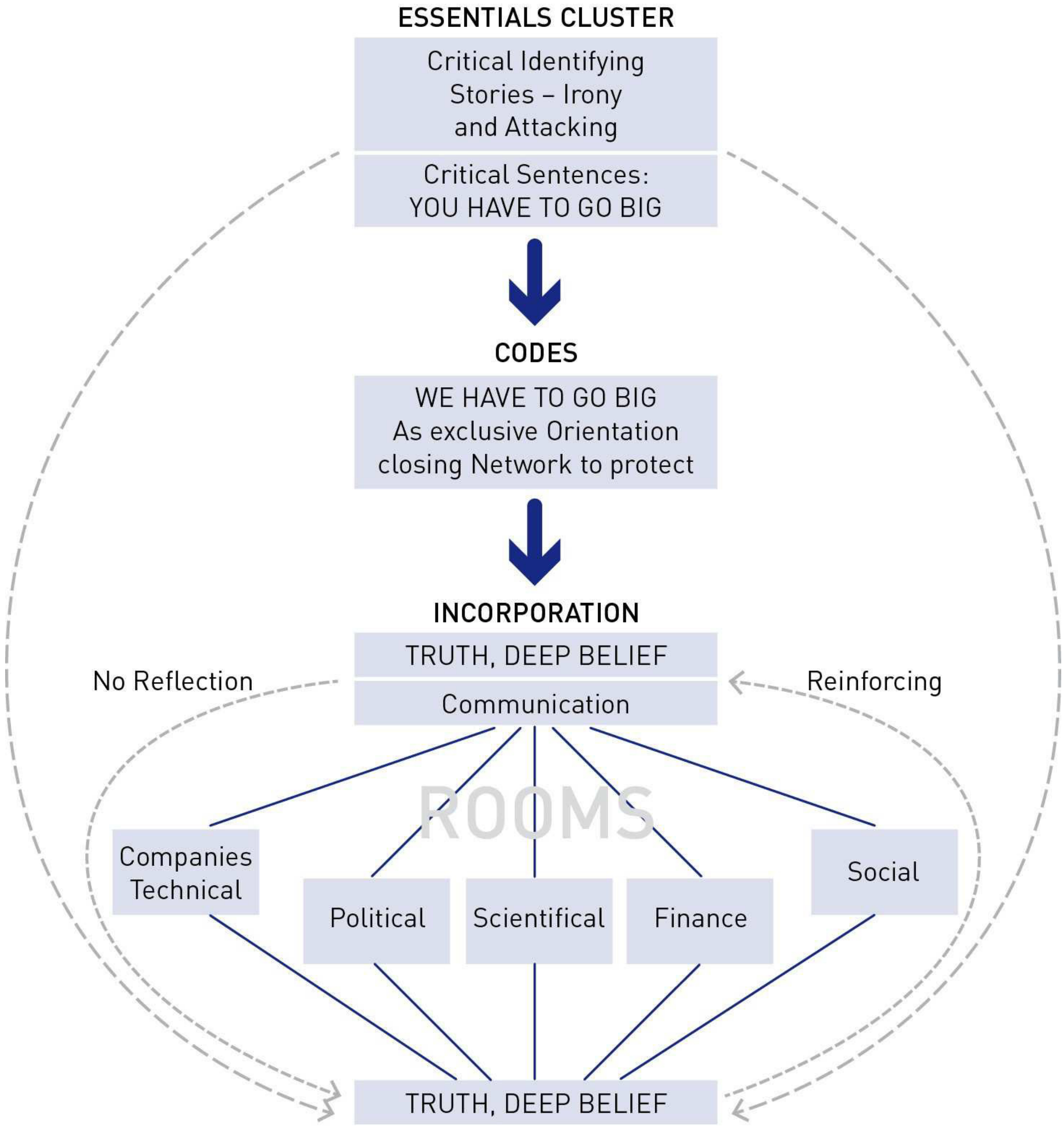

Figure 38 Process of model building spread into other rooms

As described above, the political sector was included due to the close relationship between the Green Party and the wind energy. This means that a process of reasoning from these codes or symbols was passed to others and created a wide-spreading of the mental models.[606]

Related to KANTOR, the author says that the mental models spread into other rooms. A ´room` herewith is a synonym for the place where the face-to-face communication takes place and where decisions are made. The mental models have

[606] Ibid. (2005) p. 182

been transferred into the different sectors such as political, scientific, financial, social or organizational levels.[607]

It is assessed by the author that a mainstream model was created and transferred which leads to a deepening and reinforcing process of the mainstream mental model. The interconnection between the political and the organizational level is very close combined with the direct influence of the growing size due to the technical development. The scientists were also focusing on the three-bladed horizontal-axis wind turbines and the research of other versions was stopped. The reference of the wind energy was the exclusive design. The politicians rely on the scientists and depend on their judgement. The regulations were done without considering the small wind turbines.

The author evaluates this referred to JOHNSON-LAIRD as a retranslation back from the resulting symbols to external processes or at least as a recognition that they correspond to external processes.[608] One result in the political scenenary is the discussion of the novelty of the EEG (2012). The small wind was not considered. This is recognized by representatives of the political scene including the second generation.

Small Wind Turbines as Trigger of the Large Wind Turbine Mental Model

The rejection of the small wind technology is highly generalized and a general doubt is noticeable. The way how the small wind turbine scene presents itself suits to the assessments given from the outside. Due to the lack of money and the missing regulations, they cannot satisfy the demands of the customers. The requested standards cannot be fulfilled and the products are often not reliable. This reflects negatively and undermines the negative attitude of other parties. This can also be described as a reinforcing circle.

The way the small wind technology is described by the large wind turbine representatives reminds of their early stages. The reactions and the sentences show a high similarity to the sentences the pioneers had heard in their own start situation of the

[607] See KANTOR (2012b) interview

[608] JOHNSON-LAIRD (2005) p. 182

field. The expressed formulations mirror the conclusions the pioneers have made based on the obstacles they were facing.

The approach and actual status of small wind technology seems to be a trigger for the toxic themes of the actors. The trigger can be seen as a special reminder about the own roots and origins that have been discarded earlier. Due to the high and accumulated pressure from the traditional side, the change of the former highly energetic and idealized model included most probably painful elements which KANTOR describes as mere noise.

The intensity and similarity of the sentences that are actually associated to the small wind technology can be assessed as signs of a non-reflected process of model adjustment and therefore as a non-reflected part of the Boundary Profile.[609] These toxic themes are hidden and related to the structural level of myth.[610] When they are touched or triggered, it is a constraint for the actors. These triggers have to be avoided because they affect the current model of being big.

This can be associated to the behaviour pattern of forgetting history. KANTOR describes forgetting history as part of the moral corruption on the face-to-face level that is influenced by the invisible elements of the toxic themes. KANTOR gives the following symptoms for forgetting history that can be associated to the situation:

- dismissal of history as irrelevant or unnecessary,
- obsessive focus on the future and the opportunities it holds
- exclusion of the old-timers.[611]

The following figure demonstrates the association between the past and the actual situation. The two arrows illustrate the orientation of the mental models starting from the actual state. The orientation is described as going backwards. The confrontation with small wind turbines is described as the trigger. The future orientation is illustrated as limited due to the influence of the mental models being oriented backwards.

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609 See chapter 3.1.7

610 See chapter 3.1.4

611 KANTOR (2012) pp. 241f.

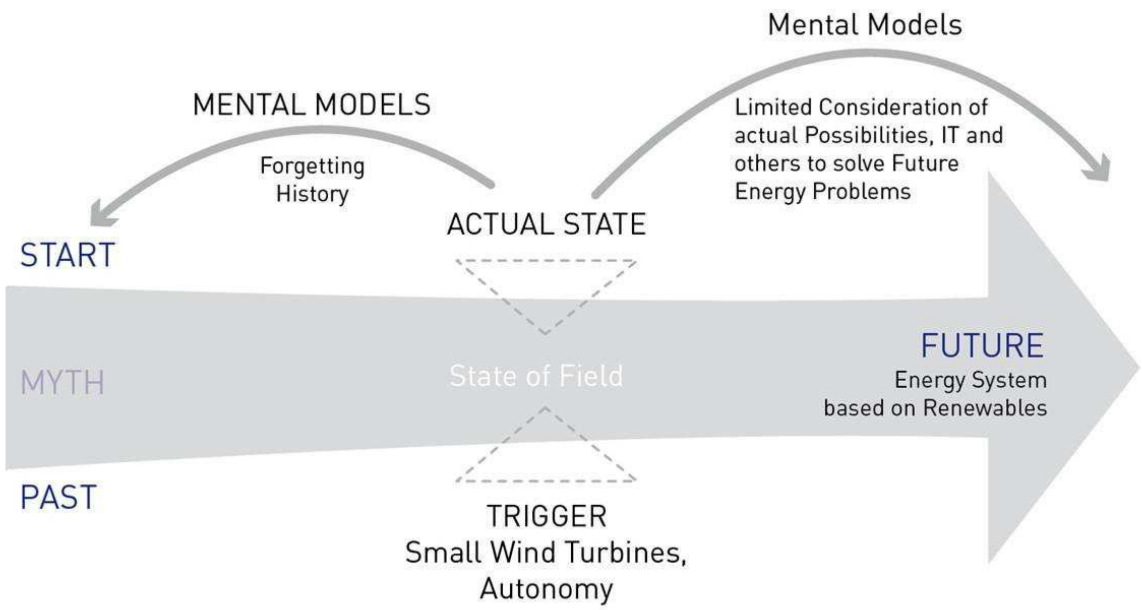

Figure 39 Timeline and orientation of big wind industry actors

Forgetting history is related to ´not knowing` on the individual level. Due to the high idealism and being different to the established system, it can be hypothesized that the adjustment of the model included a big shift in some biographies on the individual level. A big shift is a turning point in one`s life. “In *not knowing,* individuals actively engage in acts that they do know to be morally wrong but whose internal ´meaning` they are able to alter in order to justify their choice“.[612]

The representatives of the second generation seem to have another perspective although they might feel the strength of the influence of the mainstream model. They are interested in other technologies or start questioning the discarding of the small wind approach. Related to SCHEIN, the first generation is more affected by the cultural influence due to their personal emotional experience.[613]

Structural Traps

The noticeable polarization and delineation refers to KANTOR’s definition of moral models. Issues are: right side versus wrong side, chaotic and creative versus professional, small versus big, economical versus uneconomical. The concept of the enemy is a recurring structure and is still valid.

[612] Ibid. (2012) p. 243

[613] SCHEIN (2012) interview

The system type developed from random to random-closed to closed. The early stages of the field fit to KANTOR's random status. The closing of the network against the outside brings a closed effect, primarily oriented for the defence that adds dysfunctional elements. The author assumes that it stays closed by discarding the random status and that the tendency of closing is transferred to next stages and the following organizational structures as well as to the next generation.

Some experts stated that they are missing the cooperation between different companies to solve common problems. In mature industries it is quite usual to work in expert groups to find solutions. A lack of communication is also described between the project partners within projects. This could minimize the efficiency in the project execution that could be partly avoided. The descriptions are indicators that the behaviour pattern of closing might have shifted from the network to the organizations. In the actual situation, it is hindering the daily work and it can be assumed that it partly minimizes the quality.

Being professional is pointed out especially and bordered the random and creative status from the beginning. This could minimize the quality in the long-term due to the risk of idealization of being professional. Indications are the words of experts who observe that the professionalism could be improved.

The concept of the enemy seems to have a high meaning. It welded the community together and helped to sustain the big pressure. It was related to the traditional energy providers as representatives of the other side. Due to the political orientation, it can be assumed that prejudices about the ´traditional system` influenced the interpretation of the obstacles at the beginning of the field in general.

The concept of the enemy seems to be still valid although the cooperation with parts of the former enemy is obvious. It seems that it is shifted to the second generation. Due to the data, another structural trap of the concept of the enemy is assessed by the author concerning the relationship between the small wind actors and the big wind actors. The concept of the enemy is seen as a structural pattern within the system that avoids a cross-model conversation.

Another structural trap was also described. The separation of the BMU and the BMWi in energy issues on an institutional level was mentioned as a problem. It can be assumed that the responsibilities are competing that might be a reason for multiple stuck situations within the process of the energy transition. Most possibly, this structure will maintain informally although the new Ministry of Energy and Economics was found in the meantime.

The Wind Energy Culture

The pioneers walked into the field and challenged the traditional energy system. They got attacked. They welded themselves together in a network and found solutions that got acceptance and growth by a change through rapprochement towards the requests of the constraining parties.

The general idea of energy providing by wind was rescued. This was a huge success in itself. The involved persons put a lot of effort in the expansion of the field and compensated each other. The common goal was to find alternatives to the nuclear energy. The community was committed to reach this goal and incorporated the aspects of success as their taken-for-granted beliefs. They represent the driving force to take actions. This corresponds to the level of basic assumptions referred to SCHEIN in the table below.

Due to this, a connection with the level of artefacts can be seen that is normally hard to decipher. The big turbines get a special meaning as the visible part of the green culture. For the Green Party the large wind turbines are described as symbols similar to the sunflower. "*Large turbines are viewable from far away - they are the obvious proof that we can do the energy transition*" ... "*nobody could have ever believed that we reach turbines in such dimensions*".[614]

The large wind turbines are the visible and touchable achievements within the energy field and the proof of concept to reach the requested large dimensions. Additionally, this could be an influencing factor for the support of investments offshore. The failed Growian is also assumed to be an influencing factor that was specifically pointed out during the interviews. The underlying basic assumptions correspond to the mental models as incorporated values in the field. The author assesses this as the specific wind

[614] The same wording was used from Claudia ROTH in an interview about the history of the Green Party, interview with ROTH (2014) NDR

energy culture and as the ultimate source of values and actions related to SCHEIN. The cultural levels are summarized in the following table.

Table 8 Levels of culture in the German wind energy, based on SCHEIN[615]

Artefacts	Large as symbol of reaching the goals
Espoused values	Energy transition Anti-nuclear We have different concepts to the traditional system
Underlying assumptions	We need to be large to survive We need to bring large dimensions to make an impact We need to get a proof of concept and show that the size of the Growian is possible to beat

Interferences of the Deeper Individual Structures with other levels of the Team Learning Model and Case Learning Meta Model

The overall context was the need for finding alternative solutions due to the increasing awareness of climate change and for the actors as well the dependence on foreign imports. The nuclear accident in Chernobyl was a critical incident that was beneficiary for the field. Referred to OHLHORST and BRUNS ET AL., different steps with changing constellations lead to the consolidation of the big wind industry. It became an accepted industry.[616]

The adjusted model of the actors based on the exclusive technical design can be seen as the way through. It was the chance to increase in size. It is assumed that this was the only possible way at this moment of time. The actors put their energy in one basket to reach the point of acceptance. Germany as a highly industrialized country with a high

615 See chapter 3.2.3

616 See OHLHORST (2009) pp. 193ff.; See BRUNS ET AL. (2008) pp. 128ff.

qualitative electrical supply system, perfectly adjusted to the fossil energies and favouring the nuclear energy, was a field that provided a tight frame of action for the actors. The dominant technical design in itself can also be seen as one reason for the centralized orientation. The energy associations guided by citizens, communities or municipal communities also took over the approach and specialized on the large wind turbines.

The main decentralized orientation was discarded for the other path. Due to the growing acceptance of the industry and the increasing influence of the Green Party, it was also incorporated in the governmental level. The costs for the production decreased due to the concentration of the companies and the effort that was put in R&D. The German wind industry spread over the world, highly accepted and acknowledged. The network of actors set standards and developed a new field of professionals. The efficiency of the horizontal-axis wind turbines as the exclusive design is not questioned by anybody, it is like a law. The involved levels, including the processes of thinking and acting, are aligned to this kind of design.

The change of the orientation of the adjusted model is related to the technical model, the adjustment of the economical orientation was sheltered by the network structure that became the formal structure to strengthen the whole development. The mainstream mental model could be established and expanded involving the society which constitutes the conditions for the individual level that is to be seen as the micro-level. The terms and conditions are set due to the mainstream model of wind with all the consequences and interconnections as elaborated by the author guided by the Team Learning- and Case Learning Meta Model.

5.4 Theory of Change of Case

Related to KANTOR, the Theory of Change focuses on how change could happen within the *thing*.[617] As described earlier by SENGE, mental models are described as simplifications and have limitations.[618] The question is not if they are right or wrong, the problems arise when they are tacit.[619] The results of the exploration of the mental

[617] KANTOR (2012) p. 287

[618] See SENGE (1994) p. 175

[619] See SENGE ET AL. (1994) p. 235

models in the wind industry are assessed by the author as the leverage to facilitate change in the wind energy field.

Forgetting history disables the involved persons to explore the lessons learned out of the past and brings vulnerability for the same mistakes in the future.[620] The involved persons and parties have to become concerned people and parties by opening the consequences of their doing. The risk to fail on several levels is assessed as the constructive energy for these processes.

The German wind energy runs the risk to lose influence internationally while being stuck due to their mental models. Nationally, the wind energy runs the risk not to meet the expectations that go along with the immense meaning of wind as natural source for the energy transformation. The government runs the risk to lose while not considering the value of decentralized small wind applications. Related to KANTOR, the author assesses a high stake situation aligned with feelings of uncertainty and anxieties.

Referred to SCHEIN,[621] the risk to fail in the energy transformation process would be the Anxiety 2. The Anxiety 2 enables to overbear the Anxiety 1. Anxiety 1 represents the anxiety to be confronted with the limitations of the own mental models, the cultural core beliefs and the taken-for-granted basic assumptions. It is a learning process of reflecting and most probably with sequences of unlearning.

The mental models and the cultural assumptions can be evaluated as what they are: incorporated conclusions of the early years and the former success. This enables to get a brighter view at the actual situation and the consequences of strategies formed under the influences of them. The involved people get the possibility to recognize that they might be concerned people by connecting the historical situations with the guiding influence of the mental models today.

The second generation should be included to bring the future perspective in the foreground and to provide the chance of minimizing the maintaining forces of the large wind representatives.

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[620] See KANTOR (2012) p. 24

[621] See SCHEIN (1995a) pp. 5ff.

5.4.1 Defining the Need for Change

Related to KANTOR's Meta Model, this chapter considers results of the four dimensions of the Theory of Thing being the context information, the face-to-face level, the broader social structures and the deeper individual structures. Although the wind energy has achieved a major acceptance, the author evaluates indicators for a need for change related to BECKHARD on the following levels.[622]

1. Some experts start questioning the exclusive orientation to get larger due to the increase of technical problems. More size and capacity does not lead to more efficiency by nature. The troublesome achieved economical balance for some sizes (1-2 megawatts) could be damaged because the thinking that ´every three-bladed horizontal-axis wind turbine is economical` and ´the larger the better` is not reflected. A reality check is required.

2. The international competition is getting harder, the improvement of quality and the reduction of investment- and maintenance costs are important tasks as well as the solving of common problems. The lack of an open communication process to reduce mistakes and to find optimal solutions could decrease the international influence. This is related to projects and technical problems in general.

3. The exclusive design was shifted to other environmental circumstances. The offshore implementation causes a lot of technical problems that were not foreseen from the people involved or it was not questioned openly. It costs a lot of public money and brings the wind industry down in general. A reality check is necessary. The author assesses a structural trap due to the close relationship of the big wind industry and the politics.

4. The lack of suitable space is a recurring limitation. The higher versions for the woods could be the basis for new conflicts for two reasons. First, the woods are natural resorts for people and animals. Nobody exactly knows the impacts on the natural environment. Bats and birds are an important topic. Second, the woods are owned by a small group of people. A conflict of interests can rise.

[622] See chapter 3.2.6

5. The citizens condemn large projects more often that could lead to delays. This is also the case with the expansion of the transmission lines. An increasing volatility can be the effect that the tax payer has to pay.

6. The three-bladed horizontal-axis wind turbines in general and the trend of exclusive large versions are not the answer for every wind situation. Different versions suit different situations.

7. People who are offending the large wind park projects and the transmission lines, are mainly not offending the wind energy in general, they are partly offending the basic strategy and are looking for alternative solutions.

8. The decentralized approach with small wind turbines that could be an additional column within the energy transition is fenced in a vicious cycle of not being recognized, having no or less support in financing, getting no special feed-in tariff, getting less support for R&D and having an inscrutable procedure of approval.

9. The small wind products are often non-reliable and promises are made to the customers that do not fulfil the expectations, either in terms of delivery times or in terms of functionality.

10. The vertical-axis wind turbines are in the background again. The prejudice of not being efficient is still valid although international experts acknowledge them as being especially suitable for the infrastructure as the basis for SMART grids and energy efficiency.

11. The actual status of IT in combination with energy is hardly recognized although it is often espoused. Wind in combination with electro-mobility, SMART grids and regional, localized projects are rarely put into practice. Virtual power stations and the energy internet as a column of the national energy supply system are discarded although they could be technically executed. Decentralized storages could be applied immediately and regional concepts could save transmission lines.

12. Germany runs the risk to fail internationally due to the lack of decentralized versions that can be installed as off-grid solutions in the numerous areas where

people do not have access to a grid. The rural electrification in development countries needs solutions.

13. Germany runs the risk to fail in the sector of urban energy providing systems or as part of the urgent necessary improvement of energy efficiency (please note 80% of all people worldwide will live in the cities in 2050) which is also required by the UNEP.

14. Germany runs the risk to fail in the energy transformation process due to the lack of acceptance and financial obstacles. The external costs for the centralized approach based on the large wind turbines (transmission lines, storage, infrastructural damages, minimizing the value of nature) have to be included in the economical calculations.

It is assessed by the author that the mental models of the actors that were aroused on conclusions out of the early years are influencing the actual analysis of the situation, minimizing the ability of the evaluation of the possibilities given by actual technologies.

Future needs are mainly covered by the orientation of being centralized and getting larger which is assessed as being most probably a result based on the limitations of the mental models.

The most advanced people that are supposed to be the change agents run the risk to act on the basis of the non-reflected parts of their mental models. Furthermore, the model of success that spread in the other relevant rooms seems to make it difficult to discuss corrections. The second generation perceives this cultural border. They behave cautious and the system remains being closed. The meaning of the German role internationally is endangered to decrease and the energy transformation process is doomed to fail.

5.5 Theory of Practice of Case

KANTOR`s Theory of Practice contains a suggestion what actions should be taken to make the change happen based on the understanding of the *thing* and how it changes.[623] Therefore, the author focuses on suggestions related to the results of the four

[623] KANTOR (2012) p. 288

dimensions of the Theory of the Thing with emphasizing the fourth dimension being the results of the evaluation of the mental models.

Referred to the change model of BECKHARD[624] (figure 6), the change process to close the gap between the actual and the future state consists of three basic stages that are unfreezing, change and refreezing based on LEWIN described by SCHEIN.[625] The need for change on the different levels is already described above.

1. Unfreezing:

   Confrontation with the elaborated needs for change and the evaluation of the interviews to create a motivation for change that means in this case to attract the attention on the topic of the mental models to open up for further exploration. Providing general knowledge about mental modelling and the importance on decisions should be a part of it. Referred to the model of the ´7 steps of change` this could lead to a shock situation being a starting awareness of the needed reflection of the mental models. An atmosphere of psychological safety could be provided by acknowledging the major achievements of the wind industry until now.

2. Change/Moving:

   After a decision is made that the reflection of the current mental models is worth to be able to achieve a new additional focus within the wind energy field, new formulations and identifications would be possible. The new values and attitudes could lead to provide the basis for an entire analysis of the current energy situation related to the future considering large wind applications and small wind applications. The orientation of centralization could be combined with small decentralized aspects which would be a cross-model conversation referred to KANTOR (2012). A decision about a change of structures such as the funding situation or new regulations about the feed-in tariffs could be the results as well as an entire master plan.

3. Refreezing:

[624] See chapter 3.2.6

[625] See chapter 3.2.2

This phase concentrates on stabilization of the new attitudes by internalizing them in the procedures of decision-making and in the implementation of new or additional structures to strengthen the new approach such as executing the new regulations to provide stable investment conditions for the decentralized small wind as well.

The next figure provides an overview about a possible scenario of how the process of the change of the wind energy related to the energy transformation could be done further, considering the results of this thesis. The proposed involved groups or people represent the relevant sectors for the wind industry that are described earlier in this thesis. Due to the fact that the large energy providers have close relationships to the government and their active role in the wind energy, it is proposed to include representatives of the large energy providers additionally.

The decision about the final composition of the group that should lead this process is to be done after a further analysis of the situation. The author recommends a team of leaders referring to the Leadership System Model by KANTOR (2012).[626] Especially the role of the Exit Leader is requested and should be integrated in the guiding team. A participation of representatives of the second generation is suggested by the author to strengthen the future perspective.

Thus, the figure illustrates only a general overview about how the process could be. The author emphasizes on the mental pre-phase and put the focus on a reflection step.

In between steps will be necessary because of the complexity of the issue but the author is not able to define more details at this moment of time. When and how small wind turbine experts are to be involved in the process is also to be decided on later within this process. The author recommends an involvement in the moving phase at the latest for the cross-model conversations.

The (mental) pre-phase is evaluated as the leverage and is related to the stage of unfreezing that includes the confrontation and possible reflection of the mental models as described above.

[626] See chapter 3.1.8

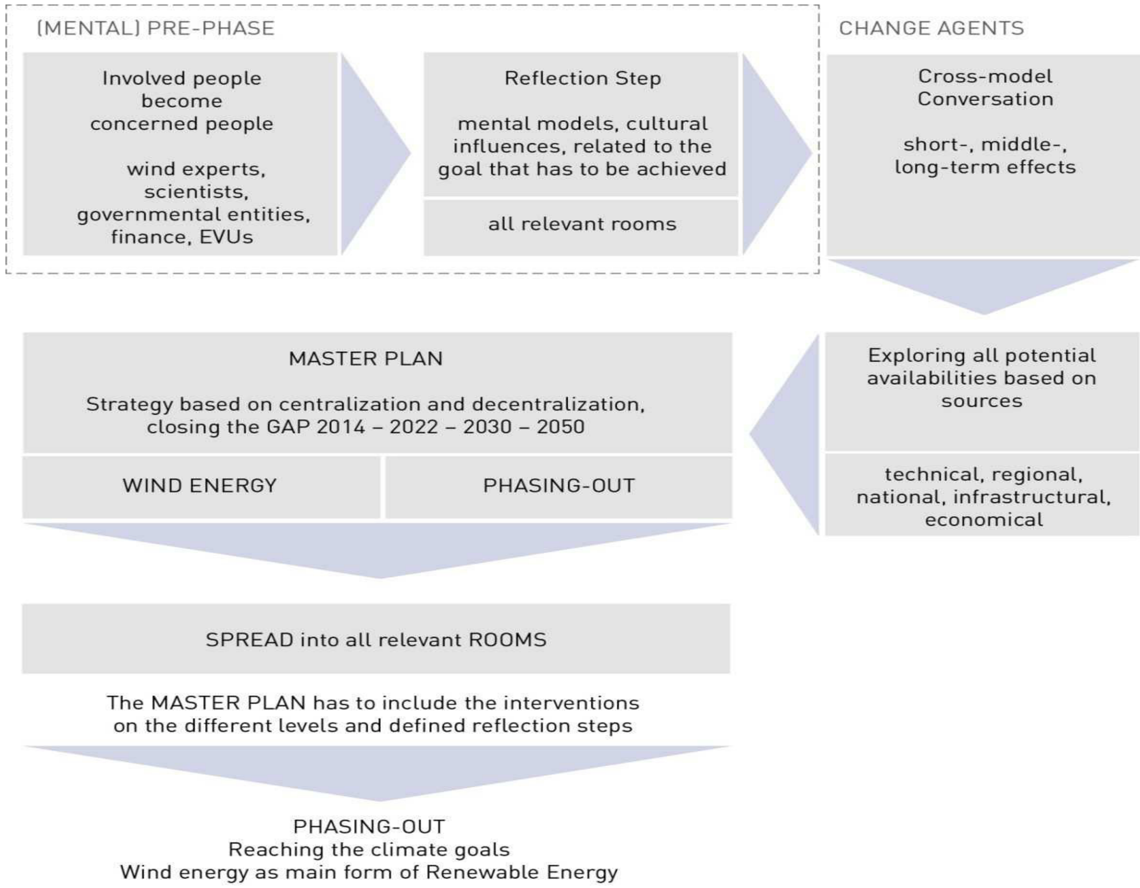

Figure 40 Pre-phase and model of energy transformation process

The concrete interventions and settings are to be worked out with the involved people. Suitable methods are to be chosen for the focus of reflection, communication and elaboration for the further strategies. They should include the systems thinking-, the dialogue- and the KANTOR approach as well as instruments for strategic analysis and development. Short-, middle- and long-term effects are also to be considered.

Examples for useful methods are: systems archetypes, ladder of inference, dialogue or learning histories.[627] All interventions should be related to a guiding model that is ideally the KANTOR model with all its ingredients to elaborate a path to successfully reach awareness and a reflected future-oriented strategy.

[627] See KANTOR (1995) APPENDIX NO. 10.11

6. SUMMARY OF THE RESULTS

The context information covers the relevant issues that enables to put the right perspectives on the scope of research and is the first dimension of the Theory of Thing. The KANTOR approach is the guiding line during this thesis.

Social systems and change

The characteristics of social systems as described by LEWIN (1953), PROBST (1987) and MEADOWS (2009, 2010) build one of the foundations of this thesis. Social systems are stamped by tradition and patterns of interaction that were successful to fulfil the purpose and build the system's structures that have a behaviour influence (SENGE 1994). Referred to SCHEIN (2005), change in systems happens by shifting the forces that have the tendency to be in a quasi stationary equilibrium.

The three-step model of LEWIN (SCHEIN 2005, SCHEIN/BENNIS 1965, FATZER 1990, SCHERMERHORN 1996) and the BECKHARD model (1987) are described as models for orientation. The ´Change Curve Model` of CHAPMAN/JUPP (1992) shows the emotional flow of the steps during a process of change (FATZER 1993, 1999, 2005).

Mental models and cultural aspects are described to achieve a better understanding of their strong influence in change processes (HOFSTEDE 1997, HOFSTEDE ET AL. 2010, LITTERER 1973). The BECKHARD model (1987) contains the term ´culture` as swaying part of the actual state and the transition state (FATZER 1999, 2005). The role of the leader within change processes is described by BENNIS (1990), SENGE (1994), SCHEIN (2005) and KANTOR (2012). KANTOR's (1995, 1996, 1997, 2012) approach containing the Meta Model which consists of the Theory of Thing, Theory of Change and Theory of Practice is the guiding model for this thesis. His assessment of mental modelling, being one main important key within processes of change, is the core element. The identification of the actual mental models, structural traps and stuck situations are the relevant results within the analysis as well as reflection of the Boundary Profile.

The energy transformation process is a societal process (KRIZANITS 2004, 2005, SCHOEFER 2005) and includes a change of fundamental structural conditions

(REICHE/BECHBERGER 2006). The people's values and core beliefs or mental models are decisive in the necessary political decisions (MERKEL 2010, EASTON 1957). LASZLO's Macroshift (2003, 2008, FATZER 2005) also focuses on these issues.

Innovation

Different kinds of innovations (WOLF 2007) and the interconnection of society and innovation are described by HOWALDT ET AL. (2007), OHLHORST (2009) and BRUNS ET AL. (2008). Typical innovation phases are determined referred to WOHLFAHRTSTAETTER (2010) based on UTTERBACK/ABERNATZHY (1975). New business and market models emerged due to the changes in the European electricity market that are described by WOHLFAHRTSTÄTTER/BOUTELLIER (2009, 2010). The Kondratjew Cycle determines the long waves and the societal transformation (WEIZSÄCKER VON ET AL. 2010, BECKER 2004).

Energy

The fundamental meaning of energy is illustrated in the Energy Policy Maslow Pyramid by FREI (2004). An overview about energy as scarce good and the limited resources was done by PELTE (2010). Energy is indicated as a system that is related to the social context which consists of natural, social and human settings as it was already stated in the early 90ies by SORENSEN (1993). The way the operation is conducted can vary depending on the values and attitudes of the members of the society and can be decentralized or centralized (KUNZE 2012). The monopoly structure provides a high security of supply on one hand and total dependence on the other hand (BRUNE 1998). Technological development comes together with economical development and is related to the access to electricity (MILLES/HORENBURG 2011) which is also the basis for the intelligent energy system (ERDMANN/ZWEIFEL 2008).

ERDMANN (1992) and ERDMANN/ZWEIFEL (2008) describe the specialties of the energy market and the vulnerability of the energy system. The discussion of market failures, sustainability, price politics, environment protection and the shortage of fossil energy leads to the definition of the role of the state in this field and to the question how to deal with the external effects. Two different approaches are presented such as the PIGOU Tax (ROGALL 2008, WIESMETH 2003, HAAS/SCHLESINGER 2007) and the COASE Theorem (OTTINGER 1993, SCREPANTI/ZAMAGNI 2005, ROGALL 2008). The conflict of interests to be managed by the politics is illustrated by FREY (1993) as the economical-ecological-political cycle, by ERDMANN/ZWEIFEL (2008) as the ´magic triangle of goals in the energy politics`. BRUNNENGRÄBER (2009) emphasizes on the strengthening of the position of the state to keep the energy and climate politics in balance.

Climate commitments

The international commitments for climate protection that are signed in the Kyoto Protocol (2005) build the political frame of action. The urgency to reduce the green house gas emissions was pointed out in the last IPCC report (2013). The EUROPEAN COMMISSION (2011) sets a focus on a long-term decarbonisation path to reach a reduction of the emissions. Germany sets ambitious targets through the EEG (MORRIS/PEHNT 2012) and went a step further by the governmental decision of the phasing-out of the nuclear power until 2022 (2011). This should be reached by maintaining stable investment conditions through the feed-in tariff, by expansion of the grid, implementation of SMART grids and strengthening the energy efficiency as described by MUSIOL ET AL. (2012). The UNEP (2013, 2014) and the European Commission (2011) recommend a combination of centralization and decentralization in the electricity sector.

Wind energy

Large wind turbines are developed to get the most energy out of the wind (TONG 2010). The standard large wind turbines with three blades are the dominant version with a capacity of 2-3megawatts up to 7,5megawatts. Limitations are given due to environmental impacts as described by TONG (2010) which cause areas of potential conflicts (PELTE 2010, TONG 2010, HEIER 2012). The offshore sector became more important but a lot of R&D is requested to do large scale implementations (HEIER 2012). As wind is the most promising renewable energy, the international wind market is still growing as detailed by the GWEC (FRIED ET AL. 2012) but it is also fluctuating. Europe is behind the goals of new installations which were set in the NREAP (FRIED ET AL. 2012). A stable investment climate is assessed by the GWEC (2012) for the growth in the future.

Small wind technology is assessed as the origin of the large wind technology (MATSUMIYA 2010) and their applications are proven traditionally. Internationally, the interest is increasing (STAUDT 2010) due to their contribution of energy production and their potential of environment protection (MATSUMIYA 2010). Key issues are the technical standards. The main design is the three-bladed design. Vertical designs are of interest due to their advantages to integrate them in the infrastructure (COOPER 2010). Outside China, the production of small wind turbines is assessed to be fragile in comparison to the huge market possibilities on a global scale (DEXIN 2012). The forecast shows an increase of 35% of annual installed capacity until 2015. With the right investment conditions a further tremendous growth of installations (up to 1000megawatts annually) is expected.

Net integration

Grid scenarios of EWEA (2010) until 2050 show the huge expansion of the European grid that is needed to integrate the wind power. Referred to LEAHY ET AL. (2010), storage facilities of big size are limited and under R&D. Decentralized solutions with accumulators are assessed as being a potential to reduce parts of the grid expansion by HENNIKE/WELFENS (2012) and LEAHY ET AL. (2010). This is also the basis for SMART grids that are essential due to the majority of people (70%) living in urban areas. Electro mobility and intelligent urbanity (VOGEL/HÖBARTH 2011) as well as the energy internet (RIFKIN 2014) are described as future solutions.

The merit order effect partly leads to a destabilization of the large power plants because their profitability is at stake. However, they are needed to secure the supply. The EEC leads to higher prices of electricity for the end customer in Germany (BUCHAL ET AL. 2013).

6.1 Summary of the Results of the Broader Social Structures

The broader social structures show the development of the field in Germany that is characterized by an interdependency of the technical, economical, social, financial, political and organizational aspects. They represent the second dimension of the Theory of Thing. The environment is of crucial importance for two major aspects. First, the specific regional wind conditions are directly related to the energy output and therefore influencing the economical results and the technical development. Second, the environmental impacts are assessed as a conflict of interests especially described by RAVE (2007) and BRUNS ET AL. (2008). The ground is a scarce good and is related to the increase of the size of the turbines (MORRIS/PEHNT 2012). This is as well related to the organizational concentration as depicted by OHLHORST (2009). The Growian was the first and only large wind project of the early years and it failed. The technical development of the dominant three-bladed design was brought further and is high advanced. The production processes are done in big numbers since the 90ies. Some experts claim that the increase of size reaches its limit and minimizes the efficiency (WEINHOLD 2012). The increase in size is also observable in the size of the projects. Starting with single decentralized small wind versions, the process changed to wind park projects with a trend of centralization.

The offshore sector is purely centralized with a financial back-up of the government in close relation to the large energy providers as delineated by OHLHORST (2009), the BWE (2013) and FRÖHLINGSDORF (2012). The investment costs for offshore is 2-3times higher than onshore (KOST ET AL. 2013) and the planned expansion is delayed.

Referred to the BWE (2013), the net integration is specified as needle-eye that causes a lot of losses of energy and extra costs. Large storage facilities are limited or still under R&D (BISCHOF 2007) and the necessary grid expansion is combined with massive investments of 42 billion euro in Germany until 2030 (DENA 2012). The citizen wind parks are politically valued as democratization of the energy sector (ALTMAIER 2013), but the tendency to huge investment projects is increasingly refused by the public (VOOGT 2014).

Politically, the wind energy was defended by the traditional system at the beginning and supported by the legislation later on. This was possible through the increasing influence of the Green Party as stated by OHLHORST (2009) and MAUTZ/BYZIO (2005). Scientific institutes and wind associations changed their focus towards lobbyism during the development of the field (OHLHORST 2009). The technical standards are set and wind energy is taught at universities based on the dominant design (RABE 2013).

Referred to the BWE (2013), Germany is the leading wind country in Europe and a global leader although the international competition is increasing. It is planned to triple the amount of wind power within the years 2011 until 2020. Referred to RENTZING (2012) and KÜHN (2013), a return in the onshore market as the most plannable mass market is expected due to the uncertainties in the international market and the unsolved offshore problems. Referred to the BWE (2013), the wind industry provides around 140.000 jobs wide-spread in Germany which is one fourth of the total employment in the renewable energy sector. KÜHN (2013) assesses negative impacts on the employment in case that the government reduces the subsidies.

The small wind sector

The BVKW (2014) characterizes the small wind sector as an emerging sector due to the increasing demand of the customers and with a possible number of 700.000 installations until 2020. An amount of 10.000 installed units is the actual status. The main capacity is 1,5kilowatts (MAEDA ET AL. 2013). EISELT (2012) emphasizes on the need for decentralized applications that can be combined with electro mobility and infrastructure and states that a huge amount of decentralized versions could save the grid expansion and could bring a noticeable contribution of energy production.

The main technical design is the horizontal three-bladed one although the vertical versions are assessed as suitable for the infrastructure and as the basis for SMART cities in combination with storage (RIFKIN 2014, EISELT 2012). Numerous small wind versions are available on the market but only less meet the requirements of the technical international standards (FRANKEN/TRECHOW 2013). A lot of versions have not reached their marketability yet.

The investment costs for small wind turbines are defined as close to the offshore investment costs (OTTER/PEHNT 2009). Referred to LANDWEHR (2011), small wind turbines are economically attractive in good wind regions in combination with a high electricity usage because the feed-in tariff is lower than the cost for electricity due to the fact that the German legislation does not provide a special feed-in tariff for small wind applications (FRANKEN/TRECHOW 2013). They are treated like the large ones with the consequence that the building permission is often refused which is determined as a juristically not acceptable planning avoidance by FEST (2013).

The regulations are different in the federal states and the communities and provide room for interpretation which enriches the complexity (RICHTER 2010). This is combined with the general assessment that small wind turbines are not working economically. LEGLER (2014) interprets this as being a sign of the young sector. Although the politicians are talking about the decentralization of the energy sector (ALTMAIER 2013), small wind applications are not considered which is in contradiction with other decentralized versions like photovoltaics and combined heat and power (EISELT 2012).

The representation of the small wind sector is the BVKW. The association was suffering from a lack of money (2011). In 2012 a new management started a new positioning (BVKW 2014).

Based on the given data, the author assessed three different models during the process of the development of the wind energy field that is described in ‘changing models of the German wind energy field’. Starting with a general model clash between the traditional energy system and the emerging wind energy that entered the market with a decentralized approach and small wind versions provided by small companies, the model clash changed to a relative model clash due to the increasing adjustment of the orientation towards centralization (second model). The third model indicates the tendency to a complete centralized orientation model which is nearly completely adopted by the traditional system due to the involvement in large wind parks and offshore. The model clash is indicated as a general model clash again, herewith between the traditional system and the integrated traditional wind energy against the new ‘old’ orientation of decentralization represented by the small wind sector.

6.2 Summary of the Results of the Face-to-Face Level

The results of the face-to-face level are separated in the observation of the newspaper and in discussions on television. Different levels of conflicts of interest are obvious in the newspaper. Main topics on the national level are the dissatisfaction with increasing energy prices (MARSCHALL 2013), the resistance against large projects (HANNEMANN 2013), competing goals of climate protection and the running of large unprofitable power stations due to the merit order effect. High employment and the security of supply are at stake (INGENRIETH 2013). The different status of wind energy in the federal states leads to a competition about the payments (HÖNING/MICHELS 2014). Additionally, the conflict of interest between Germany and the European Union about the subsidies of the energy-intensive companies is a major topic due to the risk of increasing unemployment and high paybacks (MARSCHALL ET AL. 2014). Complaints about the current strategies lead to a discussion of the basis of the regulations and the feed-in tariff is questioned politically as stated by HÖNING/MARSCHALL (2014).

The topics of the discussions are similar to the ones of the newspaper. The author focused on the speech acts during the discussions and observed the typical behaviour archetype of point-counterpoint in a closed structure related to KANTOR (1996, 2012). Due to the further observation that the small wind was no topic during the discussions, the author assumes a closed ´frame of action` influenced by the mainstream model.

6.3 Summary of the Results of the Deeper Individual Structures

The main content of the interviews are summarized in clusters that reproduce the sayings of the interview partners. The first part considers the results about the big wind industry and the second part about the small wind turbine sector. The main contents of the first part are:

- Origin of the wind industry which is described as the anti-nuclear movement with green decentralized concepts.
- The Growian which is described that it was intended to fail and partly that this was the beginning of the new up-scaling of the turbines.
- The identity-forming stories with the experience of non-acceptance, irony and attacks with the critical sentences that the new ideas do not work and that it is too small.
- High motivated people with different kind of knowledge were working in a network and welded together against the outside with having the goal to present a different energy system. The presentation of the community changed from the pioneer status to a professional business field. The concept of the enemy is partly described as being still valid. A lack of communication is assessed as actual problem in the wind projects as described by some interviewees.

- The technical development is related to an up-scaling of the dominant three-bladed design. The idea of small decentralized units from the beginning was cut and has been replaced by the trend of getting as large as possible which is connected with the driving force of being economical. The Green Party changed the orientation to centralization as well to provide a real energy alternative and the large wind turbines are partly described as a green symbol. Single persons see a lack of identity of the field due to the exclusive orientation or describe the purely economical orientation as a misguiding path.

- Professionalism has a high meaning and is described as contradiction to the pioneer status of the beginning. It is related to the concentration of the companies and important in the increasing competitive environment. Others question the high status of professionalism and describe the status as being in the *´puberty`*.

- The EEG is described as the most supporting influence for the growth of the field due to the security for the investors. The Green Party had a major role as the representative of the ideas in the political environment.

- The importance of the storage is described as well known since the beginning of the field but the research for it was not funded. The need of additional transmission lines is assessed as necessity but the dimensions are partly doubted.

The main contents of the second group focusing on the small wind technology are:

- The decentralized approach of the small wind turbines can be summarized as reminder of the past by the large wind turbine pioneers. The small wind actors are facing similar reactions from them as they were facing during their early times. This includes similar critical sentences.

- Small wind technology is assessed as being non-economical and a contribution to solve the energy problems is not considered politically although decentralization as a topic is currently discussed. The legislation is not specified for these applications of wind energy which is assessed as crucial important to change the situation for small wind in Germany. The scientific back-up is described as insufficient to change the situation and the R&D for small wind is limited.

- The lack of professional representation of the small wind sector (BVKW) is mentioned as a reason that the political recognition is so low.

- The marketability of the technical versions is often not achieved or the products do not reach their promised performance which reduces the trust of the customers.

- Resentments on both levels between the actors of the two different approaches are pictured which include the two associations BWE and BVKW.

- Some people specified that the small wind technology provides opportunities that cannot be fulfilled. The chances are mainly seen in the electro mobility and the transportation sector. Internationally, the rural electrification is valued being an important issue.

The difference between the first and second generation of the large wind actors are detailed separately. The comments of the second generation indicate a different openness to small wind approaches. At the same time, it is perceived as difficult to discuss this openly by the actors.

Interpretation of the interviews

The focus was set on the model building process of the actors who entered the purely centralized energy field with an exclusive decentralized approach with small wind turbines. Due to the experienced obstacles and economical forces, the steps of the model adjustment lead to an orientation of being exclusively ´big` and centralization. The incorporated sentences and the adjusted model could easily spread in other rooms due to the network. The close relationship to the Green Party facilitates this process in the political field. Referred to JOHNSON-LAIRD (2005), the process of reasoning was transferred to other rooms which is a synonym for KANTOR`s communication field of the face-to-face level (1995, 1997, 2012). A mainstream model was established and deepened. The basic assumptions about wind energy were temporarily set.

The small wind approach is estimated by the author as a trigger for the actors in this field of accepted large wind energy. Related to KANTOR (1996, 2012), this is described as non-reflected parts of the Boundary Profile and as toxic themes. Referred to KANTOR (2012), the author assesses the behaviour pattern forgetting history. The closing of the system and the concept of the enemy are identified as structural traps. Additionally, a tendency of polarization is noticeable that underlines KANTOR´s definition of mental models as moral models (2012).

The close relationship of the wind energy to the Green Party leads to the description of the wind energy culture related to SCHEIN (1995, 1999, 2003). The large turbines are appraised as viewable artefacts. The interferences between the deeper individual structures and the broader social structures summarize the interpretations of the results of the Team Learning Model. It is assessed by the author that based on the established mental models of the actors the conditions for wind energy in Germany were set aligned to these mental models. The different aspects of the adjusted model are to be seen as closely welded together.

The wind energy achieved high acceptance as an industry (BRUNS ET AL. 2008, OHLHORST 2009). Furthermore, it is the main renewable energy for the energy transformation and the decision of the phasing-out of the nuclear energy (2011). Nevertheless, the author estimates a risk to get stuck in the own progress which is detailed in the need for change.

6.4 Summary of the Theory of Change of Case

The author defines the Theory of Change of case, the Theory of Practice and the recommendations considering the results of the four dimensions of the Theory of Thing. The results of the interviews lead to a focus on a phase of reflection at the beginning of the change process. The Theory of Practice and the recommendations are worked out as far as possible. The recommendations are formulated for the big wind industry and the governmental level to decrease the maintaining forces (LEWIN 1953, CUMMINGS/ WORLEY 1993) and for the small wind sector to increase the changing forces in the field.

6.5 Recommendations

Based on the above elaboration, the author decides for three different task groups to give recommendations. The recommendations consider parts of the results of the Theory of Thing on the four dimensions.

These are:

1. The governmental level

2. The representatives of the big wind industry including the BWE

3. The BVKW as representation for small- and middle-sized companies of the small wind sector

Due to the fact that the influence of the governmental level is considered as an influence with high importance, the author chooses recommendations for the governmental level especially the new founded ministry of energy and economics. The recommendations are:

- To be open to increase the awareness about the influencing part of mental models in the decision-making processes

- To reflect the current mental models that are the basis for decisions and strategies with different methods

- To open up for additional perspectives considering the decentralized approach of small wind turbines and not to discard them from the beginning on by initiating a cross-model conversation

- To review the possibilities for energy efficiency and energy production given by infrastructural applications which are recommended by international experts that are assessing an important meaning for the decentralized small wind

- To review the chances of saving the cost-intensive net expansion by implementing regional projects considering the small wind in combination with storage as basis for SMART communities that could be scientifically accompanied and evaluated

- To review the chances of the combination with electro-mobility and the renewing of the infrastructure

- To focus on supporting programs that empower the funding organizations to provide support for the small wind sector to reach the marketability of small wind turbines and to evaluate the chances given by a mass-production

- To strengthen the interested customer by financial support either by funding small wind turbines and/or by separating and increasing the feed-in tariff for small wind applications or to look for other suitable supporting mechanisms.

Recommendations for representatives of the big wind industry are:

- To increase the awareness of the mental models that were developed during the history of the development of the own field by confronting the representatives with the results of the interviews
- To put the focus on the structural traps and the risk of minimization of the efficiency within the projects and the limitations of the whole field of the exclusive orientation of being big to create a positive tension
- To start a reflection with core groups with different methods ideally initiated by the BWE
- To start a cross-model conversation with representatives of the small wind sector ideally with the BVKW if this is accepted.

The recommendations of the first two groups are supposed to decrease the strength of the maintaining forces within the wind field whereas the recommendations for the third group focus on strengthening the forces driving for change. The third group are representatives of the small wind sector including the BVKW. The recommendations to strengthen their position within the field are:

- To confront the representatives with the results of the interviews mainly focusing on the feedback of how the products are presented and projects are executed
- To initiate standards of quality
- To increase the integration of the vertical versions as the potential for the infrastructural applications
- To strengthen the BVKW to present its own identification and at the same time to approach the BWE for a cross-model conversation

- To strengthen the presence on the governmental level to get more attention to be able to convince the decision makers about the possibilities of small wind applications as described above in the recommendations for the governmental level.

7. DISCUSSION

The chosen literature shows the different aspects of the issue surveyed in this thesis and is the first dimension of the Theory of Thing. The topic is characterized by highest complexity and combines economical, scientific, sociological, technical as well as psychological aspects and is to be seen interdisciplinary. The KANTOR approach is the guiding line during this thesis. Energy and systems thinking came together closely by applying the systems thinking approach on the earth system. FORRESTER`s (1961, 1971) works imprinted the start of a rethinking about the resources of energy. The high meaning of the energy field and the transformation of this field is the focus of interest. It is an international issue. Germany took an additional step that was the decision for the phasing-out of the nuclear energy. The energy transition that started long ago gets another meaning and is called the energy transformation. The wind energy is considered to play the major role within this transformation.

7.1 Changing of Energy Needs

The report Limits of Growth was a trigger on different levels in politics, economics and the whole society for a start of different thinking. Also the social movements refer to it. The limits of the fossil energy sources on earth became aware. First signals of the climate change by human impacts were seen by the scientists. MEADOWS (2009) assessed the report of being successful in transferring the message of limited energy sources whereas the core message of how to deal with these circumstances was insufficiently passed. Nevertheless, the report had a high impact. Referred to the change curve (CHAPMAN/JUPP 1992 by FATZER 1993, 1999, 2005), it can be analyzed as a shock situation.

The oil crisis in the 70ies of the last century was another shock situation. The high reliability of the energy supply was at stake. This can be defined as the need for change referred to the BECKHARD model (1987). It is understandable that the drive to focus on nuclear energy was close to the established top-down approach[628] which is described by KUNZE (2012). This form could be easily integrated into the former system. The anti-nuclear movement talked another language and it grew. People within this

[628] See MAUTZ ET AL. (2008) pp. 21ff., nuclear power stations were assessed as high compatible with the sector regime of the centralized electricity system.

movement started to search for alternatives based on another angle of perception and attitude. The energy form they focused on was wind.

Wind has its own rules and is a natural source that cannot be influenced and is depending on the geographical conditions (TONG 2010, PELTE 2010, HEIER 2012). To harvest the wind means to get adjusted to the wind. This can have various forms. Wind is advanced in converting the energy to electricity. Electricity is determined as the main usable form of energy in the future by the European Commission (2011).

The interpretation of the best way to use the wind energy depends on the possibilities that are provided by other related technical availabilities such as electrical devices e.g. generators. The suitable management of the electricity has a high meaning. Cultural influences given to the former traditional system have an important meaning as well (SORENSEN 1993). Referred to KANTOR (1995, 1997, 2012), the following table shows the overview about ´the Thing` wind that cannot be changed and ´the Thing` that are the variations of interpretations that can be changed.

Table 9 Basis of wind energy and changeable frame of action

Basics - Not to Change	Frame of Action - Changeable
Wind as natural source Different wind speeds due to the region Offshore and coastal areas are the best wind regions Inland wind is fluctuating Wind speed increases in the height (how much depends on the surrounding surface) Wind is available wide-spread also within the infrastructure Wind energy has to be converted for use Gained wind energy needs storage to ensure the security of supply	Decision about a suitable technology and design Decision about the concept: centralization or decentralization Decision about necessary combination of decentralization and centralization that meet the future needs The combination of electrical devices and management depending on the technical development Depending on the main culture dealing with energy (tradition)

The modern wind industry grew nationwide and internationally based on one technical design that was decided on in the early years of the field. Germany was the leading country in wind based on the political regulations (EEG) that was also spread as a model to other countries. It was and still is one of the main driving countries in climate protection in general that has been a topic of growing importance due to the increasing explicitness of the planet`s warming (MORRIS/PEHNT 2012).

As it is illustrated in the table 9, the usage of the source wind can have variations that include large, centralized and decentralized concepts. While the wind power with large wind turbines is determined and not questioned as the most promising renewable energy with tremendous growth (TONG 2010), international experts assess the small wind turbines as an important contribution to the future energy supply system with a growing market as described by MATSUMIYA (2010) and STAUDT (2010). Additionally, the vertical turbines are acknowledged due to the advantage of a possible combination with the infrastructure and other applications (COOPER 2010, STAUDT 2010). MATSUMIYA (2010) and ZHANG ET AL. (2012) are claiming for a generalization of the technical standards for small wind turbines to fulfil the contribution in the future energy system. The life-cycle analysis (figure 18) by MATSUMIYA (2010) is a model that supports the decision of the most applicable turbine system within its specific environment related to the purpose.

The power coefficient of different types of turbines has a high meaning and is illustrated in different variations with the same ratings of efficiency in Germany (SCHAFFARCZYK 2010, PELTE 2010, HEIER 2012). The vertical Savonius has a lower rating[629] in these illustrations in comparison to the illustration (figure 17) of KOMATINOVIC (2006). Due to the importance of these illustrations being the reference in science and economics, the openness to find the best solution in the determined environment could be decreased and it can be seen as one reason for the minimal acceptance of the decentralized approach in Germany.

Horizontal turbines are not suitable for the installations close to settlements or as part of the infrastructure due to their noise (PANTAZOPOULO 2010) and shadow effect (LANDWEHR 2011). MATSUMIYA and COOPER (2010) state that the technical problems with the swinging power of vertical versions are solved nowadays.

[629] See APPENDIX NO. 10.3

The different illustrations of the power coefficient, new technical availabilities and the importance of the purpose of a turbine might be a field for further investigation and the R&D has to be funded. The results of the interviews show that the investigation of small or vertical versions has no priority in Germany. The request of finding the best solutions related to the purpose (MATSUMIYA 2010) could be minimized.

This can be evaluated as a change of purpose in the wind energy system referred to PROBST (1987) and MEADOWS (2009/2010). The purpose is not exclusively related to meet the future energy demands in an optimal way considering centralization and decentralization. Based on the results of the interviews the current mental models might have a major influence on these proceedings. The author assesses a guiding influence of the mental models on the interpretation of the purpose. The purpose is characterized of being oriented backwards (figure 39) by espousing being oriented to the future. Related to SCHEIN (1995, 1999, 2003), the guiding impacts of the level of the basic assumptions seem to be different in Germany than internationally.

The EUROPEAN COMMISSION (2011) sets the goals of the decarbonisation path including the transportation system and emphasizes on a combination of decentralization and centralization of the energy system to partially save the cost-intensive grid expansion (DENA 2012). The implementation of intelligent management systems considering a change of the role of the customer by alternative business models is assessed as indispensable. Referring to WOHLFAHRTSTAETTER/BOUTELLIER (2009, 2010), those innovations are insufficient in the European energy system due to the tradition of monopoly although they could minimize the peak demand as already experienced in the USA. In Germany, no special feed-in or smart metering is discussed to bring the decentralized versions ahead (LANDWEHR 2011). SPRENGER (2011) describes a classification of different collisions of the electricity sector that negatively refers back to the progress of the implementation of SMART grids.

7.2 Discussion of the Results of the Broader Social Structures

The influence of the energy crisis of the 70ies (BRUNS ET AL. 2008) was the overall context of the beginning of the modern wind energy in Germany. The field started small in technical and organizational size and was characterized by a pioneer status (MAUTZ/BYZIO 2005). The technical increase in size went fast due to the scarce ground of most advanced high wind speed regions and the motivation to work economically (MORRIS/PEHNT 2012). This was the basis to gain more interest and acceptance in the political scene. The scientific level is backing the big wind industry and the associations became the speaking tube of the industry (OHLHORST 2009).

The political level and the wind energy cannot be seen separated. The Green Party was the guarantee in the German parliament to bring the topic of the renewable energy further as described by MAUTZ/BYZIO (2005). The EEG was the continuous back-up for the wind energy and is evaluated as the key for the success (MORRIS/PEHNT 2012). The trend of centralization, onshore and especially offshore, replaced the decentralized approach from the beginning completely (OHLHORST 2009). Due to the large sizes, the trend is to expand in the middle mountains and some projects are already in the process of planning (WEINHOLD 2012). The increasing international competition pressures the industry. A high percentage of the business is based on export (RENTZING 2012). In summary, the big wind industry is characterized as an advanced industry with an increasing level of employment, worldwide acknowledged and accepted as the backbone of the German energy transformation.

Limitations of the expanding big wind industry are the technical related systems. The grid expansion is delayed (BWE 2013) and the citizens are partly refusing them. Due to the increasing electricity prices (MARSCHALL/QUADBECK 2014), a change in the political strategy started in 2012 by opening the wind market for the free commerce. The new EEG (2014) defines the capacity for installations as 2,5gigawatts annually.[630]

A few scientific voices (WEINHOLD 2012, HÖHMANN 2012, QUILTER 2013) start questioning the approach of getting just larger due to the technical problems and decreasing efficiency related to the size. Due to the further expansion in natural regions, the author sees an ongoing conflict of interest between the micro-ecological and the macro-ecological level. This refers back to RAVE (2007) and OHLHORST (2009).

The small wind sector consists of small companies. The technical standards are not determined and the variations of the turbines are numerous (LANDWEHR 2011, EISELT 2012). Economically, the small wind turbines are assessed as questionable (FRANKEN/TRECHOW 2013). This and the legislation which was adjusted to the

[630] BUNDESMINITERIUM FÜR WIRTSCHAFT UND ENERGIE (2014), www.bmwi.de

larger turbines increase the problems in the implementation processes (FEST 2013). Due to the fact that a lot of versions do not reach the marketability, disappointments of the customers are recognized as described by JÜTTERMANN (2013). In the future, an increasing demand is expected worldwide (HANDELSBLATT 2010) and the BVKW expects 700.000 installed units in Germany in the next years (GRIESER ET AL. 2013). Small turbines and especially the vertical turbines are assessed of having high potential due to the applications in SMART grids, electro-mobility and infrastructural combinations (EISELT 2012).

Combining the development process of the wind industry with the KANTOR approach, the author identified different steps with changing orientations. First ideas of the start of the big wind industry were concentrated on the pure decentralized approach aligned with self-organization. This approach how to generate energy was fundamentally diverse and in contradiction to the traditional energy system. Referred to KANTOR (1995/1997/2012), the author evaluated a general model clash (figure 29). OHLHORST (2009) describes the traditional, monopolized energy system as centralized with the exclusive orientation to ensure the security of supply. During this phase, the contribution of wind energy in the energy supply is described of providing no important contribution. OHLHORST (2009) evaluates that the concepts of the traditional system and the alternative constellations secluded themselves.

The actors were successful by adjusting to the traditional energy system. The nature of wind was connected with the traditional energy supply system by increasing the size of the turbines and by accepting the general laws. This is characterized by the author as a selective model clash with the ´adjusted orientation` towards the traditional system. The model clash shifted from the general model clash to a relative model clash (figure 30). This suits the appraisal of OHLHORST (2009) who assesses the wind energy as accepted niche and later on as an accepted industry “that is adjusting steadily to the structures of the centralized system.”[631]

The actors of the approach of decentralization stepped into the field when the wind energy was mainly adopted by the traditional system. The centralization is in the foreground, OHLHORST (2009) describes this phase as the complete replacement of

[631] OHLHORST (2009) p. 288

the origin ideas. A general model clash between the big wind industry that is mainly included in the traditional system and the small wind sector is illustrated (figure 31) by the author. Due to the adjusted orientation of the big wind industry, the market entry of the decentralized small wind is challenged additionally by the mainstream model of wind. The regulations for wind were already executed with the described disadvantages for small wind applications (OTTER/PEHNT 2009, FEST 2013). The adjusted model consists of the horizontal turbine design which is described by JÜTTERMANN (2013) as the ´normal turbine` and the elementary expansion of size, both in turbines and projects.

The model clash affects most probably another level as well. The big wind industry and the small wind industry are in different phases of innovation. The big wind industry is advanced with defined technical standards and production processes. Referred to the innovation phases described by WOHLFAHRTSTÄTTER (2010), the big wind industry is in the specific phase of design innovation. The dominant design was already set in the 90ies and the production processes were improved and concentrated (BRUNS ET AL. 2008, OHLHORST 2009). In the increasing international competition the focus was set on cost-optimization.

In contradiction, the small wind sector can be assessed as being in the fluid phase of product innovation or for some specific products being in the stage of the transition phase (OTTER/PEHNT 2009). Due to the difference in the focus of optimization, it is economically questionable to bring the production processes together. Changes in the product innovation and production processes are very cost-intensive in the specific phase (WOHLFAHRTSTÄTTER 2010). Due to the lack of efficient production processes, the small wind sector is economically unattractive at a first glance. Actually, the prices per kilowatt hour are calculated similar to the offshore costs (EGGERSGLÜß 2012).

The change of the mental models is obvious due to the results of the broader social structures and the deeper individual structures. The different aspects and the different levels are interconnected closely. A change in one of the described levels of the broader social structures influences changes in the other levels.

7.3 Discussion of the Results of the Interviews

The interviews expose the real life stories besides the official literature. They are the self-identifying stories and tangible examples for how social systems are processing referred to SCHEIN (2005), LEWIN (2012), LITTERER (1973) and KANTOR (1995, 1996, 1997, 2012). The incorporated sentences suit the description about mental models of JOHNSON-LAIRD (2005) based on CRAIK (1943). The formulation of the model building process followed the steps of KANTOR (2012).

Furthermore, the manmade elements are revealed. The interpretation of how to deal with the source wind changed fundamentally due to the relevant forces in the field. Referred to LEWIN (1953), the relevant forces for this process were the maintaining forces of the traditional system. They are assessed as being very strong forces due to the structures of monopoly (BRUNS ET AL. 2008, OHLHORST 2009, WOHLFAHRTSTÄTTER/BOUTELLIER 2009, 2010). The ongoing experience of not being taken serious at the beginning and of being attacked was a serious push back of the original model. The restoring of possession of the actors (KANTOR 2012) was possible by the strict adjustment of their model by discarding their original model.

The closing of the network system and the ´concept of the enemy` stabilized the internal group of the network. These behaviour patterns are assessed as still actual being structural traps referred to KANTOR (1995/1997). They are recurring and shifted to other levels and are identified by the author as hindering influences in the progress of change.

The different levels in the Team Learning Model complement each other. The influence of the deeper individual structures on the face-to-face level and the broader social structures are obvious in the short-term perspective as well as in the long-term perspective. Related to KANTOR (1995, 1997, 2012), the communication in the specific rooms related to the face-to-face level has a high meaning. The mainstream model was established. This model is estimated by the author as the guiding strategic orientation in the wind energy and therefore, in the transformation of the national energy supply system. This refers back to OHLHORST (2009) and SIMON (2013).

The deeper individual structures reveal the shadows of the success story. Related to KANTOR (2012), the author identifies the behaviour pattern forgetting history. By entering the field in terms of LEWIN (1953) and SCHARMER (2011) the actors were confronted by energy of the maintaining forces. It is assumed by the author that the strength of these forces was as strong as the energy that was needed to discard the original model on the individual level. The author refers to KAST/ROSENZWEIG (1970) and SCHEIN (2005). Related to the high idealism of the actors it can only be assumed how much energy was needed to leave the original path of orientation.

The author hypothesizes further, that this energy was and is still pushing back the idea of decentralization in the way it was attacked earlier. KANTOR describes this as pure noise that has to be avoided. Referred to KANTOR (1996), it is assessed by the author as a non-reflected part of the Boundary Profile. Due to the fact that the energy supply is a matter of highest importance for each society and economy (FREI 2004, WOHLFAHRTSTÄTTER 2010), the transformation of the energy sector can be characterized as a high-stake situation for each individual and level being involved.

The ´new` decentralized approach represented by the small wind sector is evaluated to be a trigger. It somehow reveals the discarded model and the process behind it. Therefore, it is heavily defended. As it is described in the interviews, the author evaluates constraints on different levels such as the non-acceptance and attacks as well as the confrontation with the pioneer status related to working on a semi-professional level. The pioneer phases suit the description of SCHUMPETER (BORBELY 2008) as well as the characteristics of the pioneers which are also in agreement with BRAUNERHJELM/SVENSSON (TICHY 2011). Additionally, the told experiences about the development process of the field are in alignment with the results of the broader social structures and with the evaluation of BRUNS ET AL. (2008) and OHLHORST (2009).

The origin of the anti-nuclear movement and the close connection to the Green Party was determinative from the beginning on (RAVE 2007). The purely decentralized approach challenged the traditional system not only in a mental way but also in a practical way. Referred to MILLES/HORENBURG (2011) and BUCHAL ET AL. (2013), any interference in the electrical system runs the risk of disturbance with multiple consequences. The author assumes constraining situations for the persons who were in charge to balance the grid while being confronted with the need to feed-in the energy out of the wind mills. This could have caused reactions on the face-to-face level that were construed by the wind actors as a general push back of the traditional system that was related to their basic assumptions. The majority of the network consisted of people with an anti-capitalistic attitude (OHLHORST 2009).

Referred to OHLHORST (2009), the network was heavily offended by the traditional system. Two different views at the world or mental models stand against each other. The network protected itself by closing against the outside establishing own values and the ´concept of the enemy`. This is identified by the author as a structural trap that lasts until today.

The anti-nuclear movement is characterized by CORBACH (2006) as a "conglomerate of informal groups and individuals, formal organizations and complex networks"[632]with the common understanding of being against nuclear energy. This refers also to RAVE (2007) and KOLB (2002) who additionally emphasizes on the non-institutional aspects.[633] Due to the foundation of the Green Party (1980), the institutionalization of main parts of the network started. As it was said in the interviews, the *´ideas of the family`* were now represented in the official political scene, especially after the first election into the German Federal Parliament (1983). This appraisal is in agreement with CORBACH (2006) and OHLHORST (2009).

These aspects are especially represented by the results of the group of interviewees who are characterized by three or four features such as direct actors, pioneers, related to the origin of the anti-nuclear movement and being a member of the Green Party (table 5).

The experience of being seriously pushed back (KANTOR 2012) by the traditional system on different levels lead to the adjustment of the original model. To overcome the disappointment of the Growian might have had an influence as well. The failing of the Growian (1987) is described as the biggest disappointment in the history of the wind energy in Germany (RAVE 2007) and is still in the mind of the actors. This is obvious by the results of the interviews and in literature. WEINHOLD (2012) connected his concerns about the strategy of further increasing of the size of the turbines with the Growian. Due to the results of the interviews, the author assumes that the coping

[632] CORBACH (2006) p. 81

[633] See KOLB (2002) pp. 9ff.

strategies of how to deal with the failed Growian had an influence on setting the priority of getting larger within the development of the field.

Due to the network structure, the adjusted model and the incorporated sentences were spread in all relevant rooms in terms of KANTOR (2012). This process is indicated as the basis to establish a powerful mainstream model (figure 38). The described closing of the network against the outside protected the new ideas. The formal political representation of the ideas by the Green Party increased the acceptance and stabilized the ongoing process by supporting regulations. The outstanding meaning of the political influence for the success is pointed out by the interviewees in agreement with the literature. The discarding of the previous model of small wind energy was a part of it.

Some interviewees complained about the missing communication in the wind energy field that negatively refers back to the efficiency in projects and the dealing with mistakes. The author identifies the closing of the network as a structural trap which was possibly shifted from the network to the companies with these negative side effects.

7.4 Discussion of the Theory of Change and Practice

This part of the thesis contains the results of the four dimensions of the Theory of Thing. Referred to BECKHARD (1987), the need for change is defined considering the national and international levels. The results about the mental models are evaluated as core elements (SENGE 1994) and the leverage (MEADOWS 2009) for the ongoing change process in the German wind energy.

As stated by SENGE (1994) and KANTOR (1995, 1997, 2012), all models are simplifications. A level of awareness about possible limitations of the current mental models (SENGE 1994) needs to be achieved. This is considered in the pre-phase. Forgetting history (KANTOR 2012) is identified as a behaviour pattern that can be reflected and reframed to accepting history. Referred to SCHEIN (1995), the constructive energy of Anxiety 1 and Anxiety 2 could lead to a willingness of change. The uncertainty within such a process (figure 4) has to be managed by providing psychological certainty within LEWIN`s three basic stages of change to close the gap between the present- and the future state (figure 6, BECKHARD/HARRIS 1987) as described by SCHEIN/BENNIS (1965), SCHEIN (2005), CUMMINGS/WORLEY (1993), FATZER (1990) and SCHERMERHORN (1996).

Being confronted with the results of the evaluated mental model may lead to a shock situation for the persons and groups related to the change curve model (figure 4) of CHAPMAN/JUPP (1992) referred to FATZER (1993, 1999, 2005). The mental pre-phase is assessed as essential to reach the leverage for a fundamental change.

The steps further and concrete interventions are on a high level of assumptions due to the fact that the author did not have more data to explore the actual state. The presented model of the transformation process is based on the results of this thesis and therefore, the model is limited as well. A further research and process of diagnosis (BECKHARD/HARRIS 1987) is necessary to deepen or to correct the insights. This could be combined with first reflection groups on the different levels. The concrete constellations and the methods of interventions can only be elaborated after further analysis of the situation.

The suitable settings and the persons who are the change agents within this process have to be specified later on as well. As described by SCHERMERHORN (1996), SENGE (1994) and BENNIS (1990), the leader`s role is of highest importance for the success of change processes in general. The leaders are the ones who adjust the mental models and therefore, they are the carrier of the culture and the mental models. Their actions and success stamp their field. Referred to SCHEIN (1995, 2005) and KANTOR (2012), the reflection of the limitations of their model is of immense meaning for further progress in the process of the energy transformation.

The interviews show a high acceptance of the interviewees to open up for the research topic. The results of the interviews include first reflections of the own models of the interviewees which was intended by applying diagnostic conversations using methods referred to STRAUSS (1998), WOHLFAHRTSTÄTTER (2010) and SCHEIN (2000, 2010).

7.5 Cultural Influences

The elaborated mental models are the main part of the cultural identity and the core beliefs of a group of people based on their experience to be successful to survive. They are the basis for the typical wind culture. Referred to SCHEIN (1995, 1999, 2003), this is an unquestioned knowledge of the actors and their guarantee to be successful. The

Green Party is a main part of the network and, at the same time, it was the political backing of the network and later on of the growing companies.

The incorporated sentences formed basic assumptions that do not question the technical design and the orientation to get bigger. Furthermore, the Green Party adopted the large wind turbines as their obvious symbol of success. The symbol has a high identifying aspect (HOFSTEDE ET AL. 2010) that is more important due to their size. This refers to the visible level of the artefacts described by SCHEIN (1995, 1999, 2003). Referred to HENSLIN (1997), it can be evaluated as part of the material culture of the wind energy group.[634]

The centralized orientation and the discarding of the origin of green politics are recognized by the second generation that requires a rethinking of the energy system in general and starts questioning the mainly centralized orientation. It seems to be difficult to formulate this issue in an open and official way as it was told in the interviews. The author assumes that the actors feel the strength of the maintaining forces of the adjusted model being a part of the wind and green culture.

The author would like to refer to TUSHMAN/O`REILLY (1998) that on one hand the culture is based on success in a competitive environment and, on the other hand, cultural idleness hinders to adjust in new situations and is a barrier when change is needed.

SIMON (2013) states: “a conservative basic attitude is obvious in the energy discussion in contradiction to the studies of an alternative energy supply system earlier...a structure of concentration of power stations and their negative side effects are not questioned...a consideration of decentralized regional suitable solutions is evaluated as being old fashioned...to approve this with respect of sustainability...it is a fact that the energy transition considers only selected parts of the sustainable society”.[635]

[634] See HENSLIN (1997) p. 35

[635] SIMON (2013) p. 136

7.6 Political Frame of Action

The fact that the small wind approach is not considered in the political decisions and evaluated as not being a contribution to the energy field can be referred to the interrelated processes of the broader social structures, the face-to-face level and the deeper individual structures. The observation of the round tables on television shows the same results as the actual issues of the newspaper. The topic of small wind was not mentioned by all the representatives although they partly represented a decentralized energy approach. In the observation the author concentrated on the flow of speech acts and identified the communication structure of point-counterpoint (KANTOR 1996, 1997, 2012). Different possible directions and cross-model conversations in the general strategy of the energy transformation are hardly possible. The author assumes similar flows of conversations in the political practice in general. The representatives are acting related to their specific reference system. This is evaluated as a possible result of the constant influence of the deeper individual structures on the political level.

The topics of the newspaper are mainly middle- and long-term effects of the previous energy politics such as the merit order effect (GRUET 2011), the increase of electricity prices (BUCHAL ET AL. 2013), the threat of unemployment and minimization of the security of supply (HÖNING/REISENER 2013). Conflicts on the level of the federal states and on the level of Germany and the European Union are recurring as well (HÖNING/MICHELS 2014).

The grid expansion is delayed that increases the costs for the customers (BWE 2013). Referred to LEAHY ET AL. (2010), HENNICKE/WELFENS (2012) and BISCHOF (2007), storage in large dimensions is limited and under R&D. Big projects are refused by citizens (WAZ 2013) and the scarce ground forces to expand in more natural regions. The prices of electricity increase from year to year (WAGNER-WIEDULT 2013).[636] The ´magic triangle of goals in energy politics` (figure 15) by ERDMANN/ZWEIFEL (2008) and the ´political-economical-ecological cycle` (figure 16) by FREY (1993) are suitable illustrations. Additionally, it can be referred to ERDMANN/ZWEIFEL (2008) who describes these processes as insufficient correction of the market failure and failure of politics.

[636] The increase was 60% during the time 2002 - 2012, see WAGNER-WIEDUWILT (2013) p. 6

The micro-economical level refers back to the macro-economical level as described by ERDMANN (1992). The politicians are announcing a decrease of the feed-in tariff and a limitation of new installations for onshore applications to solve the problems. The offshore tariff that represents the most centralized approach is not touched (HÖNING/MARSCHALL 2014).

The pressure on the politics is to save the employment on three levels. The big wind industry has to be supported by subsidies and the energy-intensive industries by dispensation of their compensation of the EEA. The merit order effect (figure 21) puts additional pressure on the energy system because the energy providers are struggling due to non-profitable power stations (BUCHAL ET AL. 2013).

Furthermore, the security of supply is endangered while the energy providers start refusing to maintain the stand-by power stations. The least poisoning fossil stations powered by gas are the ones under highest pressure. Additionally, the amount of CO_2 caused by more burning of brown coal has been increasing in Europe until 2012.[637] In Germany, it increased to an amount of 1,5% in 2013 in comparison to 2012.[638] The increase of the emissions caused by an amount of 162 billion kilowatt hours produced electricity by burning of brown coal is the highest since the German reunification.[639] Also the burning of stone coal increased to an amount of eight billion kilowatt hours and reached the amount of 124 billion kilowatt hours. The amount of electricity that was produced by the nuclear power stations that were already shut-down is numerically compensated by fossils whereas the electricity produced by the gas power station is reduced by 10 billion kilowatt hours due to the merit order effect. The energy expert GRAICHEN is talking about the "paradox of the energy transition"[640].

This refers back to EKINS (2011) who illustrates the short- and long-term consequences as well as the unintended consequences that increase the problem on the long-term by easing it on a short-term as described by ANDERSON/JOHNSON (1997). Referred to BRUNNENGRÄBER (2009), it can be construed as a problem of

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[637] REIMER (2012) www.klimaretter.info

[638] HELLWEGER ANZEIGER (2014) www. hellwegeranzeiger.de

[639] SPIEGEL ONLINE (2014) www.spiegel.de, main reasons are seen in the combination of merit order effect and cheap CO_2 certificates

[640] GRAICHEN (2014) www.ml.spiegel.de

knowledge that is characterized by the occurrence of non-intended side effects based on the lack of knowledge about the subject of regulations and their interconnections related to the target.

Referred to EASTON (1957), the political system is an open system with input and output converted by the system. As seen on the different levels, the conversion process is mainly a closed system of mind that minimizes the output. The author assesses this as a stuck situation related to KANTOR (1995/1997) and referring to the change curve of CHAPMANN/JUPP (1992) by FATZER (1993, 1999, 2005) as being in the second step of avoidance of the change curve (figure 4) within the energy transformation process.

Due to the results of the interviews, the mental models of the actors of the wind industry play an important role within this stuck situation. Their history and adjustment towards the traditional system is the main reason for establishing a strong wind alliance. At the same time, it seems to be a reason for staying in the fossil-related centralized energy system approach.

In difference of the requested reference of renewables, the reference remains the fossil-based system with the centralized approach. The reference source wind is pressed in this traditional system and not considered in all its dimensions.

Referred to MEADOWS (2009), it is an ineffective effort to anticipate and cope with the situation. As described earlier, this topic is not openly discussed right now. The author identifies a distraction of the purpose of the energy transformation process related to PROBST (1987) and MEADOWS (2009/2010).

7.7 Future Concepts

The 2°- degrees border that is defined as critical stage in the global warming by several scientists (STUTZ/ITTERSHAGEN 2012, EDENHOFER ET AL. 2012, THE WORLD BANK 2012) is at stake. A major issue is to be seen in the balance of the national independency in relation to external influences as described by BRUNNENGRÄBER (2009). The failure of economics and politics are combined together. This refers back to the structure of the problem by JÄNICKE ET AL. (2003). Time is of crucial importance because it is obvious that the system has the tendency to fluctuate more which is part of a critical situation referred to LASZLO (2003, 2008).

Additionally, the limits of the sources as depicted by PELTE (2010) will put more pressure on the situation.

The nuclear phasing-out of Germany was a major step (2011). To get rid of the fossils and the nuclear is a challenge, based on the fact that 80% of the world`s energy is still provided by fossils as detailed by ARMAROLI ET AL. (2013). The energy supply system is internationally related (JÄNNICKE ET AL. 2003). A short-term solution could increase the problems in the long-term in general and create unintended consequences. The author refers to the suiting system archetype ´Fixes that Fail` as mentioned earlier in this thesis. ANDERSON/JOHNSON (1997), KIM/ANDERSON (1998), FORRESTER (1971/2010) and SENGE (1994) are suitable references.

The transformation of the energy system includes the whole society. The WBGU (2011) clearly states that this transformation is no evolutionary transformation in contradiction to other previous energy transformations. It has to be a guided transformation without exactly knowing what is going to happen referred to REICHE/BECHBERGER (2006). Guiding this process influenced by non-reflected mental models increase the risk of failing as described by FORRESTER (1971, 2010).

The UNEP (CLIMATEACTION 2013, 2014) puts a focus on urban solutions. Another focus is the rural electrification in the non-industrial countries. For those applications the mainstream model of wind, being the main interpretation of how to use the source wind, is insufficiently suitable.

International scientists already start to find alternatives and seem to be more open to deviate from the exclusive way of harvesting the wind. Surveys with vertical turbines show other results than they are known and taken for granted in Germany. They could be combined with the urgent need of rebuilding of motorways and bridges.[641]

The trend is to be seen in co-financing and in combination with resources for street lighting, electro-charging and further applications that are pointed out by the WWEA (MAEDA ET AL. 2013) earlier. Electro-mobility and SMART grids are more advanced in other European states e.g. Norway, the Netherlands[642]or Austria (2014). In Great

[641] See ABERLE (2012) pp. 5ff.

[642] PLANET-E (2014) ZDF

Britain the first decentralization conference took place in May 2014 in partnership with the UNEP.[643]

Economical development and energy are welded together by tradition as described by MOUSSIS (2009) and KAREKEZI ET AL. (2012). An additional field joins the close relationship already today. Energy and economic development are to be seen in partnership with communication technology.

The IT was the most influencing changing business in the last decades. It is supposed to be the management of the modern energy supply system. BRUNE (1998) evaluated this as the chance for energy efficiency.

SMART grids are assessed to be central in the future renewable energy management system and it is called energy (r)evolution by (TESKE ET AL. 2014) and the third industrial revolution by RIFKIN (2014). Mini grids and mini power stations connect the renewables together managed by the internet, e.g. the “Schwarmstrom”.

Storage facilities keep the unused energy to provide it on demand as requested for the business- and market model innovations in the electricity sector as illustrated and specified by WOHLFAHRTSTÄTTER/BOUTELLIER (2009, 2010). Figure 41 illustrates the IT as the binding link of all relevant levels surrounding the wind energy.

643 See CLIMATEACTION (2014) www.decentralisedenergy.co.uk

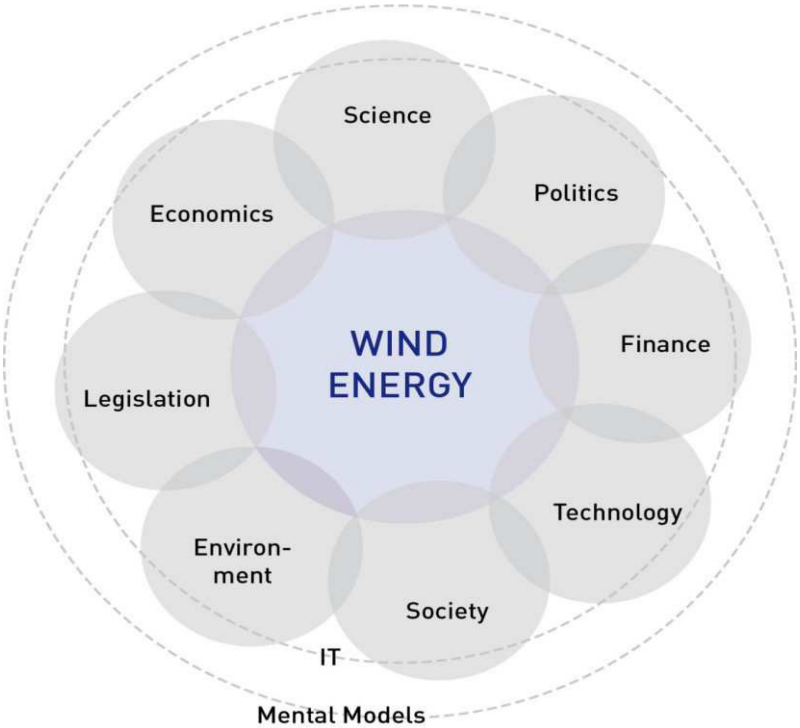

Figure 41 IT as binding link of relevant levels for the wind energy

Referred to SIMON (2013), the conditions have changed in comparison to the early stages of the big wind industry. The technical equipment for the decentralized approach is available in contradiction to the early years and can be implemented in mutual combination with centralized versions. Regional concepts considering the infrastructure are requested. The transportation system has to be included as requested by the European Union (MUSIOL ET AL. 2012).

Multiple small wind units also bring interesting amounts of energy and can be integrated in the landscape and the infrastructure as proposed by EISELT (2012). First future concepts consist of decentralized multiple mini grids administrated by the energy internet integrated with storage, applicable in buildings and other infrastructural facilities.

Referred to RIFKIN (2014), SIMON (2013), EISELT (2012) and DEXIN (2012), this approach will be one main column to achieve the climate goals in the next decades. The majority of future illustrations concentrate on the expansion of transmission lines with a centralized approach of wind energy as shown by the EWEA (2010) provided by

SINNER ET AL. (2010).[644] The SMART grid illustration of TESKE ET AL. (2014) provided by Greenpeace does not include small wind applications.[645]

The opportunities provided by the small wind approach and described by several experts are not much recognized. This was also stated in the interviews that opportunities of small wind cannot be fulfilled although the demand is noticeable. The combination of small units with storage was already favoured by LEAHY ET AL. (2010) who stated that the advanced battery storage has the potential to reduce the need for grid infrastructure and could be implemented fast.

7.8 The Change of Reference

The International Monetary Fund has recently estimated that global costs and externalities associated with fossil fuel subsidies exceed an amount of 2 trillion US dollar annually and additionally, that an amount of 30 billion US dollar for green conservation per year can accelerate global change to inclusive and sustainable growth.[646]

The transformation of the energy supply system as a huge transformation process includes all relevant parts of the economics and the society due to the fact that energy is so essential (REICHE/BECHBERGER 2006, WBGU 2011). The progress of the energy system is related to the technical process, it complements each other (BRUNE 1998). The IT is the foundation of the future management of energy supply. The ingredients are basically available (SIMON 2013, RIFKIN 2014).

Referred to LASZLO (2003, 2008), the author associates that the society is in a crucial state that is called a ´decision window` or ´bifurcation`. The current culture, the people`s values and views determine the outcome of the phase the society is in. It seems to be of crucial importance to enter a breakthrough phase and not to be too slow to change the belief system of energy and economics. A critical mass of people is needed to shift the transformation in a new orientation.

[644] See APPENDIX NO. 10.4-10.6

[645] TESKE ET AL. (2014) p. 56, see APPENDIX NO. 10.12

[646] See UNEP (2014) APPENDIX NO. 10.13

The economics of energy is related to a system as it was already considered in the 80ies and 90ies by SORENSEN (1993). To be economical was a main driving force for the actors in the development of the wind field as described in the interviews.

The traditional system based on fossils and the highly subsidized nuclear energy (HICKEL 2011, NELES ET AL. 2012, HENNICKE/WELFENS 2012) was the economical reference for the actors and the prices they were competing with. The results of the four dimensions of the Theory of Thing show an adjustment of orientation towards the traditional system including the economics.

Nowadays, new technologies such as the small wind have to compete with the advanced industry of the large wind turbines. As some interviewees stated, the economics have to get adjusted to the renewables and not the renewables to the system.

Technologies and demands have to be set in the focus of calculations due to their future potential. Following the description of the energy economics by ERDMANN/ZWEIFEL (2008) and EKINS (2011), external costs have to be determined and evaluated. Already in the 80ies by KRAUSE ET AL. (1980) and described by SIMON (2013), the decentralized oriented soft track of the future energy system was assessed of being less cost-intensive as the centralized approach.

Especially the institutional frame of action such as the concentration of power, the juristic monopoly in the energy sector, the interconnection of the energy system with the finance of the state and the European compound system were the reasons not to follow this track in the past. SIMON (2013) states further that nowadays the concrete measures do not show the change of the energy system as a whole as requested by the politicians. Regional and urban concepts with a decentralized demand-response approach are not recognized or taken serious. The missing adjustment for new business- and market models are also pointed out by WOHLFAHRTSTÄTTER/BOUTELLIER (2009, 2010) and SPRENGER (2011).

The forecast of the WWEA (MAEDA ET AL. 2013) shows the huge business potentials of the small wind sector (figure 20). The advantages for the infrastructural applications are described by EISELT (2012) and others. Considering the economy of scale, the costs could be dropped down dramatically in the next years similar to the photovoltaics and the IT as stated by RIFKIN (2014) and by entering the process innovation phase illustrated in the UTTERBACK model (WOHLFAHRTSTÄTTER/BOUTELLIER 2009, 2010).

As already said above, the products of the small wind sector are mainly in the phase of product innovation. The vertical-axis wind turbines are in the minority of installations and production that could provide even more economical potential after reaching the marketability (MAEDA ET AL. 2013). The author would like to refer to the life-cycle of wind turbines by MATSUMIYA (2010) which considers the regional conditions and the purpose of the application of highest importance besides the economics of the turbine.

The energy calculation needs to include short-, middle- and long-term costs considering the R&D and the external costs (EKINS 2011). The cost of the transmission lines and their damage of the nature, the losses of energy due to the long distances and the requested large storages, the delays and the resistance of the citizens have to be considered and included in the price. The risk of black-outs has to be calculated additionally. Decentralized regional applications have to be evaluated as well. The results of first decentralized projects show the potential of minimization of the expenses for the grid [647] as also described by SIMON (2013) and LEAHY ET AL. (2010) as well as WOHLFAHRT STÄTTER/BOUTELLIER (2009/2010).

Due to the possible combination with the infrastructure, a solely micro-economical calculation might be not suitable. This refers to EKINS (2011) who states: "...it may well be that, because of their reduction in carbon emissions, renewable energy technologies are highly desirable socially, even if at present they are not eco-innovations (though over time they may become)...".[648]

KEMP (2011) illustrates the three waves approach (figure 42) of the Energy Innovation Agenda (2008) in the Netherlands that describes the first wave of "picking of low-hanging food" that are low carbon reduction options. The second wave consists of almost mature options and the third wave of future options that require R&D.[649]

[647] See KLEMPERT (2014) pp. 28ff.

[648] EKINS (2011) p. 67

[649] KEMP (2011) p. 205

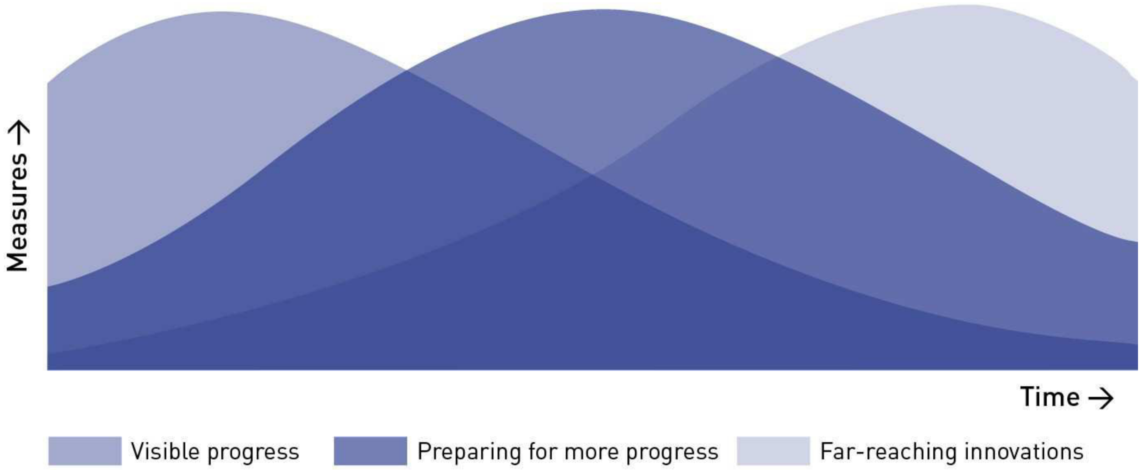

Figure 42 Three waves approach for achieving carbon reductions, KEMP 2011[650]

The economical pressure was a main force for the discarding of the original model of the wind energy actors. Being economical was expressed as a driving force to exclusively getting larger. As one interviewee said this might have been the major failure of the field which is meant as complete submission to the established economical rules. The economical reference system was the traditional fossil-based energy system and their favoured nuclear energy (NELES ET AL. 2012). Since the beginning, the wind energy was competing economically against the established energy that is identified by the author as a major impact for the adjustment of the original model. The discarding of other technical versions and the small approach was the path to success.

The result is described by SIMON (2013) who questions the unilateral direction of the energy transformation. The author agrees to this appraisal and draws an interconnection to the mental models in the wind energy that was established to a mainstream mental model. The behaviour pattern forgetting history (KANTOR 2012) is most probably a main reason that these results of the process could not have been reflected until now. It is evaluated as a permanent influence from the level of myth (KANTOR 1996) and therefore, determining the other levels up to creating stuck situations on the action level (figure 2).

Internationally (UNEP 2014) and in Germany (HENNICKE/WELFENS 2012), the subsidies for fossils are higher than for the renewables that refers back to the political dimension and political decisions.

[650] Ibid. (2011) p. 205, Source: Energy Innovation Agenda 2008, p. 22

Referred to WEIZSÄCKER VON ET AL. (2010), the society is ready to enter a new Kondratjew cycle based on the technical developments. Due to this and the increasing awareness, the conditions have changed and a new window of opportunity (OHLHORST 2009) is open (EUROPEAN COMMISSION 2011). The problem stream is obvious and openly discussed internationally. The policy stream involves all technical availabilities that can be put together to provide additional solutions (RIFKIN 2014, SIMON 2013, EISELT 2012). The political stream represented by the UNEP (CLIMATE ACTION 2013, 2014) is already searching for alternatives to integrate centralization and decentralization with small wind approaches. Internationally, the rural electrification for the emerging countries is a major topic (MAEDA ET AL. 2013). A high need for action is combined with promising business opportunities.

7.9 Applicability of the KANTOR Model

KANTOR`s Meta Model (1995, 1997, 2012) includes the Theory of Thing, the Theory of Change and the Theory of Practice. It is an entire concept of change. The Theory of Thing was divided in four dimensions to cover the relevant information for the topic. The guiding model was the Team Learning Model with the levels of the broader social structures, the face-to-face level and the deeper individual structures. The deeper individual structures contain the mental models and the self-identifying stories which are summarized by KANTOR (2012) as catalytic structures.

The author combined the Meta Model with the Team Learning Model and elaborated the Case Learning Meta Model containing all relevant steps to be able to formulate a Theory of Practice of case. The broader social structures were investigated by literature related to the PESTLE analysis (SCHEUCHER 2002) and the face-to-face level by observation (SCHATZMANN/STRAUSS 1973, DOUGLAS 1976, SCHNELL ET AL. 2005). The focus was put on the elaboration of the mental models which is the least investigated part of the case. The model was shifted from a team level to a business field level.

The qualitative method (STRAUSS 1998, STRAUSS/CORBIN 1996, GLÄSER/ LAUDEL 2010) in the interviews was chosen to analyze the deeper individual structures and to elaborate the mental models. The interviews were executed as diagnostic conversations (STRAUSS 1998, WOHLFAHRTSTÄTTER 2010, SCHEIN

2000, 2010) to provide space for the individual experiences and stories. A model building process could be construed based on the given data. The results of the application are:

- The four dimensions of the Theory of Thing provide an overview about the related topics that provides the chance to discover the interconnections between the dimensions and enriches the Theory of Practice that is based on the Theory of Change.
- Illustrations about changing models in the German wind energy based on the results of the broader social structures to identify the differences in the mental models that create a model clash.
- A deeper insight in the self-identifying stories of the actors of the early stages in the field and their conclusions out of these experiences that enabled the author to identify the incorporated sentences as the basis of the mental models and the driving force to get exclusively ´big` based on the horizontal design.
- An insight that the vertical- and other versions are excluded.
- The small wind approach is identified as a trigger. It includes the non-acceptance and the pioneer status of the beginning. The confrontation with those negative experiences is intended to be avoided that indicates that the guiding influences are on the level of unawareness.
- The behaviour pattern forgetting history reveals the non-reflected parts of the boundary profile, the toxic themes and the critical stories that are guiding the decisions from the level of myth and creating stuck situations on the face-to-face level.
- The insight that the mental models spread in the political- and other rooms due to the network structure.
- The closing of the network against the outside established recurring structural traps that influence the efficiency today.

- A first definition of the specific wind energy culture with a special meaning of the large turbines on the level of artefacts.

- The connection between the different levels of the Team Learning Model that shows the importance for the development of the whole wind energy field and the guiding influence in the transformation process of the energy field that is mainly seen in the change of the orientation towards centralization.

- The actual topics that show the different kinds of conflict levels and the political frame of action as well as the communication structure of point-counterpoint as a closed system.

- Elaboration of the need for change and a Theory of Change related to KANTOR considering the levels of the big wind industry, the political field and the small wind field.

- Elaboration of the Theory of Practice including a pre-phase for the reflection of the guiding influence of the mental models that is evaluated as the leverage for change.

- Recommendations to two levels of actors considering the minimization of the maintaining forces and to one level to strengthen the forces driving for change.

- A connection to insights of other scientists who assess the approach of the energy transformation as being non-sufficient due to the fact that the decentralized approach and additional technical versions are not recognized decently.

- Due to the immense meaning of energy, the dealing with this topic is assessed as a high stake situation for the actors in terms of KANTOR.

- By applying the Team Learning Model, the guiding influence of the most invisible parts can be interconnected with the decisions on the level of the business field and politics.

The Team Learning Model is a suitable model to do an analysis of high complex situations as the one of this thesis. The business field of wind energy is very close related to the energy transformation. High stake situations in terms of KANTOR are related to the risk of losing face on the political level, of bankruptcy on the organizational level and on the private level. It is a high stake situation because of the overall context of climate change and the risk of lack of energy for the humans.

The mental models are the conclusions out of the situation and the critical stories. They are in fact the squeezed summary of the experiences of the processes the people went through. They are passed to other people as a guarantee of success or at least as a support that makes the presence and the future more calculable. Here, the author would like to refer to SENGE ET AL. (1994), SCHEIN (2005), KRIZ (1997) and JOHNSON-LAIRD (2005). The Case Learning Meta Model includes the whole map of the process of analysis that can be also transferred to other situations.

Based on the results, the author creates a formula for energy needs of the actors in the adjustment process of the mental models. EFF = EAM = EMM < ECM whereas EFF stands for the perceived maintaining energy forces within the traditional field, EAM are the energy needs to adjust the model, EMM is the energy that is needed for keeping the adjusted model and ECM is the energy needed to change the model that has to be more than the maintaining status.

7.9.1 Deeper Group Structures and the Collective Boundary Profile

In case that a group of single persons, independent of location or region and also relatively independent of time (within one time period), almost draw the same conclusions based on the same experiences, it is assumed that these mental models are a sum of all deeper individual structures. The author now would like to introduce the term ´deeper group structures`.

Consequently, it can be assumed that the strength of an organizational culture mainly established by the influence of one or a few founders is not as strong as the wind culture. The wind culture was established wide-spread with independent people that brought the same experience together in a network. The network was composed of people with different professional background including the scientists. The circle of players around the wind energy was complete to cover the relevant issues of wind, and, this is even as much as important, the actors spread their incorporated conclusions in all these rooms (figure 38). These processes made the mental models of the big wind industry and the wind culture extremely powerful.

Analogous to the deeper individual structures that are in fact deeper group structures in the case of this thesis, the author would like to adjust the name of the Boundary Profile accordingly. Related to the deeper group structures, the non-reflected part of the Boundary Profile is not only related to the individual level, but also to a collective level. Therefore, the author calls it a Collective Boundary Profile. It is related to similar experiences in the history and similar conclusions out of it that are reflected in the mental models and the specific culture related to SCHEIN (1995, 1999, 2003).

This driving force influences the face-to-face level steadily and, therefore, also the broader social structures and the results. The following figure illustrates the levels and the deeper group structures and the Collective Boundary Profile.

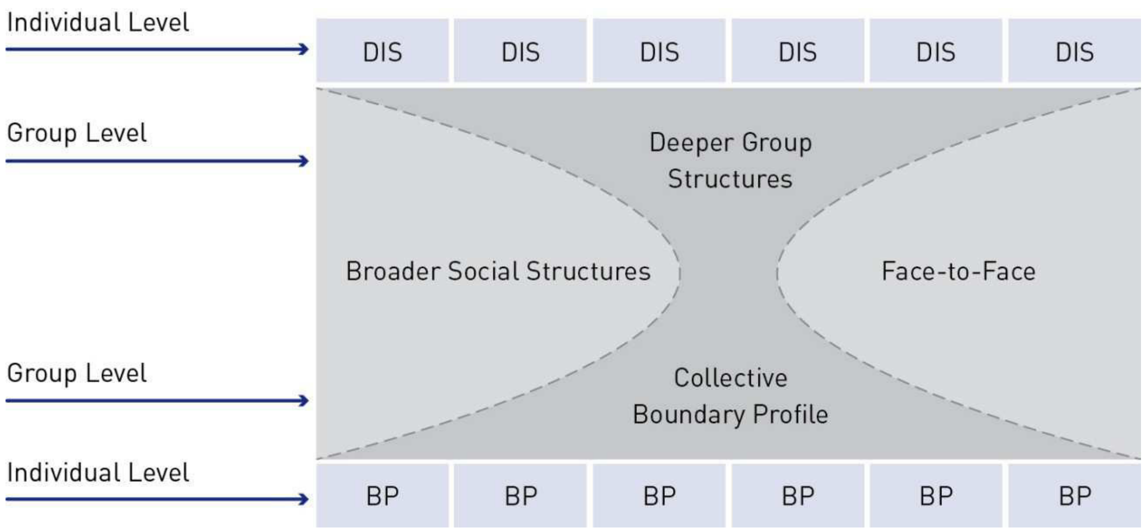

Figure 43 **Deeper Group Structures and Collective Boundary Profile**

These adjustments could be transferred to other situations. The deeper individual structures are not just related to the individual person anymore, it can be evaluated as an individual experience as part of a common process within a whole system. The dynamics of the system and the interconnections with the own individual history get another meaning.

The powerful element of non-reflected parts of the deeper group structures and the Collective Boundary Profile can be explored. It eases the load for the persons to open up with the ´least visible` which is so far construed as being personal and, therefore, it often has a negative taste such as searching for mistakes or blaming somebody. It opens up the idea of being a part of a common story that is related to a business field.

The process of exploring the deeper group structures will not be possible without touching the individual level, but the individual level is related to the bigger picture. The angle of viewing is going to be changed and the toxic themes (KANTOR 2012) lose their powerful influence by knowing and accepting them and learning from them.

7.10 Stage of Change of the Big Wind Industry

Based on the results of this thesis and the point of view from ´outside`, the author assesses the stage of change the big wind industry is in.[651]

Since the beginning, the German wind industry is in a steady process of change (SCHOEFER 2005) that is related to concentrations of the companies, the development of technical standards and the adjustment of bigger turbines. The scarce ground was a driving force and as well as the force to get more influence in the energy field (OHLHORST 2009). Due to the increasing international competition, the big wind industry is facing a new round of organizational concentration to be more effective in production, projects and maintenance as described by the BWE (2013) and WEHRMANN (2014).[652]

Until now, the change strategy of the big wind industry follows the elaborated mental models focusing on the R&D of larger turbines as described by OHLHORST (2009), MORRIS/PEHNT (2012) and WEHRMANN (2014). The turbines up to 8megawatts capacity are announced for offshore applications by several companies. A serial production is announced starting in 2015 or it is described as unknown. The serial production of such turbines will lead to a concentration of 2-3 companies in Europe referred to WEHRMANN (2014).

The increase of size is still in the strategic focus although some technical obstacles become obvious (OHLHORST 2009). The technical problems in the wind park Alpha

[651] Interview data of members of the wind turbine producing companies are not available
[652] WEHRMANN (2014) pp. 34ff.

Ventus caused a lot of outage time that was not expected.[653] Experts like HÖHMANN (2012) and CHENG (2012) state that the R&D for larger turbines needs a technology leap to deal with the increasing problem of weight that is not compensated by the additional power output. This leads to the conclusion that an increase of size does not increase the annual output related to the size which is a minimization of the total efficiency.

Related to BECKHARD (1987), the goal of the change process is to be more effective to reach the best position in the national and international market and to bring the renewable source wind forward. The need for action is given by the increasing competition.[654]

Based on the data, it is assessed by the author that the big wind industry is at the beginning of a deep change process or transformation that includes the change of the values and the basic assumptions as well as the philosophy (FATZER 2005). The author assesses the big wind industry being in the second step of the model of ´7 steps of change` (figure 4) of CHUPPMAN/JUPP (1992). The step of avoidance goes along with a wrong feeling of certainty and an overestimated assessment of self-confidence (FATZER 1993, 1999, 2005).

The actors exclusively follow their track and the current mental models by increasing the technical size. Due to technical disadvantages of the mega turbines, such as the production processes, the projects and the maintenance, the mega turbines have the tendency to be more expensive which would be the contradiction of the intention and a non-intended consequence.

The limitation of the transportation, installation and reliability is described by CHENG (2012) and HÖHMANN (2012). The measures that are taken are the ones that were successful in the past. Most probably, this strategy will not succeed in the future due to the technical limitations. The actors are doing more of the same but the actions do not solve the fundamental problem. A suitable system archetype is ´Fixes that Fail`

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[653] See KRÜGER (2010) www.readers-edition.de

[654] The author estimates that big wind representatives do not assess a need for change due to the small wind approach at this moment of time

that is described by ANDERSON/JOHNSON (1997) and KIM/ANDERSON (1998) as mentioned earlier.

Due to the impacts of such procedures (capacity of employees, money for R&D) within the organizations, it can be assumed that an increasing tendency of stress, disruptions and fluctuations occur.

Additionally, the internal communication structures and failure analysis that was observed and described by some interviewees who have a very good insight in different companies may increase the problem. The efficiency of the projects is at stake, which makes it even more important to improve in the situation of increasing competition.

Due to the author`s assessment that this communication style might be a structural trap of closing that shifted from the network to the companies, it is assumed by the author that the expressing of doubts about the current strategy of solving the problems cannot be done easily by the involved people. The cultural influence and the non-reflected part of the Boundary Profile hinder the questioning of the current strategies of problem solving.

The actual adjustment of the EEG (2014) leads to uncertainties for future planning as described by the BWE (2014).[655] It defines the goals for installation and limits them at the same time of an amount of 2,5gigawatts annually. Every installation above this amount has to be calculated with minimized funding. Additionally, all new installations above 500kilowatts are obliged to sell their electricity directly (a process in steps) after the 1st of August 2014.[656]

This might cause another shock situation due to the fact that the wind energy had a secured feed-in tariff in the last decades. Furthermore, as described by KÜHN (2013) and RENTZING (2012), the big wind industry might have a tendency to concentrate on the own market due to the international fluctuations. Limitations of the onshore capacities in Germany and offshore capacities in Europe (WEHRMANN 2014) increase the pressure.

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655 See BWE (2014) www.wind-energie.de

656 See BMWi (2014) www.bmwi.de; 1723 megawatts were installed in the first half year of 2014, see BWE (2014a) www.wind-energie.de

The actors of the wind energy might feel squeezed between the limited possibilities and the increasing international competition. In terms of KANTOR (1995/1997), the author identifies a stuck situation.

To overcome the stage of avoidance and to reach the next stage of insight, a stage of unfreezing related to LEWIN as described by SCHEIN (2005), CUMMINGS/WORLEY (1993), SCHEIN/BENNIS (1965), FATZER (1990) and SCHERMERHORN (1996) is to be initiated. Involved people are getting concerned people.

The reflection of the current strategies could be possible by being confronted with the long-term effects for the big wind industry. As described in the Theory of Change of case in this thesis, the constructive dealing with Anxiety 1 and Anxiety 2 (SCHEIN 1995) could be a suitable intervention. Therefore, it is of highest importance to deal with the previous success factors on one hand and, on the other hand, with the threats that are increasing while staying with the non-reflected mental models and the strategy based on them. The limitations of growth in the technical design could be the key element. A down-scaling could create a constructive tension by economies of scope and economies of scale (ACKERMANN/GRÜTZMACHER 2012).[657]

The internal communication structures and possible structural traps are also to be reflected to increase the efficiency in the projects. Furthermore, this process can be defined as being indispensable to reach awareness on the management level and to be able to empower the employees to act differently. The author refers to KOTTER (2007).

The reflection of the current strategies will most probably include a confrontation with the origin of the mental models. Forgetting history could become accepting history. This could open for alternative strategies with the driving force to find the best economical size and technical version related to MATSUMIYA (2010).

A positive side effect during this process could be a starting approximation to the previous decentralized approach and a change of scope of assessment of the small wind approach. A strong wind alliance with a high self-identification that covers all technical

[657] See ACKERMANN/GRÜTZMACHER (2012) pp. 108f.

options could be a long-term result as requested by the CEO of the GWEC.[658] This would strengthen the German wind energy in general and influence the political level as well.

The future success could be based on increasing cooperation with the goal to be competitive in the highly dynamical energy market. The guidelines are referred to ACKERMANN/GRÜTZMACHER (2012) besides the economies of scale and scope, the economies of skills, economies of risks and the economies of innovate.

7.11 Different Scenarios of the German Wind Energy

Based on the result of this thesis, different scenarios of the wind energy in Germany can be described by the author without getting in details.[659] The described scenarios consider both, the small wind approach and the vertical design. Besides excluding the small wind turbine approach, the vertical version was discarded completely as well.

7.11.1 Scenarios of the Big Wind Industry

Scenario 1: Maintaining the Current Strategy

The big wind industry does not change the strategy. A lot of R&D will be paid to make desperate efforts to exclusively increase the size of the turbines further with the dominant design. The turbines will not reach the requested efficiency due to the technical limitations. The investment will not pay off that weakens the companies. The mass production for the most reliable technical sizes will not be put in the focus which minimizes the effort of the process innovation. The competing prices are not as low as possible that will minimize the market share especially in the international field. The missing communication will lead to a minimization of the quality which is an additional disadvantage in the international field.

Referred to PEDLER ET AL. (1994),[660] the companies run the risk to reach a point of rank growth and a decision point in the long-term similar to the point of bifurcation

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[658] RAVE (2012) interview

[659] A detailed calculation of different scenarios exceeds this thesis, a further investigation is necessary

[660] PEDLER ET AL. (1994) p. 55

(LASZLO 2003, 2008). The options are either to change by learning and reflecting or to run the risk to lose influence with the possible consequence of a breakdown in the long-term.

The market demand for smaller versions cannot be fulfilled by the big wind industry. This sector will be taken over by international companies or by companies of the small wind sector that reach the mass production in the middle- or long-term.

Scenario 2: Reflecting the Current Strategy

The immense R&D costs of the larger design could lead to a reality check by the big wind industry that would be a start of reflection of the current strategy. The market chances and advantages of a down-scaling and versions that are technically reliable and approved (RAVE 2012) could lead to a start of a rethinking of the strategy to invest exclusively in the development of getting ´bigger`. The production and maintenance costs could be minimized by concentration on the further process innovation of the dominant design. This path includes the chance to create disruptive innovations referring to WOLF (2007) and to open new market chances.

Scenario 3: Reframing the Mental Models

The scope of assessment changes by reflecting the current mental models and strategy. The different sectors of wind energy are evaluated with all their options. Other technical designs and the advantages of a partial down-scaling are assessed based on the market demand. A part of the R&D budget is put into this path focusing on achieving a mass production for the most required small versions (MATSUMIYA 2010). This scenario is possible by reframing the mental models of these major issues:

- Exclusivity of horizontal design
- Exclusivity of getting as ´big` as possible
- Exclusivity of the marriage of the horizontal design and being as ´big` as possible.

Business chances by integration of the small wind approach

Business chances for the big wind industry by integration of the small wind approach are:

- 700.000 installed units in Germany until 2020 as estimated from the BVKW (GRIESER ET AL. 2013) and installations of 5000megawatts annually by 2020 (MAEDA ET AL. 2013).
- Off-grid solutions for the rural electrification (UNEP 2013) to increase the export.
- Infrastructural applications for urban solutions with the main focus on energy efficiency that is requested in the German and European climate goals (2011) and considering the trend of urbanization described by VOGEL/HÖBARTH (2011) as well as the SMART grids and combination with additional needs for the infrastructure.

Business chances for the new development of the large wind approach are:

The marriage between the increasing size and the horizontal design is to be reflected by considering the doubts of the experts (WEINHOLD 2012, CHENG 2012). The chances of increasing the size by applying the vertical design could be assessed (QUILTER 2013). The technical problems of the past of the electrical generation might be solved due to the newest status in this field (HEIER 2012, COOPER 2010).

7.11.2 Scenario for the Small Wind Industry

Assessed separately, the growth of the small wind sector is highly depending on the governmental regulations and whether the interested customer is getting a relief for the investment. The increase of the demand in Germany expected by the BVKW (GRIESER ET AL. 2013) and internationally expected by MAEDA ET AL. (2013) sounds positive. The motivation of the customers to produce energy independently (WOHLFAHRTSTÄTTER/BOUTELLIER 2009, 2010, SPRENGER 2011) and to save the energy costs are the main reasons. The customer segments are mainly:

- Farmers

- Energy-intensive companies
- Private households
- Independent electricity providers such as LICHTBLICK (2014) that provide a combination with storage and management, the ´Schwarmstrom`
- Green marketing for companies and cities (COOPER 2010, LANDWEHR 2011).

The precondition is to provide reliable products and standards (ZHANG ET AL. 2012) and to get the chance for a mass production to reduce the costs by attracting investors. Based on this, a trend similar to the photovoltaics is possible in case the government will change the political direction.

In case that the government does not change the direction, the small wind sector will be suffering from the disadvantages given by the regulations adjusted to the large wind sector (and the mainstream model) which will be reflected on the market by a slower growth of the sector due to the vicious circle that is described earlier (less funding for R&D, no special feed-in tariff, difficulty for building permission, no large production). The increase of the electricity prices might be a supporting factor within the next years (LANDWEHR 2011, EUROPEAN COMMISSION 2011).

Another major issue to be considered is the lack of vertical versions and the majority of turbines being below 5kilowatts capacity (FRANKEN/TRECHOW 2013). The demand of the customer for infrastructural applications and versions with a minimum of 50 kilowatts capacity (farmers) cannot be satisfied. Due to the interest of the customer and the vacuum of reliable, cost-effective products in Germany, the customer will tend to buy the products from other countries that provide better prices due to the larger production facilities (MAEDA ET AL. 2013). In case that those products might suffer from a minimized quality, it will negatively refer back to the small wind sector in general.

Depending on the provided products and concepts, some companies could achieve a market entry in other countries due to the demand of the rural electrification (UNEP 2013) that could lead to an attraction for international investors.

First symptoms of a start of an unfreezing process are noticeable. Small wind applications are illustrated in normal magazines[661] and compared with photovoltaics. The new international IEC Standards (2014) contain a short paragraph about vertical turbines. It will be valid in Germany within the next months.[662] The BVKW is strengthening its political influence steadily by improving its public relations and by establishing regional structures.

7.11.3 Epoch-making Approach - Small Wind and Society Needs

The precondition for this scenario is that the German political level assesses the small wind approach as being a contribution to the energy transition that can be combined with infrastructural needs. Centralized wind and decentralized applications are put together in the master plan as illustrated earlier. This scenario would imply the discharge of the exclusivity of the horizontal design, the exclusivity of getting as much as ´big` and the exclusivity of the marriage of the horizontal design and being as much as ´big` as described before. Due to the fact that the insufficient infrastructure provides losses on a micro-economical level that affects the macro-economical level and therefore the national economy, this scenario is basically to be calculated on a macro-economical level.

Referred to a study of the German Institute of Economics (2014), Germany`s need of investment for the infrastructure is calculated with an amount of 120 billion euro within the next ten years. It is suggested to spread the amount of money in three parts. Main topics for investment needs are:

- Expansion and renewing of the IT nets with broadband
- Renewing and expansion of motorways
- Renewing the bridges

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661 See PRISMA (2014) APPENDIX NO. 10.14

662 TÜV RHEINLAND (2014) conversation

- Expansion and adjustment of the electrical grid due to the needs of the energy transition.[663]

The author evaluates the combination of the small wind approach and the necessary measures to be taken as an epoch-making approach that suits the requirements for the future as described by several authors (EISELT 2012, SIMON 2013, RIFKIN 2014). The combinations are:

1. Small wind in combination with the needed expansion of broadband in Germany
2. Small wind in combination with renewing of motorways and other streets
3. Small wind in combination with the renewing of the bridges
4. Small wind in combination with the expansion of the grid by integration of regional small concepts with storage.

Additionally, a combination with the expansion of the electro-mobility is recommended to achieve the goal of one million electro cars in 2020[664] that was recently announced by the German Federal Parliament. The precondition is to assess the right products related to their purpose as described by MATSUMIYA (2010).

The goals of the energy efficiency as one of the five columns of the German energy agenda 2011 (MUSIOL ET AL. 2012) are urban applications that could be put in the focus as well as reduce the costs of the transmission lines (EISELT 2012) by providing regional concepts with storage (LEAHY ET AL. 2010). A reduction of requested resources such as logistics and foundations matches the actual demand of resource efficiency as well. This approach combines the future concept of the energy supply system (DEXIN 2012, RIFKIN 2014) with other needs. It also includes a cross-border thinking and acting based on a cross-model conversation and is related to the Theory of Change and Practice in this thesis.

Due to the amount of requested units, it would be easy to find the investors to build up the requested mass production (RIFKIN 2014) to drop down the prices. The

[663] SCHUL I BANK (2014) www.schulbank.bankenverband.de; See SPIEGEL ONLINE (2014a), ml.spiegel.de; See N24 (2014) www.n24.de
[664] RHEINISCHE POST (2014) B 1

measures that are taken are to be integrated in the master plan as requested by the WBGU (2011). A basic orientation for decisions is provided by the three waves approach (figure 42) of KEMP (2011) and the mechanism of cooperation by ACKERMANN/GRÜTZMACHER (2012).

The author provides an example of calculation to get a first glance of the energy output that would be possible by a combination of small turbines with the renewing of the German motorways. The amount of calculated energy is based on the result of the WISTRA project that was scientifically accompanied during the time of 1989 until 1992 in North Rhine-Westphalia. The results are based on nine turbines with a capacity between 50- and 80kilowatts (two- and three-bladed).[665]

The amount of turbines to be installed in this scenario was calculated based on vertical turbines assuming similar results (COOPER 2010) as provided in the study. The three-bladed dominant design cannot be considered due to their shadow- and park effect (TONG 2010, PELTE 2010, HEIER 2012, PANTAZOPOULO 2010). Considering the wind zone 2 and wind zone 3 (HERAS-ADRONIT 2013), the roughly calculated annual energy output of 26,3 terawatt hours is achievable.[666] The total investment costs of the nine turbines of the study (1994) are provided attached.[667]

[665] BARTELT (1994) p. 1ff., see APPENDIX NO. 10.15

[666] See APPENDIX NO. 10.16 -10.18

[667] See APPENDIX NO. 10.19, actual data are not available

8. CONCLUSION

The topic of this thesis includes elements of change and of the wind energy. The wind energy in Germany is not just an industry consisting of a few companies. It is determined to play the major role in the transformation process of the energy supply system to reach the phasing-out of the nuclear energy and to achieve the climate goals. The close relationship between the wind energy field and the energy transformation, the political system and the involvement of the whole society provide a situation of highest complexity. Furthermore, the international dimension needs to be considered.

By applying the KANTOR model, the complexity can be first differentiated and then put together creating a picture, like a puzzle.

During the preparation of this thesis, the Fukushima (2011) accident happened. It was and still is a shock situation. The way the German Federal Government (2011) dealt with this incident was untypical. It seemed to be spontaneous. Although it was a political redirection, the government decided for a phasing-out of the nuclear energy in 2022, a step not to be underestimated and a decision that is long-lasting.

The large turbines represent ´the wind energy` and the three-bladed design is called ´the normal turbine` by ALBERS (2012) and JÜTTERMANN (2013). During a lot of international journeys, it was obvious that in the mind of the people this technical design is the only one that the people could think of. An interesting phenomena, a bit like brain-washing. It is even more of interest because the discussions about SMART grids have been growing.

During the process of interviewing as part of the survey and the deeper insights in the energy system itself, the author had the chance to bring parts of the puzzle together.

The people in the wind energy sector started with a background of the anti-nuclear movement with high motivation and high idealism to build up something new. They stepped in a field of the settled traditional purely centralized energy system. Their journey was accompanied by a lot of problems due to the maintaining forces within this system (SCHEIN 2005, FATZER 2000, LIPPITT 2012, CUMMINGS/WORLEY 1993). Referred to BRUNS ET AL. (2008) and OHLHORST (2009), the political constellation offered new chances and the wind people could make use of it. It was possible by adjusting their model. The wind people were successful by growing technically and discarded their former pure decentralized approach. They gained more influence supported by the government due to the EEG. The industry grew by expanding the technical size steadily, by the concentration of the companies and by setting up technical standards. The sole orientation was and still is getting larger.

The pioneers opened a new era in the context of the 70ies and 80ies. They gained more influence and it was the first time that the fossil-based traditional system was challenged. Wind energy in large dimensions is now available. They made it happen. They were backed by a political advocate being the Green Party (OHLHORST 2009) and an increasing awareness in the society (WOHLFAHRTSTÄTTER 2010).

The wind industry is supposed to be the major column of the energy transition based exclusively on the big wind industry. This was possible with an accumulation of knowledge and reinforcing circles during these periods. Due to the adjusted model, the traditional energy supply and the centralized orientation has been maintained and is not questioned anymore (SIMON 2013). The adaptation of the decentralized approach is described by OHLHORST (2009) and by the author (figure 29-31).

The reconstruction of the process of adjustment of the original model was one main part in the analysis of the current mental models. The adjusted model was transferred by the network structure in the ´relevant rooms` and became the mainstream model (figure 38). The decentralized approach represented by small wind turbines has been left behind and is evaluated by the author of being a trigger for the large wind actors (figure 39) until today. The trigger reveals the non-reflected parts of the process of adjustment and is part of the Boundary Profile (KANTOR 1996). The decentralized small wind approach is politically assessed of being no contribution for the energy supply by the interviewees. This reflects the situation of the business field as described with the broader social structures. The small decentralized approach of wind was and still is discarded.

The times have changed. The technical equipment especially the IT is advanced to take over the management of the energy supply (RIFKIN 2014). Internationally, the model of decentralization gets attention and the UNEP program (CLIMATEACTION 2013, 2014) strongly recommends infrastructural applications. Decentralized versions are required (MAEDA ET AL. 2013). New technical solutions are on their way and they include the wind. The high potential of regional concepts including regional energy and urban solutions are assessed of being of crucial importance (EISELT 2012, SIMON 2013, UNEP 2013, 2014). RIFKIN (2014) describes the third industrial revolution as the combination of energy and communication being the energy internet. So far, the politicians have not noticed and not announced a correction of the path. The energy transformation strategy mainly based on the traditional centralized system paradigm is still not questioned in Germany.

Referred to LASZLO (2003, 2008), the society is at a decision point. Referred to BECKHARD/HARRIS (1987), there is a need for change. What is decided now will last for decades. Furthermore, it will be the fundamental decision for a future sustainable energy supply system. The earth has no natural borders besides nature (JÄGER 2007).

The big wind industry, previously the mastermind of a new orientation, seems now to be the advocate of the traditional orientation in the wind energy. Furthermore, due to the international competition and the scarce of ground, the positioning of the German wind energy is at stake in a long-term.

8.1 Summary of main Contributions

Based on the results of the four dimensions of the Theory of Thing, the author summarizes the main generalized contributions. This thesis provides:

1. The understanding of the basis of mental models and their guiding potential in a business field.

2. The understanding that mental models have an origin and a process of adjustment based on forces of the field the actors are confronted with. This process of adjustment is related to constraints and perceived high-stake situations for the actors.

3. An insight that conclusions of the successful adjustments of the original model are incorporated and formulated as sentences that are the basis of the adjusted mental model. These simplifications influence the view on the world and

therefore, they influence the decisions and strategies even though the situational conditions have changed. The incorporated sentences as basis of the mental model are transferred to other people and establish a new culture.

4. An insight that structural traps are strongly related to the process of model adjustment and are shifted from one level to other levels.

5. An insight that the Boundary Profile is relevant in business and related to situations of constraints. Situations and topics that could trigger the non-reflected parts of the Boundary Profile are avoided due to perceived constraints of the actors. This is independent of time and location. Those toxic themes and critical images are influencing the other structural levels continuously and create stuck situations.

6. An insight that the structure of a network, consisting of different professionals being important for the success of the industry, eases the process of model expansion into the rooms of relevance for the business (other professional levels and organizations). A mainstream model can be established.

7. An insight that the guiding mental models can influence the strategies of whole industries and the related systems by establishing the structures aligned to the mental model. The involvement of the political level enables to create a formal system of regulations on a regional level based on the mental model. This system is not questioned and reinforces itself. A mainstream model can be maintained.

8. An insight that the mainstream model excludes other approaches due to the regulations exclusively specified for the mainstream. A cross-model conversation is perceived as difficult to open due to the strength of the maintaining forces. A correction of the path is excluded.

9. An insight that changing conditions in the environment or technical developments with new possibilities are not assessed as such by the majority of the actors due to the strength of the active mental models that were established under different conditions in the past.

10. An insight that these non-reflected processes that refer to situations in the past may have the risk to minimize the ability of necessary adjustments of the model related to the future. Non-intended consequences of the decisions may occur.

11. An insight that due to the above mentioned, the reflection of the mental models is assessed as being essential and as the leverage for a transformation process.

Furthermore, the author provides an overview about the whole process of analysis to achieve a suitable Theory of Change and Practice. This is a further development of KANTOR´s Team Learning Model (1995) and the model of the Structural Sources of Interaction (2012). The Case Learning Meta Model (figure 26) summarizes an overview of the 7 steps of elaboration including the Theory of Thing, the Theory of Change and the Theory of Practice. It defines the scope of research that is embedded in the different steps.

The Theory of Thing is divided in four dimensions to ensure the investigation of all the essential levels. This is necessary to understand a complex topic that consists of different scientific backgrounds to be able to discover possible interrelations and to formulate interpretations based on the given data (LEWIN 2012).

To investigate the invisible part was the main focus of the research. It was the first time that the development of a whole industry is connected to the mental models in this specific way.[668] The author created new models to visualize the different steps and levels.

Additionally, the author adjusted parts of the terms of KANTOR such as the deeper individual structures to the deeper group structures and the Boundary Profile to the Collective Boundary Profile. These terms reflect more suitable the dimension of not just having individual experience, but having a group experience or phenomena with even stronger impact. This was also done to ease the application in the business analysis in the future. Based on the real life stories of the interviewees, the author created a formula about the strength of forces to achieve a willingness to reflect the mental models.

[668] Status of information of the author

8.2 Theory Building

This thesis provides an expansion of presented theories and literature of mental models and cultural influences in groups, societies or nations and organizations, change- and transformation processes as well as innovation cycles. KANTOR`s (1995, 1996, 1997, 2012) approach of mental modelling and his Meta Model that includes the Theory of Thing, Theory of Change and Theory of Practice are the binding parts of these theories. Analyzing the ´thing` implies the crossing of scientific and professional borders of disciplines as much as requested and the connection of the individual- and group level of thinking within the bigger picture of the case. Processes of model building and the process of establishing a mainstream model can be understood on a team-, organizational-, regional- and societal level. The potential of limitations of those mental models can be reflected related to the given goals.

The Theory of Thing in this thesis is related to energy consisting of the physics and sources of energy, the energy system, energy and economics as well as energy economics and politics. Wind as renewable energy source is part of the Theory of Thing. The physics have to be understood for being able to follow the development of the field of the wind energy in Germany. The Case Learning Meta Model implicates to investigate the different levels of the system including the context, the broader social structures, the face-to- face level and the least visible parts that are the mental models as one important part of the system and the Theory of Thing.

The result is a wide picture of the situation. All dimensions of the Theory of Thing are important to consider. The Case Learning Meta Model is the guidance of this process. The goal is to come up with a Theory of Change and Practice of the case, ideally with a leverage that is reflected.

Therefore, the Meta Model of KANTOR with all the ingredients is an approach that enables to understand and analyze complex situations by considering the interconnection between the original basis of the thing and the structures the humans are creating due to the importance of the topic for their daily life. The current situation as the starting point for change is determined by influences to consider.

Most frequently, personal- or group stories of the involved actors are related to the topic. Their estimations and thinking processes are the representation of their actual mental models and influence how to deal with the topic.

8.2.1 Guideline for the Application and Teaching

The essential of the ´thing`, the context, should be in the foreground at the beginning to provide an insight to the complexity that is related to the scope of research (most probably with aspects of other science and fields, national and international). The analysis of the established structures to deal with the ´topic`, the manmade structures, are to be elaborated, defined and reflected on the level of the broader social structures. The face-to-face level offers the analysis of the actual communication structures. The deeper group structures and the individual deeper structures reveal the process of model building of the actors related to the topic. Structural traps and non-reflected parts of the Boundary Profile can be discovered, accepted and changed by learning.

Referring to the Case Learning Meta Model, the author suggests the following phases once the issue that is going to be changed is defined and the estimated goals are expressed:

1. Defining the scope of analysis (focus: can be regional or societal, a special problem within the industry or business, organizational or in a team).

2. Defining the four dimensions of the Theory of Thing based on the Case Learning Meta Model by clarifying each dimension, defining the dimension of focus if there is any.

3. Defining the original basis of the thing (context information) related to nature, physics or material and related aspects.

4. Defining the structures established by the entity/the actors in the special environment (business field, organization or any other entity) by analysing the broader social structures with a decent method.

5. Defining the ´room` to analyze the current communication structures and results by suitable methods considering the results and possible non-intended consequences.

6. Analyzing the established mental models by revealing the experiences and stories related to the topic and the conclusions that might have become basic assumptions by understanding the path of success and ´normal ` behaviour.

7. Discovering the deeper group structures and the Collective Boundary Profile as part of the current reality ´how to deal with the topic`.

8. Finding interconnection between the results of the different levels (pattern, structural traps) by identifying influencing factors of the mental models such as regulations, official structures and other topics.

9. Evaluating the mental models if they are suitable or limited from the actual point of knowledge or if they have to be adjusted based on the results.

10. Defining the need for change and the Theory of Change and the Theory of Practice for the case by focusing on the leverage.

The Case Learning Meta Model can be applied and taught as a guideline in change- or transformation processes to make as sure as possible that the leverage for a successful change can be identified. Different kinds of methods are possible to be combined with the model by considering KANTOR´s hierarchy that the model is the master and the methods are the servants.

This is a contribution of useful research because the process of the application can be a guiding model for effective management practice (BARTUNEK/SCHEIN 2011) and schooling. The approach can be integrated in the transformation research and transformation knowledge as part of the Transformation Quartet of the Society of Knowledge as requested by the WBGU (2011). They request an integration of knowledge to gain an "understanding of the decisive dynamics of processes and interconnections"[669] with the special challenge to interconnect different disciplines of science.

[669] WBGU (2011) p. 23

8.2.2 System Complex of Mental Clusters related to Myth

Based on the data of the whole process of exploring and discussing, the author identifies different clusters of the mental model as a system complex. They are welded together and complete each other during the whole process. The author defines four clusters corresponding with each other by the fifth cluster that is the energy cluster.

The cluster of orientation is aligned to the critical stories and the incorporated sentences on the level of myth (KANTOR 2012). It contains the positively translated guidelines as basis for the adjusted orientation as described by JOHNSON-LAIRD (2005). This cluster is related to the motivation and the aspiration of the actors related to the increase of acceptance for the ideas (KANTOR 2012). The technical cluster indicates the assessment of the actors regarding the technical feasibilities such as the horizontal three-bladed design in this thesis. It could reach a size of attraction as the guarantee for success due to the given economical reference that is represented by the economic cluster.

The cluster of behaviour is strongly related to the structuring of the relationships internally that reflects the external relationships. The main goal is indicated by the author as protection for both, the people and the ideas. The energy cluster symbolizes the qualitative flow of energy to keep the whole complex in balance. As illustrated in figure 44, the clusters are related to each other.

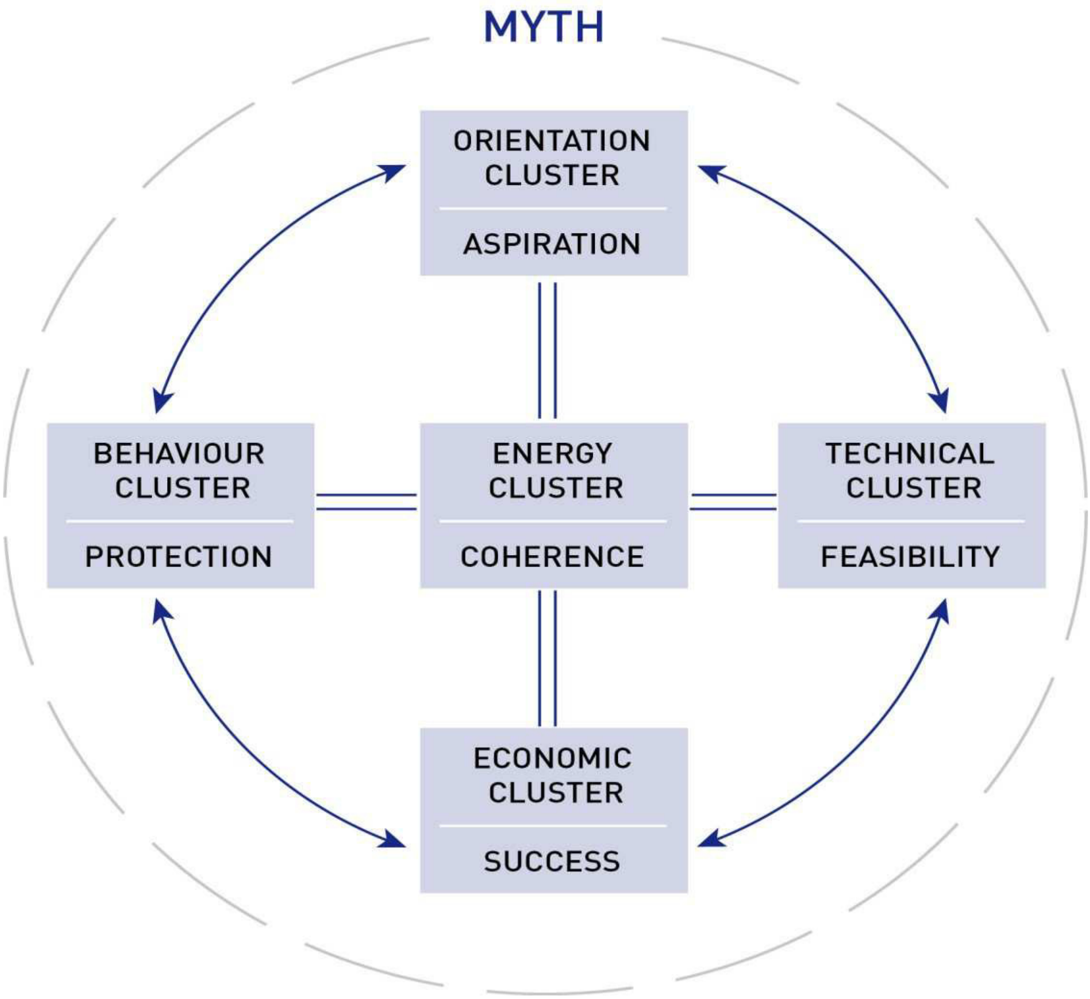

Figure 44 System complex of mental clusters related to myth

The myth (KANTOR 1996, 2012) embeds the whole system complex. Due to its closeness to the basis orientation, it strongly determines as a paradigm how to cope with external influences. This refers to the pattern of basic assumptions as described by SCHEIN (1995, 1999, 2003) and the structural levels by KANTOR (1996).

Internally, the constellation of the clusters might change their temporary position of importance (e.g. the economical success could minimize the importance of protection temporarily whilst in times of constraints the protection increases) but the basis constellation of being interconnected maintains the same.

The system is steadily striving to reach a quasi stationary equilibrium (KAST/ROSENZWEIG 1970, SCHEIN 2005, CUMMINGS/WORLEY 1993) to fulfil the purpose in the best way being represented by the orientation cluster (LEWIN 1953, PROBST 1987, MEADOWS 2009, 2010). Thus, the system is basically oriented internally. Consecutively, the system`s ability to cope with external demands is weakened and, therefore, the actors are suffering from a professional impairment that is reflected in the results (KANTOR 1995, 2012).

These processes are out of the level of awareness (SENGE 1994) unless they are reflected and the orientation changes by dissociating of being oriented to the myth.

The strength of the conglomeration of the model clusters that is described above is decisive on two levels, first within the process of establishing and second in the process of maintaining the (mainstream) mental model.

8.2.3 Mainstream Model Cycle

The following last illustration shows the model building process of a mainstream model as a generalized overview. It includes the micro level up to the macro level and could be even expanded to a global level (SCHARMER 2011). Parts of these processes are part of the daily life in a steadily changing environment (SCHOEFER 2005) on the different levels.

A mainstream model is determined by covering all the levels including the political level. This level engraves the basis of the mental model in the society due to regulations. Under those conditions radical innovations are hardly possible.

The current mental model of the wind energy is assessed as being a societal mainstream model due to the close relationship to the political level. The important influence of the EEG and the political direction are pointed out by nearly all interviewees and in the literature (BRUNS ET AL. 2008, OHLHORST 2009, MORRIS/PEHNT 2012).

The next figure illustrates this process in a generalized way.

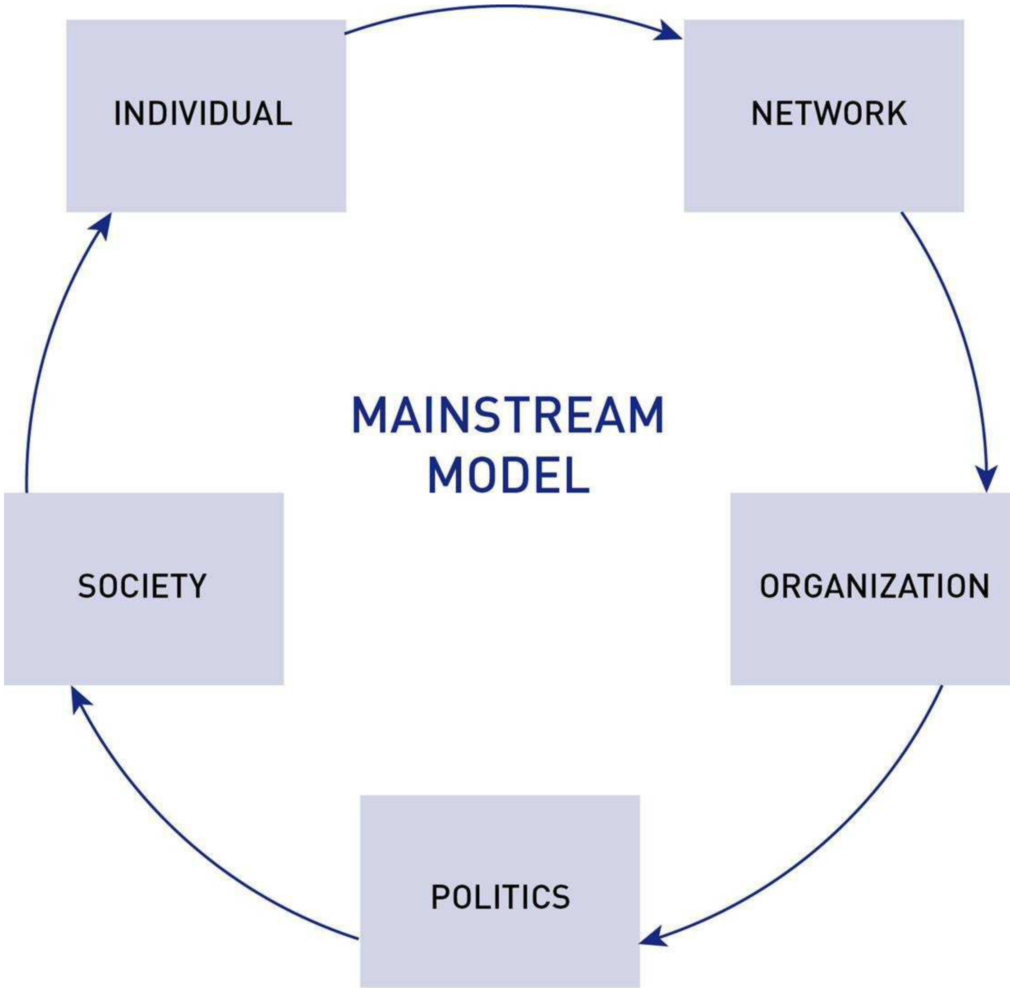

Figure 45 **Mainstream model cycle**

As described by KRIZ (1997), once the regulations are set in the system, these structuring processes limit the creativity and can establish rigorous reinforcing archetypes of interactions in which anybody is a victim who is involved as an actor.

8.3 Final Comments

The approaches of the life space, systems thinking and systems dynamics that are the origins of KANTOR`s work are all related to energy. Ideas, innovations, to gain success, it is all related to energy. This work is a synthesis of the energy field in terms of the energy supply system and the human energy system (VAN DER ZOUWEN 2011). The deeper structures are part of the whole picture. All mental models are limitations by nature. They can be completed by other mental models. Non-reflected mental models as part of the Boundary Profile or the Collective Boundary Profile can be converted in constructive energy. The mind is able to change by learning.

In the author's estimation, the representatives of the early wind energy opened a new era and unfreezed the transition process of the fossil-oriented energy supply system towards a renewable oriented system. This is their remuneration in the whole energy field and in the overall process of energy transformation.

The path they have chosen was the path that was possible at this moment of time due to the general circumstances of the purely centralized system including the mainstream thinking in the energy field. It was a tightrope walk because of the conflicts with the traditional energy supply system.

The German decision to achieve an energy system based on renewable energy without the nuclear energy is advanced. The achievement of the wind energy actors to be acknowledged in such a way that the government dared to decide a phasing-out of nuclear after Fukushima, has to be understood as a major breakthrough. The renewable idea was saved based on a model that could be followed by the traditional system because it was adjusted.

The complete discarding of the small decentralized wind energy system and other technical versions weaken the model to be appropriate for the future. The adjusted model carries the structural patterns of the traditional energy system paradigm. New innovations are available and are waiting to be put into place. The new orientation is to be set based on the nature and renewable energies as requested by the second generation.

The original model of the early wind pioneers appears again by the new small wind approach and decentralized applications that can be combined with the infrastructure and the energy internet.

Due to the essential meaning of energy, suitable answers have to be found. Due to the planet`s warming, the alternatives to the fossil-based energy supply system are of crucial importance (EDENHOFER ET AL. 2012, THE WORLD BANK 2012). The global investments in subsidies for fossil energy are immense (UNEP 2014).[670]

[670] See UNEP (2014) APPENDIX NO. 10.13

The author assesses the global society as being in the stage of avoidance within the transformation process of the global energy system. Referring to LASZLO`s Macroshift, the insight in a final decision to change the basics fundamentally will lead to a breakthrough. This is related to a change in values and the traditional belief system as also described by SCHARMER (2011).

To reach a model of a future energy supply system (RÖTTGEN 2012, ALTMAIER 2013) that is worth to be followed for the next decades and by other states might imply a general correction of the current track.

Germany runs the risk to get stuck in the energy transformation process. Actually, an article in the news describes the failing of the energy transformation by Chancellor Merkel.[671] The increase of the CO_2 by burning more coal (2013, 2014) can be construed as a problem of knowledge that is characterized by the occurrence of non-intended side effects based on the lack of knowledge about the subject of regulations and their interconnection to the target (BRUNNENGRÄBER 2009). The author assesses it as a result of the national and international politics that determine the frame of action due to the given regulations (JÄNICKE ET AL. 2003).

As described by SIMON (2013), more than thirty years after KRAUSE ET AL. (1980) analyzed the decentralized ´smooth path` of the energy transition as being the more future-oriented one due to the limited fossil resources (PELTE 2010), the environmental impacts (IPCC 2013) as well as the costs of the traditional approach, the traditional approach is still the guiding orientation in the energy transformation process. The UNEP claims for a start of rethinking of the financial architecture "so that it can better fulfil its purpose of funding a sustainable economy".[672]

The wind energy that is supposed to be the main column of the energy transformation is limited by discarding major parts of their own original energy source and furthermore, based on the results of this thesis, the author evaluates the adjusted model that became the mainstream mental model oriented to the level of myth. The internal orientation affects the external orientation by minimizing the quality of the assessment of actual and future requirements.

[671] MARSCHALL (2014) A 2

[672] See UNEP (2014) APPENDIX NO. 10.20

Referred to KANTOR (1995, 1997, 2012), the model is the master and the methods are the servants. It can be either estimated that the model of the energy transformation is insufficient or not suitable for the future requirements or the methods are not the right ones to achieve the goals. Having in mind that the transformation of the energy system is not evolutionary as described by the WBGU (2011) and assessed by REICHE/BECHBERGER (2006) who described it as an open future process related to the decisions that are made within this process, the author indicates to do the utmost to achieve the highest level of quality of decisions.

Referring to KANTOR (1995, 1996, 1997, 2012), the quality of the decisions is steadily influenced by the level of the deeper structures and therefore, the mental models. The whole spectrum of technologies that is available or that does have the potential to be a solution for the future energy system is requested to be considered as stated by EKINS (2011), KEMP (2011) and others.

KANTOR`s concept is a suitable approach that was adjusted and expanded in this thesis to meet the requirement to analyze a business field. The results show the close interconnection with the societal level that makes the model even more worth to be applied in this complex situation. As described by FATZER (2005), the author evaluates a need for a transformation process including the values and beliefs on the level of the wind energy and the political level. This internal transformation is assessed as being the basis to successfully lead the energy transformation process oriented by the demand of future generations. Fundamental sustainability as formulated by PRIDDLE (2001) and the UNEP (2014) should be the guiding orientation.

"What you can expect...in working with mental models?

This discipline offers the highest leverage for change".[673]

[673] ROBERTS (1994) p. 239

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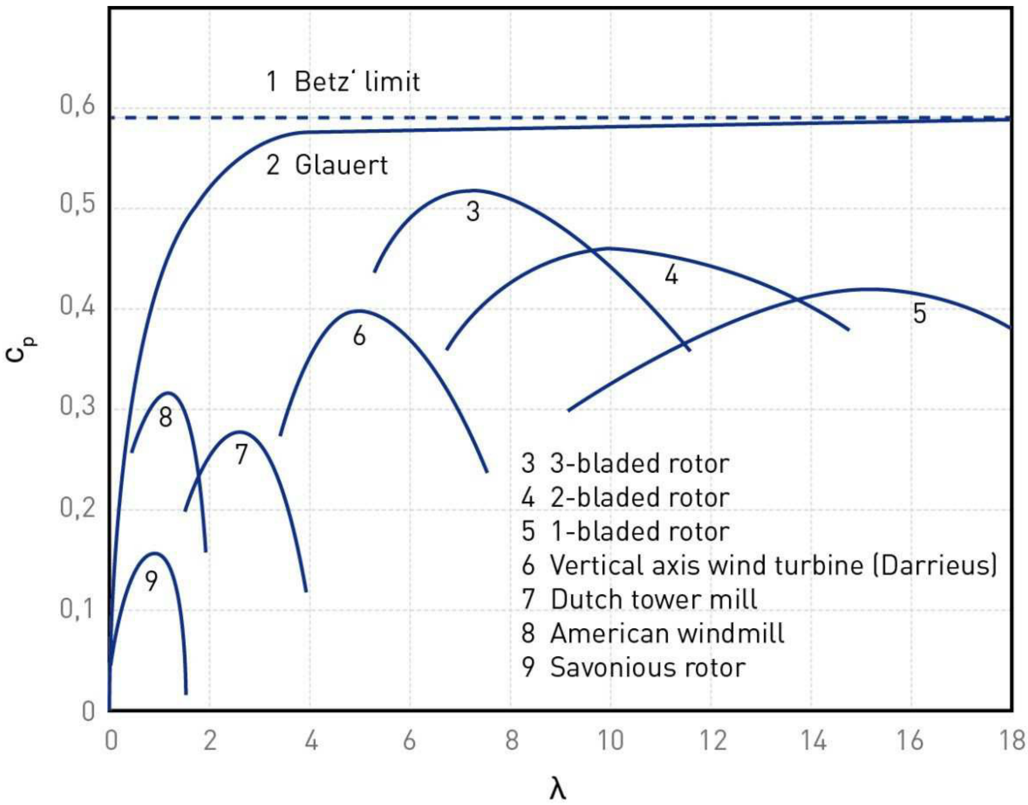
10. APPENDICES

10.1 List of Figures

10.2 List of Tables

10.3 Cp Function of Tip Speed Ratio



Cp FUNCTION OF TIP SPEED RATIO OF VARIOUS TYPES OF TURBINES,

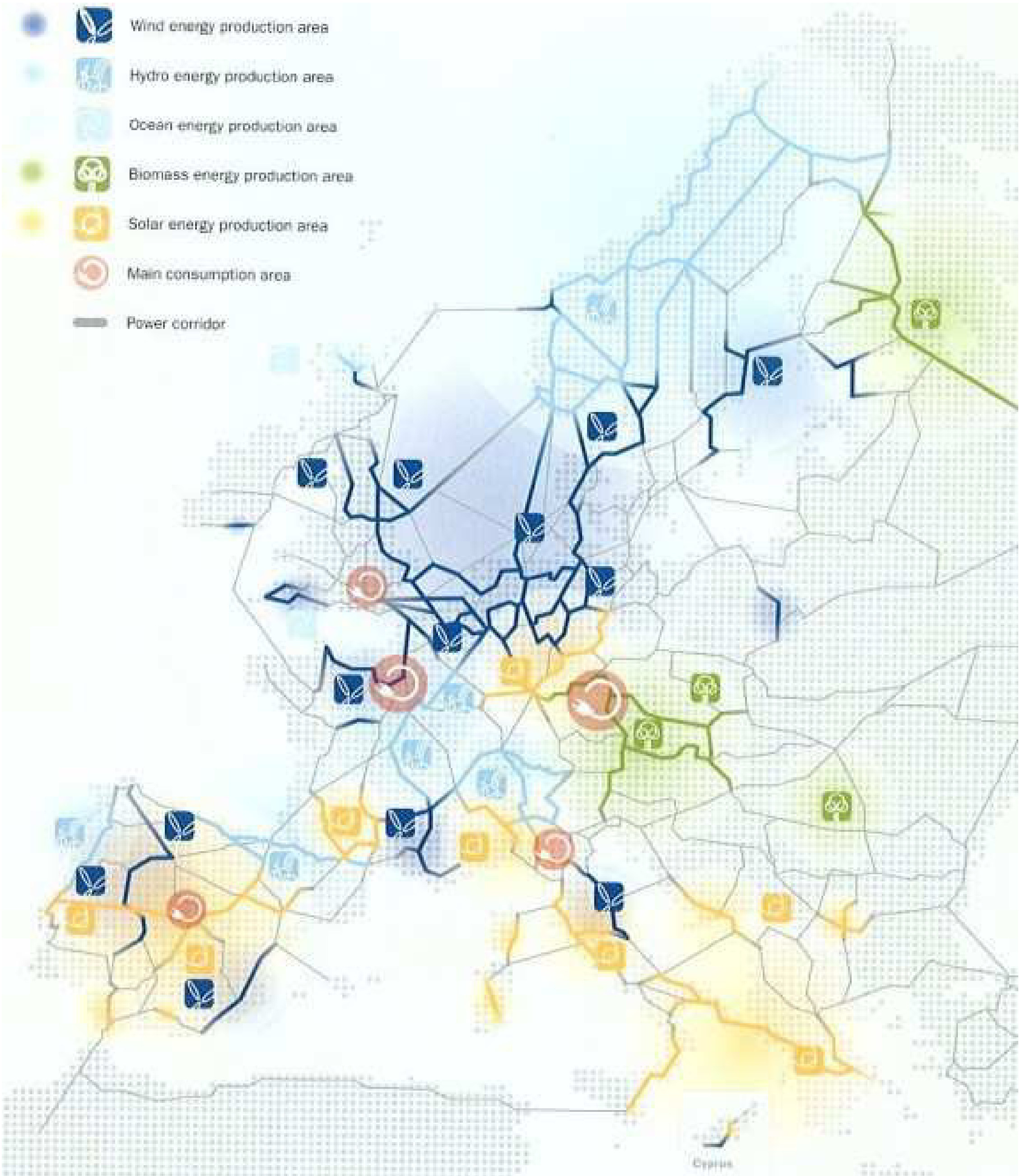
SCHAFFARCZYK ALOIS P. (2010): AERODYNAMICS AND AEROELASTICS OF WIND TURBINES, in: Wind Power Generation and Wind Turbine Design, TONG WEI (Ed.) Kollmorgan Corp., USA, WIT Press, Southampton, Boston

10.4 European Energy Grid 2010

EUROPEAN ENERGY GRID 2010

SINNER ANNE-FRANZISKA, MORTHORST PAUL ERIK, MUNKSGAARD JESPER, SUDESHNA RAY, EUROPEAN RENEWABLE ENERGY GRID VISION 2010-2050, in: Powering Europe, wind energy and the electricity grid, a report by the European Wind Energy Association, Brussels, 2010

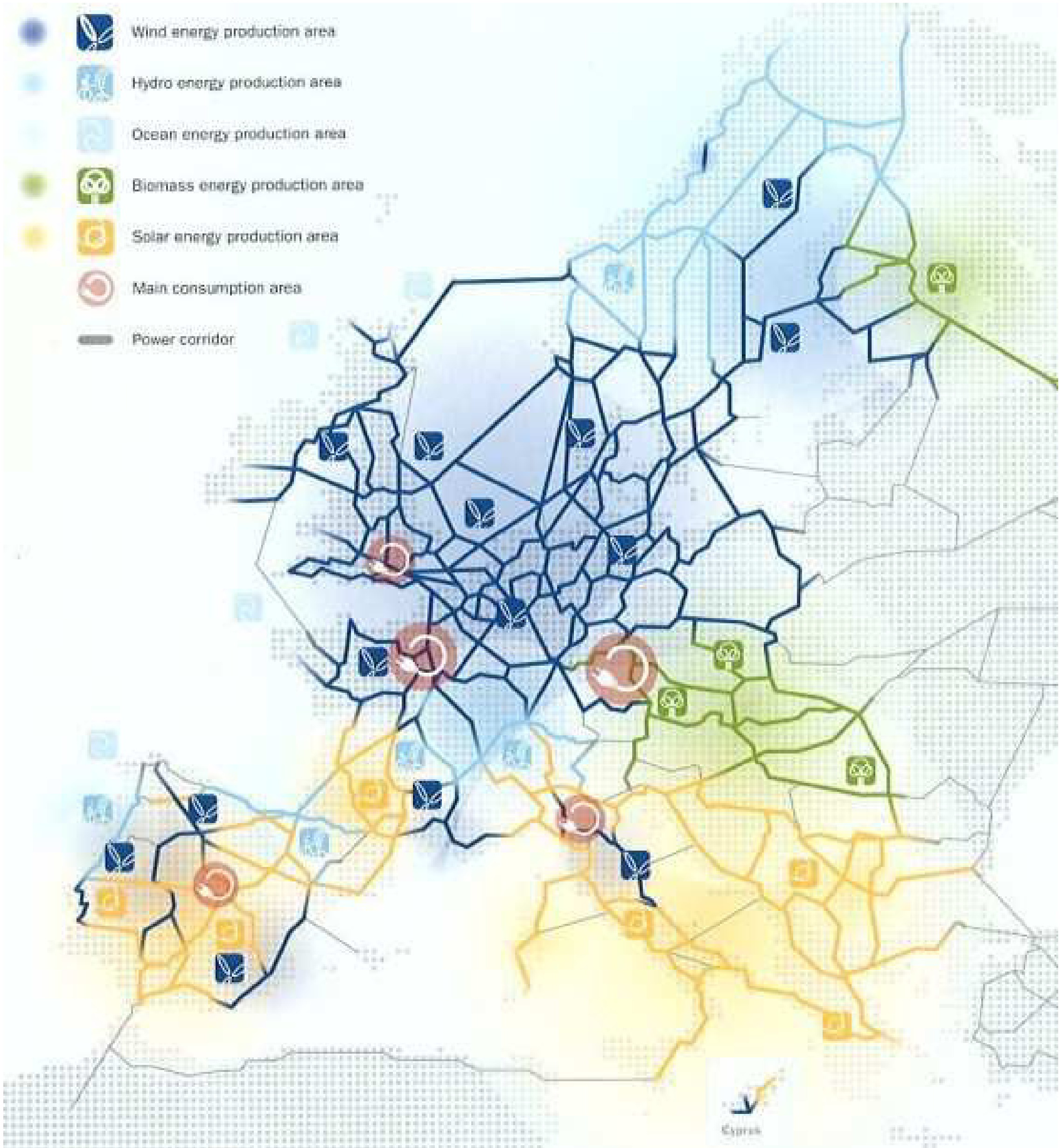
10.5 European Energy Grid 2030



EUROPEAN ENERGY GRID 2030

SINNER ANNE-FRANZISKA, MORTHORST PAUL ERIK, MUNKSGAARD JESPER, SUDESHNA RAY, EUROPEAN RENEWABLE ENERGY GRID VISION 2010-2050, in: Powering Europe, wind energy and the electricity grid, a report by the European Wind Energy Association, Brussels, 2010

10.6 European Energy Grid 2050



EUROPEAN ENERGY GRID 2050

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10.7 Invitation Letter

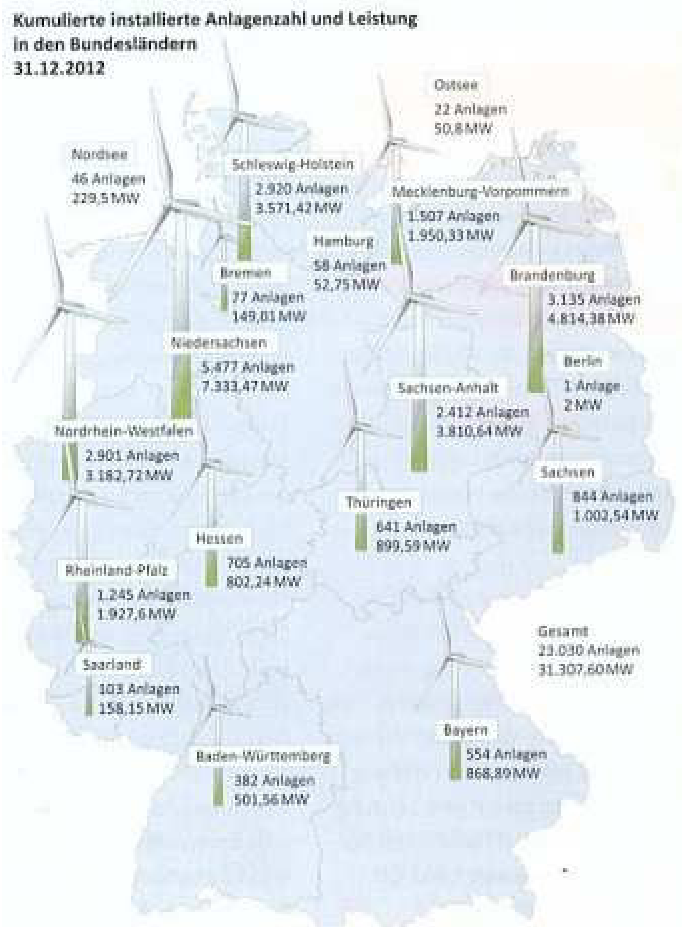
Sehr geehrte Frau xxxx,
Sehr geehrter Herr xxxxx,

hiermit möchte ich anfragen und Sie bitten mir ein Interviewtermin zur Verfügung stellen. Mein Thema meiner Ph.D. Arbeit ist die „mentalen Modelle“ in der Windindustrie zu untersuchen.
Der Hintergrund bezieht sich auf die Erkenntnis, dass Deutschland in der Großwindindustrie führend ist, die Kleinwindindustrie mit dem dezentralen Schwerpunkt jedoch wenig berücksichtigt wird.
Dies ist im internationalen Vergleich auffallend und kann langfristig die Chancen der gesamten Windindustrie weltweit führend zu bleiben, minimieren. Unter dem Druck der Energiewende beginnt eine langsame Veränderung. Die Untersuchung beinhaltet Befragungen mit Entscheidungsträgern aus Politik, Finanzwelt und Firmen und hochkarätigen Ingenieuren sowie Wissenschaftlern, um einen umfassenden Eindruck zu bekommen.
Für mich persönlich bedeutet diese Arbeit mein Spezialgebiet des Veränderungsmanagements und der Organisationsentwicklung(ausgebildet in Supervision, systemischer Prozessberatung, Lernende Organisation und Dialog, Systemarchetypen und Großgruppeninterventionen am MIT Boston) und die Tätigkeit als Managing Partner der Firma DIRECTTECH (Entwicklung in der Kleinwindtechnologie/WINDTRACKER Konzept, www.silentrevolution.com) wissenschaftlich zu verbinden.

Wie xxx mitteilte, wäre ggf. ein Termin nach dem xxx denkbar, hierüber würde ich mich sehr freuen, es wäre wunderbar wenn ich sowohl mit Ihnen Herr xxx als auch mit Frau xxx ein Interview führen könnte.

Vielen Dank und freundliche Grüße,
Sylvia Böcker

10.8 Turbines and Capacity in the Federal States



CUMULATED INSTALLED TURBINES AND CAPACITY IN THE FEDERAL STATES OF GERMANY STATUS 31st of December 2012

BWE (2013): Branchenreport, Windindustrie in Deutschland

10.9 Offshore Wind Park Projects

OFFSHORE WIND PARKS PROJECTS UNDER CONSTRUCTION IN GERMANY, STATUS 31st of December 2012

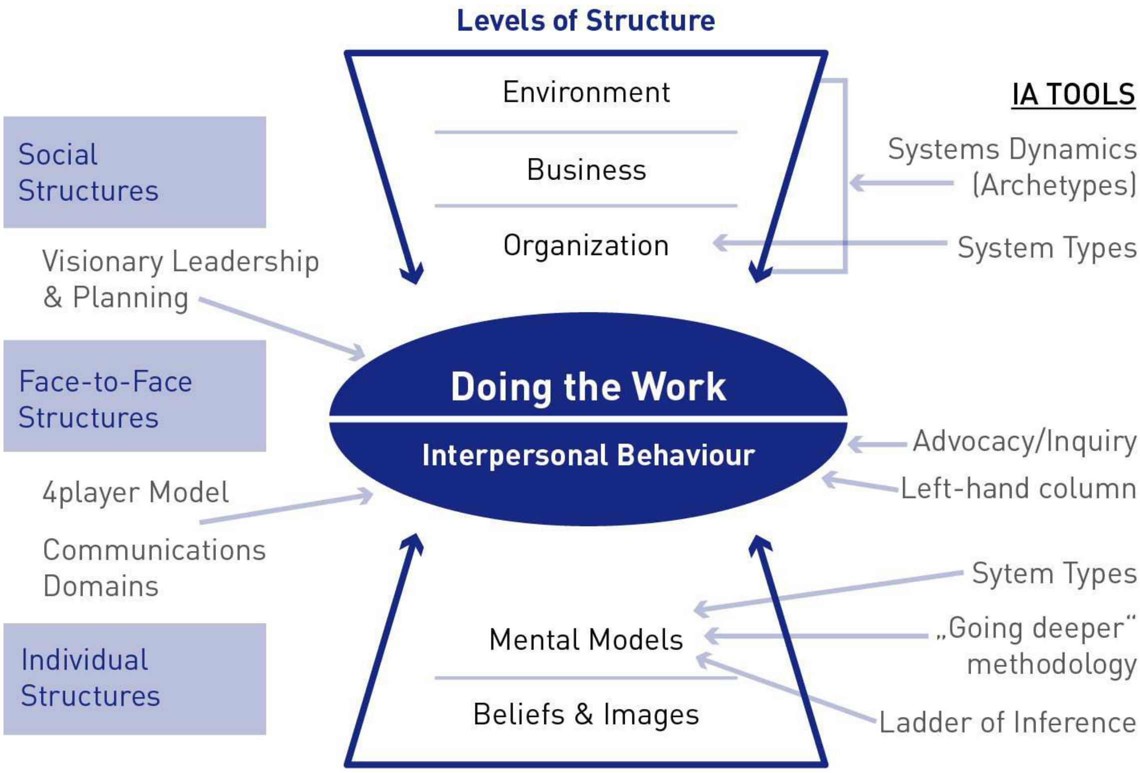
BWE (2013): Branchenreport, Windindustrie in Deutschland

10.10 List of Interviewees

ACHILLES DIETER DR.	CEO Institut für Energietechnologie
31st January 2013, telephone interview	
ALBERS FRANK	Division Manager, Windtest
25th May 2012, Grevenbroich,	
BARTHEN ERNST	Self employed
10th March 2012, 4th February 2013, Rheinberg	
BLOME STEFAN	Chamber of Farming NRW
3rd July 2012, Kranenburg	
BREMS WIBKE	Federal Parliament, GP
21st June, Düsseldorf	
BURKLE JAMES	Scientist
7th December 2012, Austin, USA	
EFFERN ERIC	Division Manager, Windtest
10th April 2012, 30th Janury 2013, Grevenbroich	
ETTWIG FRITZ	Judge retired
24th June 2012, Rheinberg (pair)	
ETTWIG BARBARA	Teacher
24th June 2012, Rheinberg	
FEST PHILIPP DR.	Federal Ministry
26th July 2012, Düsseldorf	
HARNACK JENS	Sustainability Manager Municipality
21st January 2013, Rheinberg	
HARTMANN KLAUS DR.	Financial Institute, Insurance
7th June 2012, Berlin	
HARTUNG RENE	Consultant
7th June 2012, Berlin	
HEINEMANN BERND	Government
6th December 2012, Chicago	
HEINTEL JÖRN	Dipl.-Engineer
10th June 2012, Neukirchen-Vluyn	
HEYER FRED	CEO REN AG
25th July 2012, Nettetal	

JILGE-SCHLIE MANFRED	Social Scientist
23rd June 2012, Moers	
JUETTERMANN PATRICK	Self-employed person
27th June 2012, Moers	
KAUL HARALD	Administration
17th June 2012, Finkenberg	
KRÄMER MONIKA,	CEO Windtest
25th June 2012, Grevenbroich, together with Mr. Albers	
KRISCHER OLIVER	National Parliament, GP
9th July 2012, Aachen	
LANDWEHR TOBIAS	BVKW
5th July 2012, Stuhr, Niedersachsen	
LORENZ ANNE	Consultant
4th July 2012, Moers	
LORENZ KLAUS	Consultant
4th July 2012, Moers, together with Mrs. Lorenz	
MARNETT MARKUS	Scientist
7th July 2012, Aachen	
RAATSCHEN KLAUS	Raatschen Elektrotechnik
12th June 2012, Kamp-Lintfort	
RAVE KLAUS Dr.	CEO Global Wind Energy Council
6th September 2012, Kiel	
SCHECKEL MICHAEL	Ostwind Gruppe
22nd January 2013, Duisburg	
SEEL GERD	Self-employed person
4th August 2012, telephone interview	
THEILE BARTHEN Luise	Teacher
14th June 2012, Rheinberg	
THYEN ELMAR	TRIANEL
23rd July 2012, Aachen	
VERHEYEN OTHMAR	University Duisburg
14th November 2012, Duisburg	

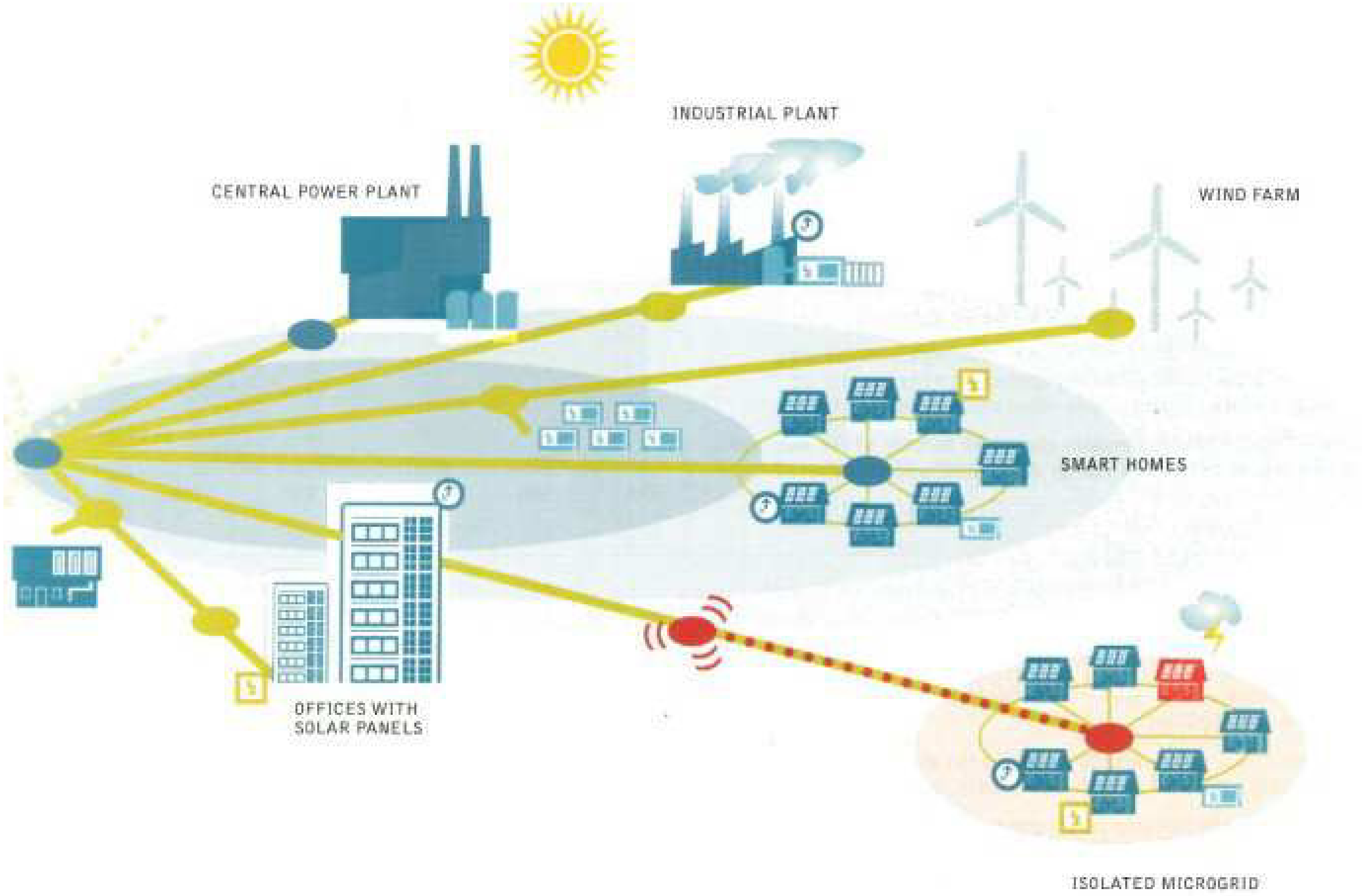
10.11 Model and Tools based on KANTOR



Suitable methods in combination with the Team Learning Model

KANTOR (1995), seminar script

10.12 SMART Grid Vision for the Energy (R)evolution



The SMART grid vision for the energy (r)evolution, in:

Pow E(R) 2030, A European grid for 3/ renewable electricity by 20130,

TESKE ET AL. (2014), GREENPEACE Germany, date March 2014

10.13 Global Expenses and Costs

Sign at the UNEP`s HEADQUARTER in NAIROBI, FIRST UNITED NATIONS ENVIRONMENT ASSEMBLY, June 2014

10.14 Electricity from the Roof

BAUEN UND WOHNEN | Warum die Zukunft dem Kleinwind und Häusern mit Ausstattung

Strom vom Dach

Windmühle mit Zukunft: Horizontal-Rotor bringt Strom

Foto: Günter Menzl/fotolia, BVKW, Wespe, Baufritz, Intofrank/Fotolia.com

Der Strom, der aus Wind, Sonne, Wasser und Biomasse gewonnen wird, macht mittlerweile 28,5 Prozent am gesamten Stromverbrauch in Deutschland aus. Ein Rekordhoch! Und es könnte noch mehr werden. Zwar sind die Einspeisevergütungen durch die Reform des Erneuerbare-Energien-Gesetzes (EEG) zum 1. August gesunken (bei Windkraft auf aktuell 8,9 Cent pro kw/h), dennoch sind sich Experten sicher: Kleinwind hat Zukunft. Gemeint sind Mikro-Windkraftanlagen die auf Hochhäusern, auf dem Dach oder im eigenen Garten aufgestellt werden können und von der EEG-Umlage befreit sind. Stephan Schwartzkopff vom Bundesverband Kleinwindanlagen in Berlin sieht diese Technik sogar als „weltweit entscheidend für unsere zukünftige Energieversorgung".

Die Anschaffungskosten für eine Mikro-Windkraftanlage liegen bei 7000 bis 8000 Euro. Selbstbausätze gibt es ab 1500 Euro. Mit einer solchen Anlage können bei mittlerer Windintensität (3 bis 4 Meter pro Sekunde) zwischen 1000 und 2500 kw/h Strom im Jahr produziert werden. Erste Anhaltspunkte wo wie stark der Wind bläst, vermittelt der Deutsche Wetterdienst unter www.dwd.de.

Fleißig wie die Biene: Das Modell WESpe taugt für Standorte mit durchschnittlicher Windgeschwindigkeit

„Eine schwarze Null ist drin. Bei fallenden Anschaffungskosten und steigenden Strompreisen kann man mit seiner Windanlage auch den ein oder anderen Euro verdienen", sagt Anja Aster von der EnergieAgentur.NRW in Wuppertal.

Bislang werden die Mikro-Anlagen in Deutschland in geringer Stückzahl hergestellt. Bei entsprechender Massenproduktion wird ein Preisverfall, ähnlich wie der bei Solaranlagen, erwartet.

Lohnt sich der Kauf einer Windkraftanlage trotz des neuen EE-Gesetzes?

Doch es zählt nicht allein der Preis. Die Tatsache, dass sich der Betreiber einer Kleinanlage unabhängig von Stromriesen macht und den Multis sogar ein Schnippchen schlägt, motiviert. Denn so weiß man, woher der Strom wirklich kommt.

Noch steht Deutschland am Anfang der Entwicklung. Schätzungsweise 2000 Kleinanlagen drehen sich beispielsweise in Nordrhein-Westfalen, die sich effektiv mit Solaranlagen kombinieren lassen. Denn scheint die Sonne, muss der Wind nicht blasen und umgekehrt.

Bevor man sich jedoch eine solche Anlage zulegt, sollte man sich unbedingt beim Bauamt der Gemeinde erkundigen. Wie hoch darf die Anlage sein, welche Seitenabstände sind einzuhalten, welche Geräuschentwicklung ist akzeptabel und was sagen die Nachbarn dazu?

Übrigens, wer sich mit seinen Nachbarn einig wird und diese für Strom aus Windkraft begeistern kann, kommt viel schneller – auch finanziell – auf den sprichwörtlichen grünen Zweig. *hü*

Strom vom Dach, in: PRISMA, Nr.33/2014

10.15 Original Data of the WISTRA Project

WISTRA-Project

month	01/90	02/90	03/90	04/90	05/90	06/90	07/90	08/90	09/90	10/90	11/90	12/90	amount	
1 Rüt									2.968	5.650	3.500	5.840	17.958	
2 Gre									*1.610	*2.932	*2.075	*3.239	*9.856	
3 Opp									3.583	4.904	3.509	4.674	16.670	
4 Kal									1.370	3.870	3.200	5.420	13.860	
5 Hem									1.395	2.916	2.367	3.480	10.158	
6 Wet									3.250	5.000	3.400	5.940	17.590	
7 Küs									3.878	4.852	13.542	8.400	30.672	
8 Boc									3.211	5.001	4.017	6.480	18.709	
9 Vre									1.862	2.958	1.256	4.230	10.306	
													145.779	kWh

month	01/91	02/91	03/91	04/91	05/91	06/91	07/91	08/91	09/91	10/91	11/91	12/91	amount	
1 Rüt	7.600	4.219	3.931	2.310	970	3.300	1.970	1.250	2.200	4.000	6.940	6.300	44.990	
2 Gre	*4.346	*2.490	*1.501	*1.716	*1.089	*1.851	*1.051	*819	*1.194	*1.896	*3.412	*2.986	*24.351	
3 Opp	0	0	1.958	2.893	2.438	3.366	1.659	1.529	1.834	3.286	4.366	4.772	28.101	
4 Kal	6.652	2.945	1.493	3.235	1.950	3.160	1.600	1.253	1.840	2.040	5.475	3.618	35.261	
5 Hem	6.906	3.450	4.215	1.440	1.575	2.349	1.385	1.445	537	5.661	798	3.642	33.403	
6 Wet	6.830	3.590	3.340	3.920	2.608	3.848	2.944	1.866	1.418	4.280	4.720	6.600	45.964	
7 Küs	9.250	3.180	4.660	4.140	5.420	6.360	3.727	2.363	4.500	4.500	6.480	12.420	67.000	
8 Boc	11.478	4.944	4.449	4.758	2.400	4.290	3.174	1.422	3.096	3.255	7.095	6.354	56.715	
9 Vre	4.440	3.330	2.530	3.142	1.312	2.506	1.320	560	*841	1.740	5.060	5.060	31.841	
													367.626	kWh

month	01/92	02/92	03/92	04/92	05/92	06/92	07/92	08/92	09/92	10/92	11/92	12/92	amount	
1 Rüt	5.040	4.950											9.990	
2 Gre	*2.089	*2.669											*4.758	
3 Opp	1.723	2.625											4.348	
4 Kal	3.513	3.803											7.316	
5 Hem	4.554	*4.932											*9.486	
6 Wet	4.380	4.860											9.240	
7 Küs	7.830	7.710											15.540	
8 Boc	5.826	4.250											10.076	
9 Vre	4.560	2.780											7.340	
													78.094	kWh

amount 09/1990 - 02/1992 (the signed values with a * are considered) **591.499 kWh**

BARTELT HEINRICH (1994): Windkraftanlagen in NRW, Ergebnisbericht eines Projektes zur Windstromerzeugung im nordwestdeutschen Binnenland, WISTRA, 2. Auflage 1994, Düsseldorf, p. 92

10.16 Example of Energy Output of one Motorway

Possible energy output by integration in the ininfrastructure

Example: *one motorway*

Details: *1 km motorway*
installations in both directions
distance between the units 50m
correction factor of 5% in case of disturbences

Amount of units:
1 KM motorway (1.000 m) / 50m (distance between the units) = 20 units x 2 (both directions) = 40 units
factor of correction; 40 units x 5 % = 2 units
result: basis of calculation 38 units

Basis of output of example:

Annual output of 9 installed units of the WISTRA project in 1991 (complete year):	367.626	**kWh**
Average output per unit:	40.847	**kWh**

Calculation of 1 KM motorway:

Output of one unit:	40.847	**kWh**
Output 38 units:	1.552.199	**kWh**
	1.552	**MWh**
	1,55	**GWh**

Calculation of motorway A7:
The A7 is the longest motorway in Germany with a total length of 962 Kilometer.

1 kilometer motorway:	*40*	*units*
962 kilometer motorway:	*38.480*	*units*
factor of correction 5 %:	*1.924*	*units*
Total amount units A7:	*36.556*	*units*

Output of one unit:	40.847	**kWh**
A7 - output 36.556 units:	1.493.215.117	**kWh**
	1.493.215	**MWh**
	1.493,22	**GWh**
	1,49	**TWh**

Example of calculation of output of one motorway, wind zone 2 (German rating), data of energy output based on original data of 1991 of the WISTRA project, see APPENDIX NO. 10.15

BARTELT HEINRICH (1994): Windkraftanlagen in NRW, Ergebnisbericht eines Projektes zur Windstromerzeugung im nordwestdeutschen Binnenland, WISTRA, 2. Auflage 1994, Düsseldorf, p. 92

10.17 Example of Energy Output of TOP-10 German Motorways

Calculation of Top 10:

Calculation of TOP 10 motorways with complete length in Germany

Top 10 of longest motorways

Range	motorways	length in total	
Range 1	motorway A7	962	Kilometer
Range 2	motorway A3	778	Kilometer
Range 3	motorway A1	732	Kilometer
Range 4	motorway A4	585	Kilometer
Range 5	motorwayA9	529	Kilometer
Range 6	motorway A8	497	Kilometer
Range 7	motorway A6	477	Kilometer
Range 8	motorway A2	486	Kilometer
Range 9	motorway A5	440	Kilometer
Range 10	motorwayA20	322	Kilometer
Toatal	Top 10	5.808	Kilometer

Quelle: http://www.meine-auto.info/ratgeber/autobahn-info/top-10-deutsche-autobahn.html

1 kilometer:	*40*	*units*
5.808 kilometer:	*232.320*	*units*
factor of correction 5 %:	*11.616*	*units*
Total amount units A7:	*220.704*	*units*

Output of one unit:	40.847	**kWh**
Output 220.704 units:	9.015.169.856	**kWh**
	9.015.170	**MWh**
	9.015,17	**GWh**
	9,02	**TWh**

Calculation total motorways:

Total length of German motorways of 12.879 kilometer.

1 kilometer motorway:	*40*	*units*
12.879 kilometer:	*515.160*	*units*
factor of correction 5 %:	*25.758*	*units*
Total amount units:	*489.402*	*units*

Output of one unit:	40.847	**kWh**
Output 489.402 units:	19.990.766.628	**kWh**
	19.990.767	**MWh**
	19.990,77	**GWh**
	19,99	**TWh**

Example of calculation with the TOP-10 motorways, wind zone 2 (German rating) and of the total length of German motorways, origin of length of motorways: http://www.meine-auto.info/ratgeber/autobahn-info/top-ten-deutsche-autobahn.html (2014)

Data of energy output based on original data of 1991of the WISTRA project, see APPENDIX NO. 10.15,

BARTELT HEINRICH (1994): Windkraftanlagen in NRW, Ergebnisbericht eines Projektes zur Windstromerzeugung im nordwestdeutschen Binnenland, WISTRA, 2. Auflage 1994, Düsseldorf, p. 92

10.18 Example of Energy Output considering Wind zone 3 (1000 kilometers of 10.000 kilometers)

Calculation wind zones:

This calculation is based on total length of motorway of 10.000 KM.
In comparison to the other calculation (only wind zone 2) we will consider 2 wind zones
we will calculate a part of 1.000 kM of the total length with the output of wind zone 3.
We assume a double wind speed in comparison with wind zone 2.
Doubling the wind speed is calculated with 8-times the output (Pelte).

Wind zone: 2

1 kilometer motorway:	40	units	output one unit:	40.847	kWh
9.000 kilometer:	360.000	units	output of 489.402 units:	13.969.788.000	kWh
factor of correction 5 %:	18.000	units		13.969.788	MWh
Total amount units:	342.000	units		13.969,79	GWh
				13,97	TWh

Info:
Double the wind speed = 8 times the energy

Wind zone: 3

1 kilometer motorway:	40	units	output one unit:	326.779	kWh
1.000 kilometer:	40.000	units	output of 38.000 units:	12.417.589.333	kWh
factor of correction 5 %:	2.000	units		12.417.589	MWh
Total amount units	38.000	units		12.417,59	GWh
				12,42	TWh

Total amount of wind zone 2 and windzone 3:	26,39	TWh

The definition of wind zones is referred to German definition of wind zones

This example of calculation is based on 10.000kilometers motorway considering 1.000kilometers of 10.000kilometers being wind zone 3.The double average wind speed of wind zone 3 is assumed. Due to the nature of wind it is related to 8-times the energy output, See HEIER (2012) pp. 41ff.; TONG (2010) pp. 6 ff. and PELTE (2010) pp. 183ff.

Data of energy output based on original data of 1991 of the WISTRA project, see APPENDIX NO. 10.15,

BARTELT HEINRICH (1994): Windkraftanlagen in NRW, Ergebnisbericht eines Projektes zur Windstromerzeugung im nordwestdeutschen Binnenland, WISTRA, 2. Auflage 1994, Düsseldorf, p. 92

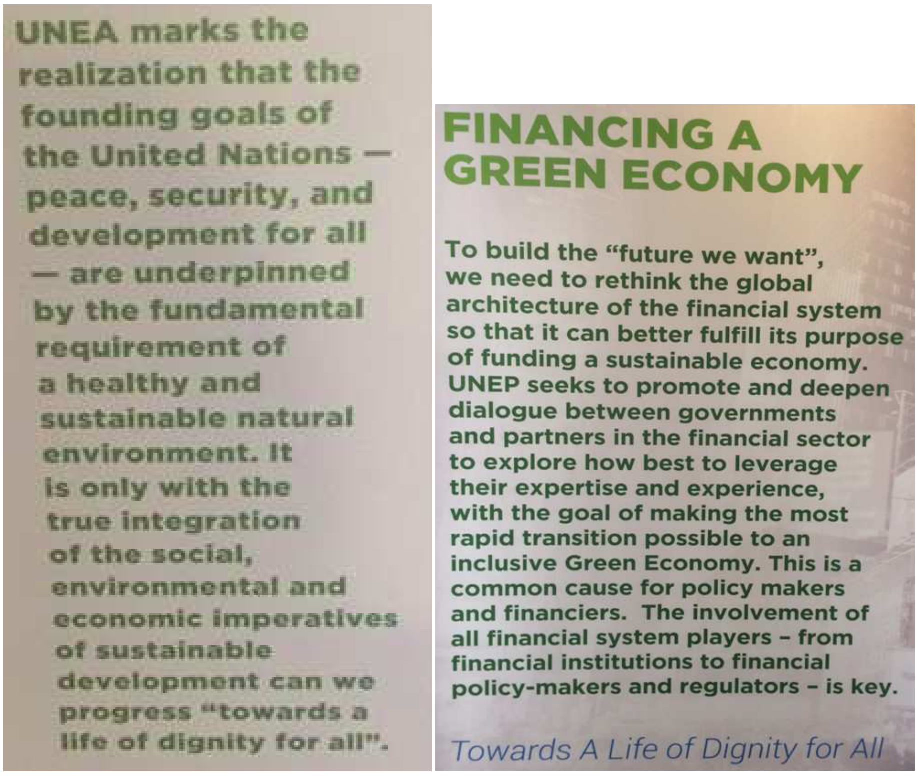
10.19 Total Investment Costs of the Turbines of the WISTRA Project

	location	investment costs DM
1 Rüt	Rüthen	152.727
2 Gre	Greven	193.835
3 Opp	Oppenwehe	168.800
4 KaL	Kamp-Lintfort	178.513
5 Hem	Hemer	164.277
6 Wet	Wettringen	174.755
7 Küs	Küstelberg	259.743
8 Boc	Bocholt	193.056
9 Vre	Vreden	192.516
	Total	1.678.222

Total investment costs including the turbines, foundation, cables and grid connection to the energy provider as well as maintenance. Two turbines were installed inclusive storage facilities, all prices are in German Mark, status 1994

BARTELT HEINRICH (1994): Windkraftanlagen in NRW, Ergebnisbericht eines Projektes zur Windstromerzeugung im nordwestdeutschen Binnenland, WISTRA, 2. Auflage 1994, Düsseldorf, p. 55

10.20 Requiring a Sustainable Future



Signs at the UNEP`s HEADQUARTER in NAIROBI, FIRST UNITED NATIONS ENVIRONMENT ASSEMBLY, June 2014