Optimisation of the share of renewable energies in electricity systems in the European Union

Cornerstones of an alternative political and institutional scenario

Master Thesis
zur Erlangung des akademischen Grades eines

Master of Science (M. Sc.)

an der Universität Koblenz-Landau
Fachbereich 3: Mathematik/Naturwissenschaften

vorgelegt von

Christine Lucha
aus Berlin

Koblenz, 2006

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Abstract

This paper analyses ways of an optimisation of the renewable enery share in the electricity sector in the European Union. The relevance of this study is to be derived from the ongoing debate on liberalisation and the future of energy supply especially on the European level. The underlying concern is to support the development of renewable energy and electricity saving policy strategies in order to prevent climate change. This implies that a large range of factors have to be taken into account to capture the complex ways in which policy affects this process and vice versa how policy is affected by the technical, legal and economic processes. The result is neccessarily an interdisciplinary approach because policy needs do not respect disciplinary boundaries. The approach consists in a transfer of philosophical and legal theories into the electricity sector—the design of participative goal setting procedures and the Montesquieuian concept of separation of powers. Based on the experiences with the expansion of renewable energies gained in Denmark and in Germany, its success factors as well as the barriers, and by applying the specific approach, cornerstones of an alternative institutional and political scenario are developed; resulting in a democratic and sustainable electricity supply system based on renewable energies and a high level of decentralised generation. In order to reach such a system, a general separation of public regulation power, (consumer) ownership power and market power as well as a mutual control of these powers is crucial.

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List of Abbreviations

app.	approximately
ASEW	Arbeitsgemeinschaft für sparsame Energie- und Wasserversorgung
BBE	Bundesverband Bieenergie
BDI	Bundesverband der Deutschen Industrie
BDW	Bundesverband deutscher Wasserkraftwerke
BEE	Bundesverband Erneuerbare Energien
BGH	Bundesgerichtshof
BMBF	Bundesministerium für Bildung und Forschung
BMELV	Bundesministerium für Ernährung, Verbraucherschutz und Landwirtschaft
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
BMVBW	Bundesministerium für Verkehr, Bau- und Wohnungswesen
BMWi	Bundesministerium für Wirtschaft
BNA	Bundesnetzagentur
BNE	Bundesverband Neuer Energieanbieter
BSW	Bundesverband Solarwirtschaft
BWE	Bundesverband Windenergie

CDU	Christlich-Demokratische Union
CHP	Combined Heat and Power
CSU	Christlich-Soziale Union
DERA	Danish Energy Regulation Authority
DKK	Danish Crowns
DLR	Deutsches Zentrum für Luft- und Raumfahrt
e. g.	for example
ECJ	European Court of Justice
EEG	Erneuerbare Energien Gesetz
EnWG	Energiewirtschaftsgesetz
EREC	European Renewable Energy Council
EU	European Union
FIT	feed-in tariff
GWB	Gesetz gegen Wettbewerbsbeschränkungen
GWh	Gigawatt-hours
i. e.	that is
IER	Institut für Energiewirtschaft und rationelle Energieanwendung
IPCC	Intergovernmental Panel on Climate Change
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hours
MW	Megawatt
MW_p	Megawatt peak
MW_e	Megawatt electrical power
NGO	Non-Governmental Organisation

OOA	Organizationen til Oplysning om Atomkraft (Organisation for Information about Nuclear Power)
OVE	Organizationen om Vedvarende Energi (Organisation for Renewable Energy)
PJ	Petajoule
PSO	Public Service Obligation
PV	Photo-voltaic
R & D	Research and Development
RE	Renewable Energies
RE	Renewable Energy
RES	Renewable Energy Sources
SPD	Sozialdemokratische Partei Deutschlands
StrEG	Stromeinspeisegesetz
TGO	Transmission Grid Operator
VAT	Value-Added Tax
VDEW	Verband der deutschen Elektrizitätswirtschaft
VDMA	Verband der Deutschen Maschinen- und Anlagenbauer
VDN	Verband der Netzbetreiber
VKU	Verband kommunaler Unternehmen
WPPD	Wind Power Planning Directive

1 Introduction

The aim of my research is to contribute to the necessary fundamental transition from the fossil and uranium stamped electricity supply system to a democratic sustainable electricity supply system based on renewable energy (RE) and basically decentralised generation. The study is divided in three main parts addressing the history, the status quo and future strategies of RE development:

In section 1 the research question is laid down and the specific approach to answer this question is described. Sections 2 and 3 consist in an analysis of the historical development of RE expansion as well as the characteristics and dynamics of the current electricity supply system including the RE support schemes in Denmark and Germany. In section 4 the success elements and the basic barriers and problems to the further expansion of RE and decentralised generation are elaborated. Section 5 consists in the development of cornerstones of an alternative political and institutional scenario for an optimised RE share in the electricity system.

These analytical parts are followed by conclusions and limitations in sections 6 and 7. In these parts the outcomes of the problem analysis and the development of an alternative scenario are checked on their practical relevance for the current political processes and on their limitations. In addition to this, further research areas are named. Thereby these chapters provide an answer to the problem formulation.

1.1 Problem formulation

Fossil fuels constitute the dominant energy source in the world, contributing to about 80 % of total primary energy supply and 67 % of electricity generation in 2003 (Staiss et al., 2006, p. 34–37). This dominance leads to serious environmental problems, one of it being climate change. To slow down climate change, a transition to a low/non-carbon energy supply based on renewable energy sources (RES) combined with energy conservation measures and an increase in energy efficiency must take place quite rapidly. Thus, the celerity of growth of RE utilisation becomes a central issue. It is no longer a question of technical potential of the RE technologies, but how this potential can be realised and substantially contribute to the future energy and especially electricity supply. It is widely recognised that the contribution of fossil fuels will increase even more in the future if no public pressure is exerted to achieve a fundamental change and no active policies for RE, decentralised generation and energy conservation are implemented. The reasons why the change in the electricity supply system will not occur by itself and will be actively decelerated, are manifold and are to be found in the existing technological, economic, legal, political and institutional conditions as well as in the power structures of the prevalent energy and electricity supply system:

Despite many and rapid technological advances and price degression, electricity from RES is still mostly more expensive than equivalent conventional power when calculated in the traditional way. This is mainly due to the fact that external costs of fossil fuels and uranium are often not internalised to level out the playing field between fossil, atomic and renewable energy. Besides this, one has to keep in mind that the use of fossil fuels and uranium has been and still is highly subsidised on the national as well as on the European level. Furthermore the fossil fuel price volatility and security of supply is ignored in most of the cases when it comes to a comparison of the costs and especially the risks of a fossil fuel based installation with a RE installation. In addition to this, the prevalent electricity supply structure is backed by a strong and powerful lobby with direct and often short-term economic interests in the continuation and further expansion of the existing system. These actors are not willing and, due to the interests of their stakeholders in continuous profit maximisation, not able to participate in the necessary change of the prevalent energy infrastructure and markets to the needs of electricity generation from RES. The political processes are largely influenced by this lobby groups, and governments often see their task in fostering the economic growth of the established energy companies and/or believing in the regulation forces of the "markets".

Therefore a strong counterbalance is needed to further the necessary turnaround from the use of and dependency on fossil fuels and uranium to a climate-friendly and democratic energy system based on RE and energy conservation. The central question in this research is thus the following:

How can the electricity governance system be optimised politically and institutionally in order to reach the necessary expansion of Renewable Energies?

As they deliver best-practice examples, the current Danish and German electricity systems are analysed with a focus on the RE support on their success elements and barriers with regard to RE expansion. On this basis a deduction of the necessary changes for an optimisation of the RE expansion is made by relying on the specific approach as described below in section 1.2. With the term "optimisation", the RE expansion needed to achieve the global climate protection goals is meant throughout this paper. This research deals mainly with the development of the cornerstones of an alternative institutional scenario and changes in the political process in order to achieve a transition to an electricity supply system based on RE. The focus hereby lies on the transfer of legal and philosophical theories into the electricity sector in order to achieve an optimisation of the RE expansion. The hypothesis is that this transfer can be helpful to open up the discussion to the aspects of goal setting procedures and power structures and, by this, discuss changes that lie beyond the appliance of economic theories and only dealing with practical and technical implementation.

The overall idea is to deliver one element in the process of "optimisation and coordination" of the Member States of the European Union (EU) concerning the support of RE as recommended by the EU Commission in its report on the further support of RE (COM, 2005) in giving a guideline on what elements to respect in establishing and further optimising RE support. The results are of specific relevance when it comes to establish the legal framework for the "New Energy Policy for Europe".

1.2 Rationale of the study

Given the brief outline of the problem area above, it is obvious that relationships and interdependencies in the field of electricity supply are too complex to be dealt with using simple models, and that clear solutions are consequently not readily at hand. It has to be dealt with technological developments, power structures in the prevalent electricity supply system, structural and legal constraints on the economy and public authorities, the emergence of new interests, values, and pressure in society, complex interactions of industry, research, governments and interest/lobby groups. These requirements call for an interdisciplinary perspective and approach. So, analysing the electricity systems and respective changes asks for a combination of technical, economic, legal and political theories and knowledge.

Krupp (as cited in Weber, 1999, p. 6) once characterised the energy sector as follows:

> "Energy is the physical fuel of societal dynamics. Its form and use is an integral part of a society. Therefore, the politics and the economics of energy provision and consumption are too complex to be left to any particular discipline or elite. Also, there is no such discipline as energology. Therefore, an interdisciplinary approach has to be taken which methodologically has to muddle through."

The challenge is to avoid only ‘muddling through’ but to develop an interdisciplinary approach that is politically operational and delivers an increased spectrum of action for the politicians, the general public and especially the respective RE associations and movements. This is of special relevance when fundamental changes in the system are needed. Changes of relevance for the whole society and need an overall support and participation in the goal setting and the subsequent implementation measures—like it is the case when dealing with future electricity supply strategies.

1.2.1 Interdisciplinary approach

My aim is therefore to approach the research question interdisciplinarily by transferring legal and philosophical theories to the political and institutional process and subsequently drawing consequences for the design of an alternative electricity governance system. In addition to this, economic theories are applied in order to explain the overall development of the electricity sector, its status quo, and the barriers to overcome the prevalent electricity supply system. Besides this, the relationships between the design of the technical system, the fuels used and the interests of the most powerful electricity companies are shown. The interlinkages and mutual influences between the actors and organisations of the prevalent electricity supply system, and the political and institutional processes as well as the setting of laws and rules are analysed.

As illustrated in figure 1, changes in the political processes, especially the goal setting, and changes in the institutional and organisational setting-up, especially the power structure and the interlinkages between the institutions and organisations, seem to deliver the crucial impetus for the subsequent adaptation of the basic technical, economic and legal conditions that furthermore secure the implementation of the changes in the system. The political process itself is widely influenced by economically dependent lobbyists, economically independent lobbyists, and innovative entrepreneurs and pioneers[1]. These assumptions on the role of the political process and the sequence of the process of changes are checked by analysing the RE development in Denmark and Germany, its success elements and barriers. The results of these analyses form the basis of the elaboration of the alternative political and institutional scenario.

[1] Economically dependent lobbyists are privately and/or economically influenced by the decisions being discussed. It can be someone employed within a fossil fuel company or selling equipment or getting economic support from such companies (political parties, pressure groups, or researchers). Independent lobbyists are not subject to such influence upon their private economy. Innovative entrepreneurs and pioneers are private persons who try out new technologies or invest in these.

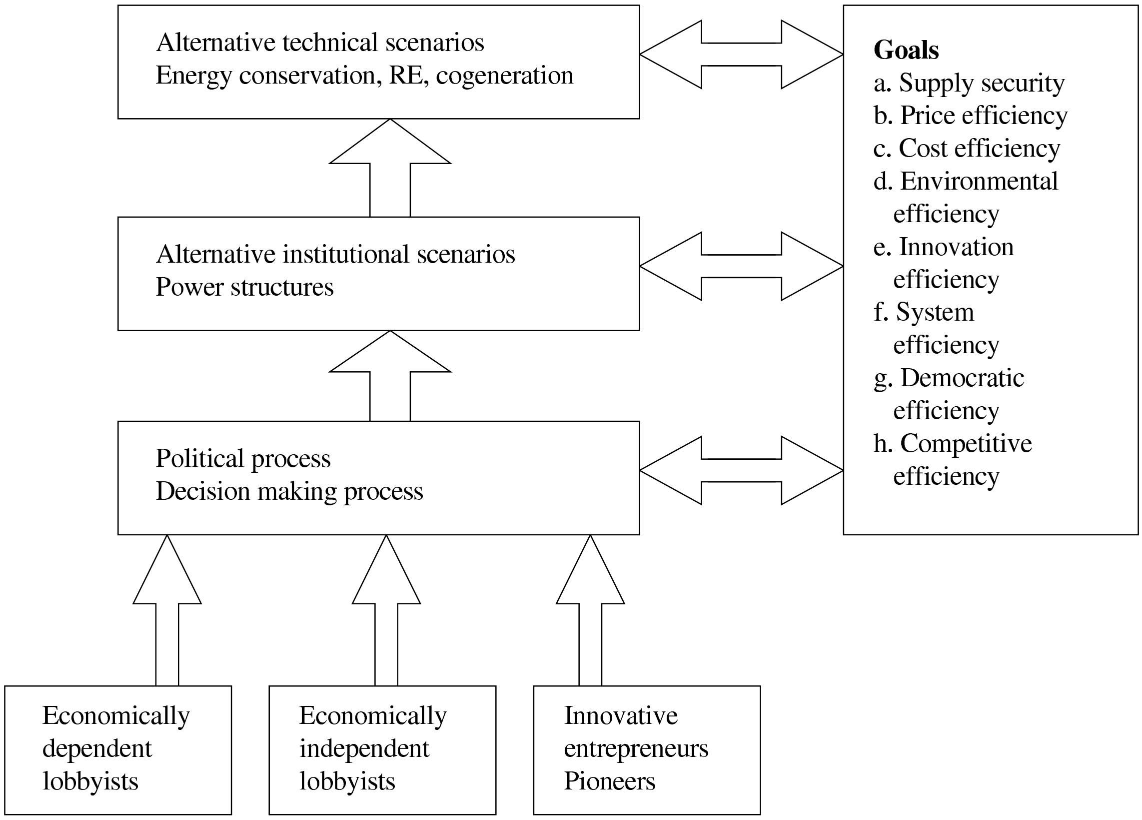

Figure 1: Alternative institutional and political scenario. Source: Hvelplund (2001a, p. 143)

By the term "institutional" both the 'sociological' meaning of institutions as the elements that pattern behaviour, such as laws, standards, rules, norms, morals etc. including certain rules for economic behaviour referred to as property rights, as well as the broader meaning of institutions as 'concrete things', such as organisations, companies, universities, state agencies etc.

Experiences with RE development in Denmark and Germany The approach thus builds on the experiences already made in Denmark and Germany with the RE development as well as on the existing conceptual and theoretical findings on technological change starting with an overview on the historical RE development in Denmark and Germany with focus on the political process and the subsequent institutional and legal changes. The RE expansion in Denmark and Germany is analysed on its implications for the political and institutional setting and vice versa.

The analysis also includes an overview on the main basic conditions of relevance for RE installations in order to demonstrate that the adaptation of the technical and economic conditions follows the changes on the political and institutional level:

- grid connection for RE installations and grid reinforcement;
- purchase conditions of the electricity produced in these installations;
- fiscal and financial framework for RE investments;
- ownership rules concerning RE installations as well as concerning the electricity distribution and transmission grids and
- organisations and institutions in the electricity supply system and their interlinkages.

Interviews and analyses regarding success elements and barriers for RE expansion In this analysis, technical and economic as well as legal, political and institutional elements are addressed that either act as success factors or as barriers to RE deployment. This is done on the basis of already existing analyses and complemented with interviews with energy experts in Denmark and Germany. For explanations of the success as well as the barriers, economic theories such as the phenomenon of path dependency and political and philosophical theories such as the discourse theory are consulted. With regard to the still remaining barriers that prevent the rapid RE deployment needed to achieve the climate protection goals, ways of a better integration of RE into the prevalent system are discussed. It is argued that such integration does not go far enough to achieve the energy transition. This forms the starting point for the cornerstones of the alternative scenario, showing necessary measures and changes in the system for an optimisation of RE shares.

Cornerstones of the alternative political and institutional scenario My aim is to develop cornerstones of an alternative political and institutional "radical" scenario. This alternative scenario consists in a democratic, climate-friendly electricity supply service system based on RE in basically decentralised generation. The respective necessary changes do not only require technical alternatives, but also entail new institutional and organisational solutions which are contrary to the economic and organisational, business and cultural interests of existing companies within the prevalent electricity system. The change requires strong democratic forces that are economically independent of the prevalent fossil fuel and uranium based energy companies.

This scenario is based on a respective macro- and microstructure adressing the relevant actors and organisations in the electricity supply system, their relationships and power structure as well as the political decision-making procedures. Starting with the complex of goal setting and what to respect in the respective processes, the focus will be on the need for independent actors and organisations, and effective participative and open decision-making processes in the electricity supply system. The scenario is of qualitative nature and focuses on the necessary political and institutional/organisational changes.

Participative goal setting by respecting the separation in normative and regulative levels One of the cornerstones consists in the definition of overall goals of the electricity supply system and the respective goal setting process. In order to gain the necessary consciousness and support for the implementation measures for an achievement of these goals, the goal setting process should be structured in a way that allows a broad participation and involvement of the society. The problem is that the political discussion on future electricity supply is mostly carried out in expert circles and only dealing with single questions in the respective field of expertise. The overall debate on a future electricity system under the heading "what do we want, and why?" by addressing the different alternatives is lacking. The members of the society thus are not aware of the choice they have between different alternatives and their respective consequences.

The "three-level-approach"[2] in this part guides the research. According to this approach, one has to distinguish the level of the normative decree ("Gebotenheitsebene"), and the level of appraising balancing between one goal and other goals and principles ("Abwägungsebene") when it comes to discuss policies and measures. On the third level named governance or regulation level ("Steuerungsebene"), the ways of implementing the respective targets found out on the preceding levels are to be discussed. These three levels and their succession have to be respected when it comes to develop future strategies in a democratic way. This approach shall create an awareness of the weight and importance of the questions and respective answers related to the future electricity supply for the whole society today and for the next generations.

[2] Own formulation of the author. For the approach see Ekardt (2004a, p. 533) and Ekardt (2004b, pp. 29ff).

Translated to this research, the debate about the setting of ambitious RE expansion targets and the energy turnover to a democratic electricity supply system with independent actors has to be placed on the first level, as these elements contain the normative question about the future electricity supply system the society wants. The conflicting principles and goals touched by this fundamental change have to be discussed on the second level, but not as single economic interests of stakeholders but as part of the competing prevalent electricity supply system as a whole. Both discussions have to be carried out by involving the public in participative processes. Granted that the decision will turn out in favour of a democratic electricity supply system based on RE and decentralised generation, the effective and most efficient ways to implement such a fundamentally different electricity supply system have to be found on the third level as a consequence of this decision.

Independent actors and organisations via the concept of separation of powers
The change to an electricity supply system based on RE in mainly decentralised generation addresses different actors in the prevalent direct electricity supply service system and the respective governance system and their relationship on the local, regional, national and the EU level as illustrated in figure 2. The figure describes the structure of the electricity supply system and its respective governance system [3] . The electricity supply system is divided in the direct electricity supply system—consisting of the chain of fuel extraction, power production, transmission and distribution—, and the indirect electricity supply system—that is the production of capital equipment for the direct electricity supply system. On the receiver side again, the direct electricity receiver system—the equipment that receives the electricity and transforms it into energy services, such as light or electric heat etc.—and the indirect electricity receiver system—which produces the respective capital for the direct system—are differentiated. As my paper is dealing with the cornerstones of an alternative institutional and political scenario, the distinction is made between "end of pipe" technological and institutional scenarios, such as improved coal-fired power plants, smoke abatement equipment, and "alternative" technological and institutional scenarios. The interlinkages of these scenarios, and the political and institutional settings are demonstrated by the boxes "parliament", "EU energy regulation", "market" and the respective arrows. The influences of lobbyists with direct economic interests and lobbyists with no direct interests in specific solutions on the political and institutional settings are shown by the respective boxes and arrows. The boxes "Historical situation" and "External inter-

[3] I will come back to this figure in detail in section 5.

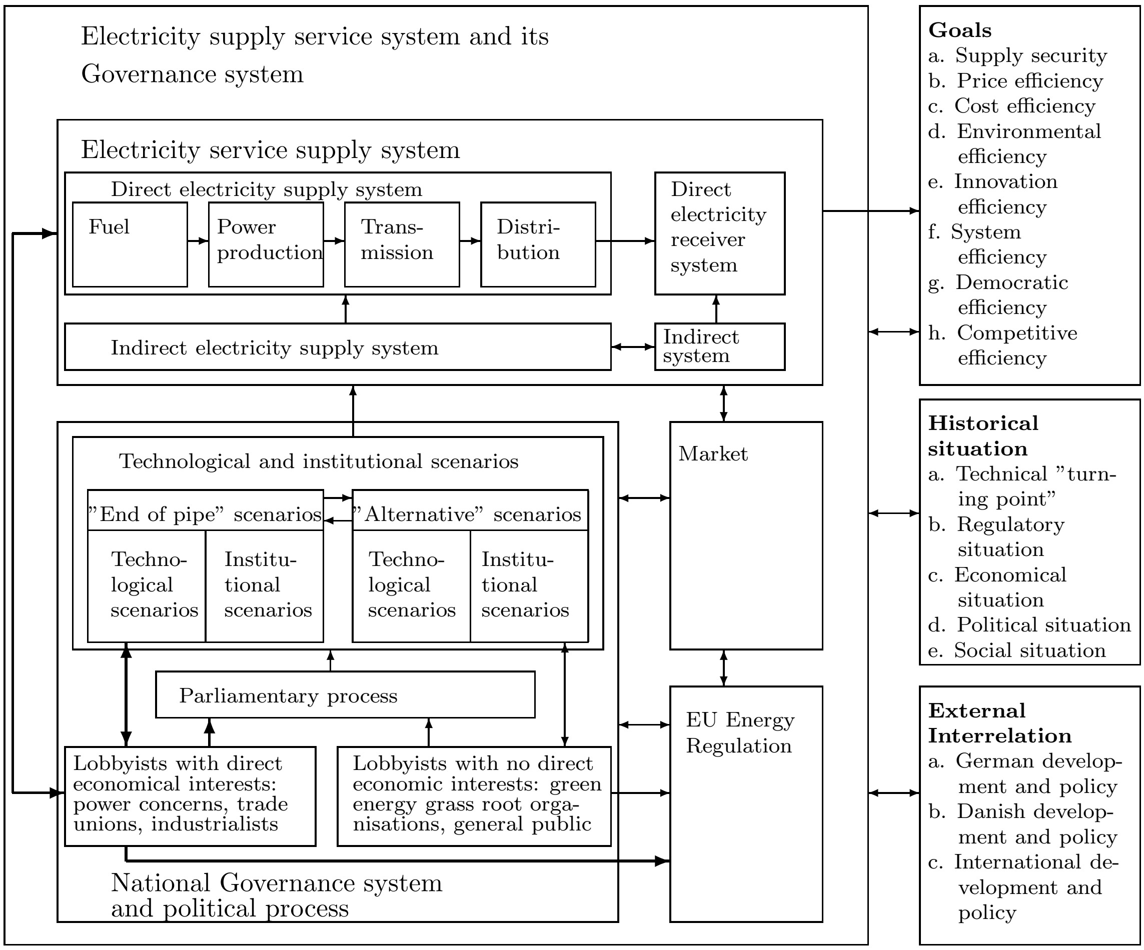

Figure 2: The electricity supply service system and its Governance system. Source: Hvelplund (2001a, Figure 6, p. 62)

relation" deliver the (external) framework for analysing the political action spectre. The box "Goals" contains a set of energy policy goals, against which the different types of electricity supply systems are to be evaluated; for this evaluation, see section 5.2.1. On the basis of these analyses it is demonstrated that the current power structure in the electricity supply system with its interlinkages, mutual influences and interests in the maintenance of the prevalent system prevents a fundamental change in the system to a more democratic and participative system based on RE in basically decentralised generation and electricity conservation. There is a need for independent, truly "liberalised" actors and organisations in the different power sectors, as there are the market power, the public regulation power and the (consumer) ownership power sector.

Therefore the power structure is in the focus of the research and a link is made to the concept of separation of powers as developed by Montesquieu in legislature, executive and judiciary. It is analysed if this concept of separation of powers is transferable to the electricity supply service system, how this could be implemented and what consequences are to be drawn from this separation.

Montesquieu claimed that the three powers should be divided up and independent from each other so that each power would have a power over the other. Besides this, all the bodies of power have to be bound by the rule of law. This is according to Montesquieu the best way to prevent an abuse of powers. The idea is to apply the same arguments used for the separation of powers in legislature, executive and judiciary for a separation of powers in the electricity supply service systems in

- public regulation power
  = parliament forming the "legislature",
- (consumer) ownership power
  = utilities, private supply companies, independent organisations etc. forming the "executive" and
- market power
  = buyers' and sellers' power forming the "judiciary".

It is shown that especially the separation of (consumer) ownership power and market power leads to a crucial aspect in regard to the RE expansion: public support and involvement via local ownership of RE installations. The ambitious RE expansion targets can only be achieved if they are supported by the people, especially on the local level, where the RE installations are placed. The support on the local level is essential and of high relevance for the overall support for RE, because these persons can act as interceders for RE expansion and contribute to the ecological sensibilisation and awareness processes in the electricity sector if they made good experiences with the respective RE expansion in the neighbourhood. So, it is necessary to guarantee local ownership of (parts of) the RE installations by individuals and/or cooperatives and municipalities.

The alternative scenario with its request for ambitious RE expansion targets and a separation of powers needs a strong public pressure to be exerted on the policy makers to get the turnover started and implemented, as the other actors due to their economic interdependency with the current electricity supply system are not willing and able to support this change and will lobby against it. This addresses two further consequences that can be drawn from the separation of powers between the public regulation or parliament power/market power and respectively between market power/ownership power: the involvement of the public, and here especially RE associations and grassroot movements and especially the consumers in the electricity supply systems in the shape of

- public consultations and debates in decision-making procedures on elements of the electricity supply systems and
- consumer ownership of distribution and transmission companies.

This is based on the assumption that “acceptance” or support can be “bought” to a certain degree only, but also needs possibilities to influence the political processes and involvement in the decision making processes for the public and backed by the analysis of the RE development in Denmark and Germany as well as the interviews with energy experts.

Another element of crucial importance for the RE deployment is the adaptation of the current electricity supply system, and especially the grid, to the needs of RE and decentralised generation. This matches with a consequence of the separation of powers between ownership power and market power and is discussed—as the other consequences—in detail in section 5 on the cornerstones of the alternative scenario.

This approach allows for an intense examination of the prevalent electricity supply system in Denmark and Germany with focus on RE development and gives an impression of the challenges connected with an optimisation of the RE shares leading to an alternative electricity supply system. It delivers ideas for what to respect and how to approach this turnover to a democratic electricity supply system based on RE in basically decentralised generation and electricity conservation. By this it can be helpful both as a guide for policy making as well as a sensibilisation tool with regard to the dominance of the existing interlinkages between the political/institutional levels and economic and technological levels when it comes to a change in complex systems.

1.2.2 Methods used and assumptions

This part gives a short overview on the methods used in the research as well as the assumptions.

Methods The methods used are the following:

- observant participation: participation in a discussion of concrete decision-making processes in the Bundesministerium für Umwelt, Naturschutz und Reaktorsicherhei (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, BMU);
- semi-structured interviews with relevant actors and stakeholders;
- literature analysis;
- discourse analysis by reading reports and written material leading to the decisions made in the political processes.

In general the interviews investigated the perception of success factors as well as key obstacles to RE development in Denmark and Germany, strategies, ideas and measures to foster future RE deployment and ways to preserve the public support for the respective expansion of RE.

Interview partners were

- Jane Kruse and Preben Maegaard of the Nordisk Folkecenter for Vedvarende Energi (Nordic Folkecenter for Renewable Energies), Ydby, Hurup Thy, for questions of public support and future strategies for the RE deployment;
- Sabine Frenzel of the Bundesnetzagentur (Federal Grid Agency, BNA) for approaches to integrate RE into the systems and incentives for the electricity companies to guarantee this integration;
- Stefan Wagner, Gesellschaft für Netzintegration e. V., Dauerthal, for questions of a (technical) integration of higher shares of RE into the grid,
- Dierk Bauknecht, Öko-Institut Freiburg (Institute for Applied Ecology) for approaches on how to foster a rapid RE deployment and decentralised generation.

Assumptions As the alternative scenario is developed on the basis of success elements and barriers for RE development in Denmark and Germany, it is mainly related to the electricity supply systems in these two countries. But the main ideas can be transferred to other countries, since general conclusions are drawn for all electricity supply systems.

For the necessary RE shares in regard to climate protection, the study relies on the findings of the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2001). For the share of the RE needed in this respect, it is drawn upon a current study of Greenpeace that sets a target of a RE share in electricity of more than 70 % in 2050 in the EU-25 (Teske et al., 2005).

For the status quo of the technological development of RE based electricity supply and the respective technological possibilities it is relied basically on the research of the Department of Development and Planning, Aalborg University[4] and the consortium of the Institut für Technische Thermodynamik, Division Systemanalyse und Technikbewertung, at the Deutsches Zentrum für Luft- und Raumfahrt (Institute for Technical Thermodynamics, Division for System Analysis and Technology Assessment, at the German Aerospace Center, DLR), Stuttgart, Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (Center for Solar and Hydrogen Research), Stuttgart, Wuppertal-Institut für Klima, Umwelt, Energie (Wuppertal Institute for Climate, Environment, Energy) as well as the Institut für Energiewirtschaft und rationelle Energieanwendung (Institut for Energy Economics and rational use of Energy, IER) and prognos[5].

So, mainly necessary changes in the political and institutional system are elaborated, and not specific concepts of technological or economic adaptation measures of the electricity supply system to the RE needs.

2 Characteristics and dynamics of the RE development and support in Denmark

When regarding the characteristics and dynamics of RE support in Denmark it has to be distinguished between the situation before and after the year 1999, the year in which the last and far-reaching reform of the electricity system was adopted by the Parliament and should have entered into force in 2003. It is of high interest to describe the situation before

[4] Such as Lund (2006), Lund (2005), Lund et al. (2004).
[5] Such as Nitsch et al. (2004), Fischedick and Nitsch (2002), IER et al. (2002).

and after 1999 as the respective rules rely on different approaches on how the system should work. Consequently the description of the RE support as well as the basic conditions for RE in the electricity supply system are split in the pre-1999 and the after-1999 situation where this makes sense.

First a historical overview is given in order to introduce the Danish RE development, especially wind power[6], and how it has been embedded in the general energy and climate protection debate since its early beginnings.

Secondly, details on the RE support, especially those rules of relevance for the investors, as well as on the ownership structure of the Danish electricity supply system and the RE installations are given in the subsequent subsections.

2.1 History of RE development and general energy strategies

Renewable energy development in Denmark has been strongly influenced by early research and development work of RE pioneers as well as a continued and widespread public support for these new technologies. The tradition of using wind power to generate electricity can be traced back to the pioneering work of Poul la Cour at Askov Folkes High School in the 1890s. He developed and built a wind turbine for electricity production with a rotor diameter of 22 m incorporating mechanical speed control. In 1918, 120 rural wind turbines were installed with capacities between 20 and 35 kW. During the following decades, these wind turbines were further developed and tested—this period cumulated in the 200 kW Gedser Mill developed by Johannes Juul, which was in operation from 1959–1967 (Meyer, 2004, p. 25; Gipe, 1995, p. 54). This mill became the 'mother' of the Danish wind mills in the 1970s, characterised by three blades on a horizontal axis in an upwind position and pitchable blade tips to control overspeed[7].

2.1.1 1972–1980. Dansk Energipolitik 1975: Oil crisis and energy supply security

Soon after the oil crisis in the 1970s, a number of initiatives were taken to promote RES and especially wind power in the Danish energy system. By this time practically all the electricity was generated in large, centralised thermal power stations. The country was extremely vulnerable to disruptions in oil supply and the subsequent price increases, as its

[6]For the development of biogas in Denmark, see for example Mæng et al. (1999).
[7]For details on the technological development, see Gipe (1999).

economy was heavily dependent on oil, all of which was imported (Hadjilambrinos, 2000, p. 1112). Eighty-five percent of the electricity were generated in central steam-turbine power stations using oil as fuel. Energy planning had been based on the "principle of supplying whatever was needed" (Lund, 2000, p. 250). Power stations were planned and built on prognoses based on the development of historical needs. There was no Energy Minister in place, neither an energy department and no actions plans in case of being cut off from fuel supplies. In 1950s, however, Denmark had established an Atomic Energy Commission and in 1958 set up its research centre at Risø near Copenhagen.

A committee set up by the Danish Academy of Technical Sciences published a report proposing a broad wind energy programme in 1975. This was followed by a second report in 1976 which outlined a five-year-programme in the field of wind energy (Meyer, 2004, p. 26). During the last part of the 1970s, a number of small and medium-sized industrial firms were involved in the development and production of small-scale wind turbines to be used by private households. In addition, a wind power programme for the development of large-scale wind turbines was implemented in 1977, jointly sponsored by the government and Danish utilities (Meyer, 2004, p. 26). On the basis of this programme, three large wind turbines of 630 kW were installed near Nibe. No Danish company was interested in building these wind turbines. The turbines were therefore procured on a multi-contract basis, involving Risø, one technical university and a utility. Like with other large wind turbines in these years, for example in the Netherlands, many technical problems occurred, e. g. fatigue problems in the blades and problems with the gear box, with the result that the turbines were pulled down again after a relatively short time period (Kamp et al., 2004, p. 1631). The Danish power companies, however, mainly proposed replacing oil power stations with nuclear power plants.

The parliament in 1976 passed the Electricity Supply Act, which entered into force in 1977. In its first paragraph, the Department of Trade was commissioned to prepare energy policy statements on a regular basis (Lund, 2000, p. 250). Thus, in the same year, a first official energy plan (Dansk Energipolitik 1976) was published by the Ministry of Trade. The plan's leading objective was to reduce oil dependency by introducing new fuels and by slowing down the growth in demand. To achieve these goals, the government and the power companies intended to focus on nuclear power[8]; CHP plants were excluded because they would impede an economic use of nuclear power-based electricity (Hvelplund and Lund, 1998a,

[8]The plan called for the construction of five nuclear power plants which were to provide at least 23 % the total primary energy demand by 1995, see Blegaa et al. (1977).

p. 90). Public resistance against the plans for introducing nuclear power aroused, mainly organised by the Organizationen til Oplysning om Atomkraft (OOA; Organisation for Information about Nuclear Power) and the Organizationen for Vedvarende Energi (OVE; Organisation for Renewable Energy), pointing out that this was not viable answer to the oil crisis because of the radioactive waste and the pollution risks. Already a few months after this first official energy plan, an alternative energy plan was published by a group of energy experts from Danish universities (Blegaa et al., 1976), which focused on a combination of energy conservation, higher contribution from RES and decentralised production in CHP instead of nuclear power. This plan made it possible to discuss alternatives also in the broader public, rather than being dependent on one solution only (Lund, 2000, p. 251).

In order to give advice on energy questions, to assist other authorities, to administer Danish energy legislation and to conduct analyses and assessments of the development in the field of energy, nationally and internationally, the Danish Energy Authority (Energistyrelsen) was established in 1976. This authority was first a part of the Ministry of Trade, but became a part of the newly founded Ministry of Energy in 1979[9].

2.1.2 1981–1986. Energiplan 1981: Development of a RE option—via agreements with utilities?

The next important official document in energy questions was the Energiplan 1981, published by the Ministry of Energy. This second official energy plan expressed a reorientation of governmental energy policy, especially due to its specific target to disconnect the relationship between economic growth and the growth in energy consumption. Besides this, there was another novelty: the Energiplan 1981 presented four alternatives, one of them included nuclear power (but the final decision on its introduction would be put to a referendum), another one focused on RE, a third one on energy conservation, and the last one on natural gas (Hadjilambrinos, 2000, p. 1120–1121). These alternatives were very much alike, however, in the sense that they all calculated more or less the same rise in primary energy consumption by 2005 and included the very intensive use of coal (Lund, 2000, p. 251). This plan was again followed by an alternative energy plan, expanding on the draft of 1976 and developing a scenario with a decrease in energy consumption (Hvelplund et al., 1983).

[9] The year in which one of the units of the nuclear power plant on Three Mile Island in the U. S. suffered a partial core meltdown, being the worst accident in U. S. commercial nuclear power generating history.

This alternative plan proposed an intensive use of CHP production in combination with app. 2000 huge wind turbines and energy conservation measures. These propositions were heavily criticised for not being able to solve the problem of technical regulation issues related to wind power production; during certain periods, wind fluctuations and winter heat demands would force the system to produce more electricity than demanded (the phenomenon of 'surplus electricity production'). The power companies published a report stating that wind power could contribute to 10 % electricity demand at a maximum, however, even those would cause serious technical and economic problems (Lund, 2000, p. 252). As part of a green energy plan for the island of Bornholm these technical problems were analysed in detail. It was shown how wind power and CHP could be organised to support one another, if their energy production was coordinated together with heat pumps and heat storage[10].

As a reaction to a growing public pressure to support the RE expansion and backed by member of the parliament the electric utilities adopted an agreement with the wind turbine associations on wind power purchase at a tariff corresponding to 85 % the average consumer tariff in 1984.

In 1985, the Danish parliament decided to abolish nuclear power from future energy plans, without a referendum, as the majority of the public was clearly against the introduction (Lund, 2000, p. 251). In the same year an agreement was made between the state and the utilities that by 1990 they should have invested in 100 MW of wind power. The utilities, however, did not fulfil the agreement until 1992 (Gipe, 1995, p. 58). Danish utilities had little experience in handling dispersed, small-scale electricity systems such as wind turbines, as they had been focusing on large-scale conventional power generating systems; most Danish utilities were very skeptical about wind power and RE in general.

Still in 1985, the Ministry of Energy established an advisory committee with members from the central administration, the power companies, and the natural gas companies that was to examine the possibilities for the use of CHP. This committee estimated the maximum potential for CHP in Denmark to be 450 MW electrical power, corresponding to a total electricity production of only 6 % the total electricity supply[11] (Hvelplund, 2005b). In 1986, a political decision was made between the government and the utilities concerning

[10]For details of this analysis, see Lund and Rosager (1985). For further and current research results on this topic see Lund and Münster (2003b); Lund and Münster (2003a) and Lund (2005).

[11]In reality there were by the year 1998 already over 400 small-scale CHP plants in medium and small towns supplying heat to local networks and institutions, representing a capacity of 1400 MW_e. Over 150 industrial cogeneration facilities provide an additional 200 MW_e (Hadjilambrinos, 2000, p. 1121).

the future expansion of electricity supply in Denmark; this agreement included a decision to have 450 MW decentralised power installed until 1995, mostly generated in CHP plants and based on Danish energy sources such as natural gas, waste or biofuels (IEA, 2002, p. 102).

2.1.3 1987–1995. Energy 2000: CO_2-reduction for the lowest price?

With the so-called Brundtland Report, published in 1987, the issue of climate change was put on the world agenda; for Denmark, having at this time one of the highest CO_2-emissions per capita in the world because of the intensive use of coal, this caused another supply problem and initiated a new discussion on future energy strategies.

In 1990 a new energy plan was elaborated (Energy 2000), which set the goals of a 20 % reduction of CO_2 emissions and a 15 % reduction of the energy consumption until 2005, compared to the 1998-level. Besides this, a CHP plant capacity of 1500 MW was planned for the year 2000. This plan, again, put forward three alternatives to achieve these targets; the alternatives differed in putting the emphasis either on supply, environmental concerns or economic growth. The use of natural gas meanwhile had expanded so much that all three alternatives planned for this fuel to dominate the Danish energy market (Lund, 2000, p. 253). Still, in 1990, an agreement was made between the government and the Danish utilities about another 100 MW of wind capacity to be met by 1994. In connection with Energy 2000, the government adopted another CHP agreement with the utilities on the increased use of biofuels and natural gas to be accomplished primarily by means of construction of CHP plants and retrofitting the existing coal- and oil-fired district heating plants.

Shortly after the publication of Energy 2000, the government changed and as a consequence the Ministry of Energy was merged with the Ministry of Industry. Energy policy was no longer in the focus of this Ministry, public regulation initiatives were not taken to further the process and this led to a decrease in the investments in wind power: in 1993 they were only half of what they had been between 1989 and 1991 (Lund, 2000, p. 253).

Although thousands of individually and cooperatively owned wind turbines had been installed in Denmark without difficulty, Danish utilities encountered opposition to the proposed wind plants. Legally, Danish utilities are cooperatives and are owned by the customers, half of them directly and half of them indirectly as they are owned by the municipalities—for details on the ownership structure see section 2.4.2. In practice however they were often viewed as outsiders, and their future neighbours treated proposed wind farms no differently than they would have treated any other type of power plant. At the utilities' request, the government appointed a special wind turbine siting committee in 1991 to find sites for the second 100 MW utility-program and to recommend general siting rules for all other turbines. The committee estimated that the Danish landscape could absorb 1000 to 2800 MW of wind capacity, taking into account local objections and the preservation of scenic areas[12] (Gipe, 1995, p. 63).

In 1992 the power companies refused to continue paying a price based on the principle of a long term marginal costs for the electricity bought from CHP plants, which was done on the basis of an agreement imposed on them by the parliament since 1984. This buy-back rule again was possible mainly because of the continuing pressure from the public and especially the environmental and RE NGOs (OVE and OOA). After fruitless negotiations with the power companies, the Danish government in 1992 introduced regulations for the feed-in tariff, which was fixed at a favourable rate of 85 % of the consumer price of electricity in the area. Thereby the power companies were enforced to pay according to the long term marginal cost principle (Meyer, 2004, p. 28).

During the 1990s, however, CO_2-policies and ways of reducing CO_2-emissions still were influencing politics widely. With this, the idea of installing a quota system appeared. The main question now was how to produce electricity in the cheapest way by respecting CO_2-targets. Gaining public support for the politics via a participation process was no longer in the foreground.

With another change of the government in 1992, the responsibility for energy politics was first separated from the Ministry of Industry and later on transferred to the newly founded Ministry for Environment and Energy in 1995.

2.1.4 1995–1998. Energy 21: Priority for RE and CHP?

In 1995 another alternative energy plan with the title "Democracy and Change" was elaborated (Hvelplund et al., 1995). This plan stated that the implementation of sustainable energy solutions needed new organisations and an open and participative decision-making process.

[12] As of January 2005 Denmark had an installed wind capacity of 3118 MW, 424 MW at offshore wind turbines, see `http://www.ens.dk/sw14294.asp`.

In 1996 the fourth official energy strategy was launched, called "Energy 21". Its overall ambition was a 20 % reduction of CO_2 emissions from their 1998 levels by 2005 (Basse, 2004, p. 203). Besides this, the plan formulated the basis for adjustments and reforms in the energy sector in order to match the new market conditions, evoked by the reinforced liberalisation process of the electricity markets throughout the EU.

Still, after the mediocre results of the former agreements, a third agreement of another 200 MW utility-owned windmills was made in 1996 between the government and the utilities. Additionally, in 1998, the utilities were required by the state to install 750 MW offshore wind-power, but this was reduced to 300 MW in 2002. At the end of 1997, there were more than 4500 wind turbines with a total capacity of over 1000 MW and annual power production of more than 1200 GWh. About 80 % of these belonged to individuals or windmill cooperatives (fællesmølle), with the rest owned by electric utilities, primarily the local distribution municipal and cooperative utilities (Hadjilambrinos, 2000, p. 1121). For details on the ownership structure of RE installations, especially wind turbines, see section 2.4.3.

2.1.5 1999–2003. Electricity reform and wind power planning directive: The way to liberalisation?

On 3 March 1999 a majority in the Folketing (Parliament) entered into an agreement for a reform of the electricity sector. The draft of the respective Act on the amendment of the electricity supply act was presented with a number of integrated initiatives, including CO_2 quotas for electricity production, amendment of the act on subsidies for electricity production, amendment of the act on the utilisation of renewable energy sources, and amendment of the heat supply act. Important elements of this act are the right of all consumers to the supply of electricity by means of a supply offer from a supply-committed enterprise, and consumers' obligation to contribute to the payment of general public service obligations (PSOs) and to maintain and develop environmentally benign electricity production. The reform of the electricity system of March 1999 was said to respond to the EU-Directive 2003/54/EC put forward to carry through a liberalisation of the national energy markets. Accordingly, the Electricity Supply Act of 2 June 1999 (Act on Electricity Supply, 1999) carried out new regulation to ensure unbundling between monopoly and competition areas.

Besides this the Danish feed-in tariff for wind turbines and other RE suppliers was gradually phased out and planned to be replaced by a quota system with tradable RE certificates (Act on Electricity Supply, 1999, §§ 60–63). The trading of RE certificates was originally planned to start in January 2000, but due to a number of operational problems of the system including high transition costs at a small national market, the Danish government postponed the starting date for trading several times.

As a consequence complicated transition rules have been introduced (Meyer, 2006, p. 214). With a statuary order to the new law, the feed-in tariff was first made time-limited, and from 2000 it was reduced for new turbines. In 2002, it was further reduced for new turbines to the present low level with an amendment of the electricity act. From 1 January 2003 subsidies to new wind-power capacity were to be abandoned—until RES certificates are issued, however, a settlement price amounting to 10 øre/kWh still is paid—and a transition to market prices for wind power was to be carried out. Consequently, private investments in wind turbine installations have declined radically after the electricity reform. For more details as what concerns the amendments in the RE support see section 2.2.

In addition to the electricity reform a national wind power planning directive (WPPD) was issued in 1999 (WPPD, 1999)[13]. The provisions of the directive are implemented by means of regional and municipal planning, and the directive stipulated that areas suitable for wind power installations in terms of environmental impacts and energy efficiency shall be designated and laid down in regional planning guidelines. It followed from the provisions in the directive that, as a main rule, areas for wind power use may only be laid down in municipal and local plans if the areas are already designated for this purpose in the regional planning guidelines. The regional planning authorities thus have the primary responsibility for the wind power planning in Denmark, including the construction of environmental impact assessment reports.

As a general rule, the WPPD states that "windmills shall foremost be positioned in parks" and "placed in an easily comprehended geographical pattern corresponding to the landscape" (WPPD, 1999, p. 2). In the subsequent paragraphs the placing of the wind power installations is further restricted: with the exception of smaller windmills (household mills: 25 meters) and windmills planned for before the directive was enacted, new installations

[13]The WPPD from 1999 replaced the previous wind power directive from 1994 (Danish Ministry for Energy and Transport, 1994). The purpose of the 1994 directive was to promote an increased installed capacity of wind power through the municipal planning. The directive obliged the municipalities to amend existing plans or to propose new ones, determining if and to what extent further windmills may be installed within the municipality.

shall be located as to ensure that they are perceived as detached constructions and not closer to buildings (i. e., neighbourhoods) than four times the height of the turbine. If the distance is less than 500 meters, the extent of the neighbours' discomfort shall be especially attended to[14]. The public is involved in the planning process for windmill installations in several stages: firstly, before the drafting of regional plans and once more before the regional plan is adopted, secondly, prior to the proposal for a new municipal plan and previous to its announcement, and thirdly, in connection with the announcement of a local plan. The establishment of new windmills in Denmark is thus almost without exceptions regulated within the legal framework of physical planning[15].

The change of the Danish government at the end of 2001 resulted in further fundamental changes in Danish RE policy; government economic support for the development and demonstration of RE has been abolished to a large extent. A strategy of buying CO_2 quotas outside Denmark in order to reach the reduction targets was established, the policy of supporting RE and energy saving within Denmark was phased out (Hvelplund, 2005a, p. 85). Instead, development is supposed to rely on the market (Meyer, 2004, p. 25). In 2001, the responsibility for energy policy was transferred to the Ministry for Economic and Business Affairs.

2.1.6 2004–2006. Energi2025: Let market rule?

In March 2004 the government arrived at a number of energy policy agreements with a broad majority in Parliament and with the trade organisations for the Danish power distribution company Elfor. Under these agreements the system responsibility and the overall transmission system was transferred to the state with a view to being administered independently of commercial interests. This state ownership is undertaken since then by the government company Energinet.dk, which also resumes responsibility for natural gas transmission and the natural gas system. At the same time, grid and distribution companies were ensured full control over their equity capital while consumers could rely on this not resulting in higher prices. In June 2004, the Danish Parliament passed an

[14] For details of the Danish planning system and the ongoing municipal reform, which implies radical changes, not least regarding the responsibilities left with the County Council and the preconditions for regional planning, see Pettersson (2006, pp. 132-133).

[15] Offshore windmill installations in Denmark are however subject to specific regulations which imply that the operator must make a request for the right to exploit the wind energy offshore as well as apply for a permit to install the windmills. The Government, represented by the Ministry of Transport and Energy, is responsible for the authorisation.

amended version of the Electricity Supply Act. Furthermore, the income limit adjustment has been changed significantly in the executive order issued in September 2004. For more details on the structure and the organisations and members in the electricity sector, see section 2.4.2

This broad political agreement of March 2004 was followed by an agreement on wind energy and decentralised power and heat: according to this agreement the whole production of energy from windmills and local CHP plants shall now be sold under market conditions. The agreement also shall form the basis for the construction of two more offshore wind farms in Denmark and for the replacement of about 900 older windmills with approximately 175 newer and more effective mills before 2010[16]. According to the Minister for Economic and Business Affairs in the press release of March 2004 this "will strengthen growth and employment, not the least in the wind energy industries. It should also bolster Denmark's leading position in environmentally friendly energy technologies" (Danish Ministry of Economic and Business Affairs, 2004b).

Furthermore, in 2005 the responsibility for energy was transferred from the Minister of Economics and Business Affairs to the Minister for Transport and Energy. The Ministry for Transport and Energy published a new energy strategy (Energi2025, 2005) which includes a draft action plan for the expansion of the overall electricity infrastructure. Energy strategy 2025 is a part of the follow-up on the broad political agreement of 29 March 2004 and is supplemented by a political agreement on energy-saving initiatives[17]. The government's intention is "[...] to use the market for an increased use of RE. An increased use of RE in step with market needs for new capacity will be far more cost-effective than politically forced increased use of RE. The framework for the market must be established so that RE is promoted in ways that are of benefit for society" (Energi2025, 2005, p. 7).

According to the basic projection of the Danish Energy Authority in the background report to this strategy[18] the contribution of RE to electricity supply will amount to more than 36 % in 2025. Wind energy will account for a major part of this increase. In a recent report by Elkraft System (the former system operator for East Denmark), it is concluded that it is technically possible and economically profitable to increase wind power capacity in Denmark to 8500 MW by the year 2025 covering about 50 % of the Danish electricity consumption (Meyer, 2006, p. 213).

[16]For details see Danish Ministry of Economic and Business Affairs (2004a).

[17]According to this agreement a market-based framework for energy saving efforts and objectives both in the short and the longer term for energy consumption shall be established, see Danish Ministry of Energy and Transport (2005).

[18]For the other projections, see Energistyrelsen (2005, p. 137).

It has to be kept in mind that Denmark since 1995 is a net exporter of energy; the oil and gas production from the North Sea fields[19] cover Danish consumption and constitute an export of major importance for the Danish economy. The government expects that the Danish oil production will be favourable for the a number of years to come, as it has been assessed that there still remain a large number of exploration opportunities in the Danish sector.

Since 1 January 2005 all electricity is traded on the electricity market, and thus electricity produced with environmentally friendly production technologies is meant to compete with conventional production technologies. However, until RES certificates are issued, a minimum settlement price is paid to RE production, amounting to 10 øre/kWh for installations connected to the grid after 1 January 2005 (Act on Electricity Supply, 2005, S 56). This settlement price is now included in the PSO payment which is part of the distribution/transmission price paid by the consumers on their total consumption (Act on Electricity Supply, 2005, § 8 para. 2 and para. 3). For the details see the following section.

2.2 RE support

In Denmark generation of electricity from RES is based mainly on wind power and biomass. From 1994 to 2004, the share of electricity from RES increased from 3.9 % to 22.7 % of net electricity production, of which wind power contributes the largest share with 75.5 %[20].

One of the keys to Denmark's previous success in RE expansion, that is mainly before the year 2001, has been a consistent national policy with a high level of public interest and pressure resulting in a strong domestic market for wind energy; during the 1980s Denmark installed 30 to 50 MW of wind capacity per year. There was a relatively reliable demand for manufacturers to meet. This assured them of a market sufficient to finance continued development of new, more cost-effective turbines (Gipe, 1995, p. 57). Actually, Denmark was at this time the only place in the world with a domestic wind power production market.

A combination of tax regulations, government subsidies and a general agreement on electricity sales prices have had a major influence on the development of RE installations:

[19]The oil production began in 1980 and of natural gas in 1984 (Hadjilambrinos, 2000, p. 1121).

[20]For the figures see monthly and annual statistics on the web-page of the Danish energy authority `http://www.ens.dk/sw12341.asp`. See this page also for nation wind register of wind installations (wind turbine master data register).

- Settlement price;
- Subsidies;
- Special taxation rules.

As the RE support was subject to a fundamental change in the course of the electricity reform in 1999, the description of the RE support as what concerns the settlement prices and the subsidies is divided in the years before and after 1999. The development of the taxation rules, however, is described in one section as it had been changed continuously over the years. As wind power is by far the most important RES in Denmark, the focus of this section lies on this type of RE. Where appropriate and necessary to the overall understanding, the rules and mechanisms related to other RES and decentralised production, especially in CHP installations, are given.

2.2.1 RE support before 1999

Settlement price From 1984 until 1999, private wind turbine owners as well as owners of biomass/biogas installations received a settlement price at 85 % of the electricity price for household consumers, excluding charges and with a deduction for administrative costs (Basse, 2004, p. 206). This payment was financed via the state budget until 1999[21]. This price was paid by the Danish electricity utilities/grid operators and was essentially secured for at least 6 to 8 years. It varied between 0.25 and 0.35 DKK/kWh (0.033–0.047 €/kWh), reflecting the varying prices from different local distribution companies. The overall price including CO_2-duty and energy duty refund amounted to 0.50 and 0.60 DKK/kWh(0.067–0.08 €/kWh). Since more than 90 % of the electricity were produced in coal fired steam turbine plants, this meant, however, that the wind electricity sales price was very dependent on the world market coal price and the financial situation for electricity companies in Denmark.

Through the early 1990s, this payment was limited to cooperatives and owners of single wind turbines under 150 kW. For owners of larger turbines, and for cooperative members living outside the district where the cooperative's turbines were installed, payment was limited to 70 % of the retail rate. The size limit for individually owned turbines was eventually raised from 150 kW to 250 kW and then eliminated in the mid-1990s (Gipe, 1995, p. 60).

[21]Since the electricity reform it is financed by the electricity consumers via the PSO payment.

With regard to RE, the Danish legislation ensured that all electricity consumers effectively have to share the excess cost, if any, of using RE in the electricity system, in order to avoid distortion of competition between suppliers. In practice this means that electricity generated using RE, or all forms of CHP production has a priority access to the grid. It was up to utilities to implement a tariff structure which implemented this. In the eastern part of the country, the transmission company Eltra had implemented this using a tariff which reflected the energy mix during each period. In winter, when there was a lot of CHP-generated electricity and much wind, tariffs tend to be slightly higher than in summer. Large customers who have the right to purchase electricity from any generator in Europe effectively have to buy a mixture of locally made prioritised electricity and imported electricity (plus transmission fees) (Krohn, 1998, p. 4).

Subsidies The government granted direct subsidies as a certain percentage of the building costs (investment grants) for RE installations, varying between 15 and 40 % depending on the technology[22]. For wind turbines investment grants were first, from 1979 on, 30 %, then they were changed to 20 %, and later on to 15 % and then 10 %; in 1989 direct subsidies for wind turbines were no longer granted. These subsidies showed that wind power was taken seriously by the government, which had a positive side effect on the banks, when loans were considered (Lund, 1996, p. 5).

2.2.2 RE support after 1999

On 28 May 1999 the Danish Parliament approved the change from the feed-in model (political price-/amount market model) to the quota/trade-able green certificates model (political quota-/certificate price market model)[23]. This model was supposed to be launched in the beginning of 2003. One of its crucial elements is that the politicians have to decide upon a quota of RE that should be produced during each of the following years. Because of this quota, consumers further on are obliged to buy a specific share of their electricity consumption from RES. Thus, on the basis of their expected production, RE suppliers can sell certificates on the market, where consumers, usually through their electricity distribution company, will purchase enough certificates to fulfil their buying obligation. In parallel, the market is responsible for the establishment of a price for the certificates, which accord-

[22]Solar (until 2002): max 30 %, small biofuel units: max 16 %, heat pumps (until 2002): max 15 %, biogas (until 2001): 30–40 %.

[23]For the terms see Hvelplund (2001c, p. 7)

ing to the law, should not be lower than 0.01 DKK/kWh or higher than 0.27 DKK/kWh (1.32 €ct/kWh and 3.57 €ct/kWh). The change from the feed-in tariff to the planned trading of green certificates was also decided because Denmark expected an EU decision in favour of the certificate model (Meyer, 2004, p. 25). The transition has been much more complex than foreseen by the politicians and was postponed several times. As a consequence complicated transition rules have been introduced.

The transition programme that was agreed upon in June 1999 was meant to pay special attention to private RE producers. The programme took into account the following criteria:

- time of investment;
- ownership (only private owners are compensated for the expected losses from liberalisation) and
- size of the installations (the subsidy is conversely scaled to the installed capacity of the installation. Size is though only of relevance for wind turbines installed before 1999).

According to the government, this programme was installed to soothe the transition to market liberalisation. It was intended to maintain a pay-off from investments made prior to the reform by private investors.

Finally, in June 2002, inter alia due to the small market/the missing common European market for RE certificates and the lacking interest of investors respectively the investment insecurity, the quota system with trading of RE certificates did not begin; as foreseen by some energy experts the model could not work out. The certificate idea was postponed again and replaced in between by a combination of CO_2 quotas and a moderate and flat support for RE installations. The idea was to improve the competitiveness of RE by increasing the fossil fuel costs by adding a cost margin for CO_2 certificates.

In detail the following rules were laid down (Munksgaard and Schiöppfe, 2006, p. 7–8):

- certification of RE production as a first step to develop a market for green certificates (VE-bevise);
- an obligation to buy green electricity based on RE and/or cogeneration (so called prioritised production or prioritised sale). This obligation was abandoned at the end of 2004;

- a subsidised (regulated) price for electricity generated in RE plants built before the end of 2002;
- the subsidy of 0.27 DKK/kWh previously granted by the government for RE electricity production was substituted by a subsidy paid by electricity customers. From being a public transfer to the power market, the subsidy turned into being a charge paid by electricity customers to the electricity company (system operator);
- subsidies to RE or cogeneration from installations owned by the power companies were restricted to a period of four years.

This to and fro in the support scheme created considerable uncertainty for Danish investors especially in the wind energy sector and gave rise to a decreased growth of land-based wind turbines: In March 2000, 36 MW of wind power had been installed, whereas the capacity newly installed in March 2001 was only 2 MW. The 600 MW of wind power built in 2000 were based on contracts before 31 December 1999, when the feed-in system still was in force (Hvelplund, 2001c, p. 18).

Wind According to the current rules (Act on Electricity Supply 2005, §§ 55–56d and wind turbine executive order), payments to wind turbines depend on the date of connection to the grid, the age of the wind turbine and/or the full load hours, whilst ownership has no influence any more.

Generally the payment consists in the market price for electricity (spot market price at Nord Pool in the area the turbine is connected) and a subsidy. The owners of wind turbines connected to the grid from 2003 on are responsible for the sale of their production on the electricity market and for the related costs; for the turbines connected to the grid earlier than 2003 the system operator sells the electricity on the spot market until a certain number of full load hours is used up, after this the owner herself or himself is responsible for the sale on the electricity market and the related costs[24].

For new turbines with removing certificates (replacement) there are special regulations:

- turbines connected to the grid between 1 April 2001 and 1 January 2004 receive an extra premium of 0.17 DKK/kWh (0.023 €/kWh) for 12 000 full load hours for

[24] For the detailed rules for wind turbines, see Danish Energy Authority (2005).

the production covered by a removing certificate from a 150 kW or less turbine decommissioned between 3 March 1999 and 31 December 2003.

- onshore turbines connected to the grid between 1 January 2005 and 31 December 2009 receive an extra premium up to 0.12 DKK/kWh (0.016 €/kWh) for production covered by a removing certificate from a 450 kW or less turbine decommissioned between 15 December 2004 and 15 December 2009. The premium is regulated in relation to the market price as the total of premium and market price must not exceed 0.48 DKK/kWh (0.064 €/kWh).

As what concerns the expansion of offshore wind turbines an agreement was reached on the installation of two offshore wind parks of 200 MW each, located at Horns Revs and Rødsand. These parks shall be installed based on negotiated tenders.

Other RE installations RE electricity from existing plants based on RE apart from wind power are eligible for a subsidy that together with the market price will ensure a tariff of 0.60 DKK/kWh (0.08 €/kWh) for 20 years from the date of grid connection and for at least 15 years as from 1 January 2004. New RE plants are eligible for a subsidy that together with the market price will ensure a tariff of 0.60 DKK/kWh (0.079 €/kWh) for 10 years and 0.40 DKK/kWh (0.054 €/kWh) for the following 10 years. Special rules for new biogas plants mean that this subsidy is only applicable to plants connected to the grid before the end of 2008 and with a ceiling of 8 PJ for total biogas use in Denmark (see under `http://www.ens.dk/sw23705.asp`; last checked 06.09.06).

2.2.3 Taxation

During the 1980s, Denmark increased electricity taxes to 0.31 DKK/kWh (0.041 €/kWh), including a 0.10 DKK/kWh (0.013 €/kWh) tax on CO_2. The other two elements are an excise tax return and a VAT return. Of these taxes, private owners of wind turbines (that means owned by non-power companies) were exempted from 0.27 DKK/kWh (Krohn, 1998, p. 7). In the 1980s and early 1990s the government made local ownership an additional preposition for the tax returns (Christensen and Lund, 1998, p. 4). Since early 1992, the utilities too have been exempted from 0.27 DKK/kWh in carbon taxes for wind energy that they generated themselves.

For private persons that own shares in windmill cooperatives, a special tax-rule applies, allowing them to have windturbine-shares with electricity sales up to 3000 DKK (app. 400 €) without income tax. This rule makes windturbine-shares equal to investments in energy savings and local renewable energy such as domestic solar heating or PV electricity. This means that persons owning only a few shares in a wind turbine cooperative are not taxed on their wind turbine income. Besides this, interest on a loan for a wind turbine share is tax deductible (Bolinger, 2001, p. 15).

For a person that owns larger shares in wind power cooperatives, 60 % of the electricity sale above 3000 DKK are taxed with income tax as normal income, but the operating and maintenance costs of the wind turbines are not tax deductible (operation and maintenance costs are usually 10–20 % of the electricity sales). Alternatively, a person that owns many shares can choose to treat a wind power investment as a company. Then normal tax deduction of expenses and tax depreciation rules for machinery applies, i. e. a declining balance 30 % annual depreciation is allowed. Farmers and companies with wind turbines or wind turbine shares usually do this, and they can include a wind mill as an asset in their company/farm. If the allowed tax depreciation exceeds income from the windmill, other income in the company can be used to cover this before taxation. A special rule applies to wind turbine cooperatives with more than 10 persons/companies that each treat this investment as a company. In this case these persons and companies cannot treat the wind power investment as part of their individual companies. This has the effect that they cannot reduce tax of other income to cover depreciation of the wind turbines[25].

2.3 Grid conditions: Connection, reinforcement and respective fees

2.3.1 Grid connection and grid use

Power from RE installations and from decentralised CHP plants has prioritised access to the grid (the prioritised purchasing of RE electricity, however, has been abolished in 2004). This means that the system operator can only cut production from these installations if reductions in conventional power do not solve the problem (Act on Electricity Supply, 2005, § 27c para. 5). The system operator is responsible for supply security and in order

[25]For the legislation that regulates the taxation of windturbine shares for private persons,see Law on income tax for the state of September 17, 2002, LBK no. 791, and regulation following this law.

to fulfil this obligation shall maintain technical quality and balance in the interconnected electricity supply system and ensure that there is sufficient production capacity in the interconnected electricity supply system (Act on Electricity Supply, 2005, § 27a para 1). According to § 27c para 2 Act on Electricity Supply (2005), the grid users are obliged to provide the system operator with all information necessary to allow for the fulfilment of these obligations, that is their plans for electricity production, consumption, and trade for the following 24-hour period. The system operator shall approve these plans before the beginning of the next 24-hour period. This approval may be conditional on modifications made necessary in order to ensure supply security. If the system operator makes changes to plans after they are approved, he has to compensate the grid users for their respective losses. However, if the grid is about to break down and has broken down, no compensation is given (Act on Electricity Supply, 2005, § 27c para7). If a grid user's actual electricity production, consumption or trade in a given 24-hour period does not correspond to the one approved by the system operator, the system operator, according to § 27c para 8 Act on Electricity Supply (2005), may require reasonable payment for the imbalance caused to the system. This rule, however, according to § 27a para 8 Act on Electricity Supply (2005), does not apply to electricity production from

- wind turbines that basically were connected to the grid before 2002 and are privately owned[26],
- to other RES electricity production installations under the conditions as laid down in § 57 Act on Electricity Supply (2005)[27],
- to decentralised CHP-plants as defined in § 5 no. 1 Act on Electricity Supply (2005) or
- to electricity producing waste-incineration installations covered by § 58a Act on Electricity Supply (2005).

[26]According to §§ 56a and 56b Act on Electricity Supply (2005) for wind turbines (1) that are not utility-financed and were connected to the grid before 31 December 2002 or (2) with an installed power of 25 kW or less and connected to an installation for own-use.

[27]RES installations that are neither utility-financed RES-installations using biomass as fuel nor installations that use RES and other fuels, see §§ 57, 57a and 57b Act on Electricity Supply (2005).

2.3.2 Costs for grid connection and grid reinforcement

As a general rule, RE installation owners and distribution utilities share the cost of interconnection to the grid. Independent RE generators in general must pay the cost of connecting to the nearest technically suitable point on the grid (Act on Electricity Supply, 2005, § 67 para. 1). In the event that grid reinforcement is necessary in order to interconnect the generator, or the utility requires interconnection at some more distant point, the utility must pay these extra costs (Act on Electricity Supply, 2005, § 67 para. 2). This cost-sharing arrangement is important in that it more or less guarantees that RE generators will be able to interconnect to the grid, and at a limited and manageable cost that is roughly known in advance (Bolinger, 2001, p. 16).

For land based wind turbines installed in a wind turbine area specifically designated in a regional plan (see section 2.1.5), a special rule applies[28]: The network undertaking is obliged to extend the grid to a connection point up to the boundary of the wind turbine area if there is sufficient certainty that the wind turbines will have a combined installed effect of at least 1.5 MW (Lorenzen, 2001, p. 13). To distribute these costs, the utilities have made a fund for distribution of the grid reinforcement costs among all utilities.

Offshore wind turbines erected in the sea areas pointed out in the action plan for offshore wind turbines the utility owning the grid, where the turbine is connected on the sea or land, is obliged to pay expenses for the establishment of an external grid to the internal grid connection of the wind turbines. If the turbine is not erected in the area of the action plan the owner of the turbine is obliged to pay the cost of connecting the turbine to the land based grid.

The Danish Energy Agency is the authority to whom prospective turbine owners or owners of other RE installations may appeal power company decisions on these matters.

2.4 Main institutions and ownership structure of the electricity supply system

The Danish model for infrastructure governance is based on an extensive public ownership, legitimated within the welfare state model (Midttun et al., 2003, p. 134). The dominant public ownership model stems from a strong historic tradition of public management in

[28] For the obligations in detail, see Statuary order on grid connection of wind turbines and tariffs of May 8, 2003, BEK no 331, Chapter 4

major infrastructure sectors, dating back to the end of the 19th century when electricity supply was seen as a public task to be provided in an interplay by municipal and national authorities. The later developed theory of natural monopolies was also used to justify this model.

In the following an overview on the main institutions and organs of the electricity supply system and their basic tasks is given in order to set the frame before the respective ownership rules as well as other requirements concerning the task performances are described.

2.4.1 Main institutions and organs

The Electricity Supply Act of 2005 lays down the following provisions for specific tasks and responsibilities in the electricity supply system:

Collective electricity-supply companies and transmission grid operators These companies (Act on Electricity Supply, 2005, § 5 no. 8) are composed of the system operators (Act on Electricity Supply, 2005, § 5 no. 13) and the transmission enterprises (Act on Electricity Supply, 2005, § 5 no. 16). They are to carry out, according to publicly regulated conditions, grid or transmission activities or system operating activities and bear the overall responsibility for the security of electricity supply, the coordination of the overall electricity system, and for the implementation of special demonstration and development programmes for the use of environmentally benign methods of electricity generation (Act on Electricity Supply, 2005, § 28 para. 2 no. 4). Should the present owners wish to dispose of owner shares in main transmission grids, the State has the pre-emptive right (Act on Electricity Supply, 2005, § 35). The Danish State exercised this right in 2004 by overtaking the transmission grid: since 2005 the transmission grid is state-owned and defined as “a collective electricity-supply grid the purpose of which is to transport electricity from production sites to a central point in the distribution grid or to connect it to other, interconnected electricity-supply grids” (Act on Electricity Supply, 2005, § 5 no. 15).

The decision that operation and overall transmission is to be handled by the state was taken in a political agreement in 2004. Until then the tasks of the transmission grid operatorshad been performed by the two TSOs (Eltra and Elkraft Systems), which in turn were owned by the distribution network companies.

The Danish Minister for Transport and Energy is the sole owner of Energinet.dk on behalf of the Danish state and ensures that Energinet.dk complies with the provisions of the Danish Act on Energinet Danmark. Energinet.dk is headed by a Supervisory Board consisting of eleven members. Eight of these members are appointed by the Danish Minister for Transport and Energy. The other members are employee representatives.

Distribution grid operators Grid companies (Act on Electricity Supply, 2005, § 5 no. 11) are responsible for the operation and maintenance of the grid. The former electricity distribution companies continue to function as grid companies, with the requirement that if the company commits itself to other tasks than grid operation, such activities have to be corporately unbundled, at least if the grid company has more than 100 000 connected consumers (Act on Electricity Supply, 2005, § 45 and § 47). The (distribution) grid is to function as a public infrastructure which, against reasonable payment, is placed at the disposal of all users of the electricity system on objective, non-discriminatory terms. The grid companies are to safeguard technical security of supply and promote efforts for energy savings and efficiency as well as conducting information activities to create the greatest possible degree of transparency about market conditions for all groups of consumers.

At the end of the year 2005 the number of distribution network companies amounted to 112 and the number of regional transmission network companies to 10. Aiming at a later merger, three regional transmission companies have established a common operating company for their transmission lines. The distribution network and regional transmission companies have to ensure the needed transmission capacity, an efficient transportation of electricity, the connection of generators and customers, the measurement of supply and consumption, and—if needed—to make transmission capacity available to the transmission system operator for a charge. Two Danish transmission system operators operate and maintain the two 400 kV grids and the international interconnections. The new Act on Energinet.dk from December 2004 contains the legal basis for merging the two electricity transmission system operators as well as the two 400 kV grids (Elkraft and Eltra) and the gas transmission system operator (Gastra) into the state-owned company of Energinet.dk.

The distribution network companies have in addition a number of administrative tasks to fulfil on behalf of the Government such as payment of subsidies to producers of renewable energy, purchase and sale of electricity having priority, research and development (R & D), collection of fees for public service obligations from the consumers, information campaigns, and energy saving measures. From 1 January 2000, distribution network and transmission companies have become separate companies submitted to public economic control. These companies are subject to economic incentive regulation, where the Danish Energy Regulatory Authority determines for each company a cap for income from tariffs.

Electricity trading and supply companies Electricity trading companies (Act on Electricity Supply, 2005, § 5 no. 4), including trading companies with an obligation-to-supply companies have the function of retailers. About 25 electricity trading companies were present on the Danish market in 2005.

The obligation-to-supply companies or enterprises with universal-service obligation (Act on Electricity Supply, 2005, § 5 no. 7) are to ensure that all consumers in a defined supply area are offered a standard package of energy and energy-saving services supplied on reasonable conditions.

As part of the adjustment to a more competitive electricity market, the electricity companies have eased the previous statutory commitments so that a number of distribution companies are no longer obliged to purchase electricity from their own power plant. This has led to a number of mergers and the establishment of trading companies and procurement alliances in the distribution sector (Lorenzen, 2001, p. 5–6).

Ministry and public authorities The responsibility for energy questions changed many times. Since 2005 it is settled at the Ministry for Energy and Transport. The Danish Energy Authority (Energistyrelsen) is assigned to that Ministry, and has the task to support the Ministry in its daily work as well as inter alia in the elaboration of strategies and the public relation work.

(DERA) is the supervisory body and board of appeal of the energy sector. The Authority was set up as part of the liberalisation and legal reformation of the Danish electricity sector and commenced its activities on 1 January 2000. DERA has the services of a secretariat staffed by employees who are made available by the Danish Competition Authority, and who work solely for DERA. The Authority's principal task is to regulate the monopoly companies in the energy sector. This includes the grid and transmission companies, the companies with supply obligations in electricity and gas as well as the district heating companies. The Authority must ensure that grid owners do not derive unreasonable advantages from their natural monopoly status and that all consumers enjoy fair, uniform and transparent prices and conditions of supply. The aim of the Authority is to enhance efficiency and reduce the consumers' energy expenses.

2.4.2 Ownership regarding utilities and the grid

The Danish tradition of cooperatism and decentralised governance has been the driving force in the development of the nation's electricity industry. The initiative for electrification did not come from private capital, it came from the municipalities and from the small farming cooperatives which built and operated their own electric power plants. The first electricity plant with public supply was established in 1891 and in the following years several hundred electricity generating plants were established. These plants were usually municipally owned in urban areas, while in rural areas the model of cooperative societies with the individual consumers as members prevailed. These companies were responsible for both production and distribution of electricity (Lorenzen, 2001, p. 4). The facilities were not operated for profit reasons, but to provide the needed service to individual and cooperative or municipal enterprises. The involvement of the government in the development of the electricity industry was minimal. Technological development in the form of increasing economies of scale was the driving force in the integration of the Danish electricity industry at the end of the 1970s[29], as it was everywhere else. But in Denmark this integration raised from the bottom and the rural cooperatives and municipalities managed to maintain a large control over the electricity industry: they succeeded in keeping ownership of the electric utility system, preserving its orientation of service provision to their constituents and safeguarding the distributed nature of as many of the functions of the electricity regime as possible.

Nearly all of the companies which constitute the electricity system are owned by the consumers either directly (cooperatives or limited companies, amounting in the year 1999 to app. 50 %) or indirectly (in the case of municipally owned companies, amounting to 47 %) through a hierarchical structure of shareholders' councils and management boards[30].

Until the year 2000 besides the consumer ownership system there was a "consumer profit" system in place, in the sense that the electricity companies were not allowed to accumulate profit for any other purpose than investment in the electricity system; if investment was not needed, any surplus had to be paid back to the consumers through lower prices.

[29]By 1978, all the electricity utilities in Zealand had been incorporated into a single institution, Elkraft, which had been in charge of planning, construction, operation and financing of power stations, and the high voltage transmission system. A similar development occurred in Funen and Jutland, where the existing electricity utilities combined in a partnership, Elsam, which has been responsible for coordinating the planning and operation of the electricity system (Hadjilambrinos, 2000, p. 1119).

[30]For the details of this structure, see Hvelplund (1995).

Since 2001, however, there is a differentiation made between the types of electricity companies with regard to the consumer ownership and profit rules[31]:

Electricity-trading enterprises These companies are run as ordinary commercial companies with no restriction on profit making. There is a restriction, however, that production and trading companies do not own more than 15 % of grid or system operators or companies with a universal-service obligation (Act on Electricity Supply, 2005, § 92i). There are no requirements concerning consumer influence.

Enterprises with universal-service obligation (Act on Electricity Supply, 2005, § 5 no. 7) are to ensure that all consumers are offered a standard package of energy and energy-saving services supplied on reasonable conditions. Directly or indirectly elected representatives of the consumers must have a minimum of 1/3 of the voting rights at their disposal. The owners of these companies may make a price-regulated profit (Act on Electricity Supply, 2005, § 72).

Grid enterprises These companies have to be run as non-profit companies; apart from a reasonable return on investment capital, there is no possibility of yield for the owners. Directly or indirectly elected consumer representatives must have the controlling influence (Act on Electricity Supply, 2005, §§ 40-44). The existing 112 distribution companies[32] are either owned by the local municipalities or by the consumers in the form of cooperative societies or partnerships, though some have been changed into joint stock companies recently.

Collective electricity-supply companies These companies are to carry out, according to publicly regulated conditions, grid or transmission activities or system-operating activities (Act on Electricity Supply, 2005, § 5 no. 8). They are composed of the system operators (Act on Electricity Supply, 2005, § 5 no. 13) and the transmission enterprises (Act on Electricity Supply, 2005, § 5 no. 16) and as such bear the overall responsibility for the security of electricity supply, the coordination of the overall electricity system, and for the implementation of special demonstration and development programmes for the use of

[31] For an overview, see Lorenzen (2001, p. 7).

[32] See Dansk Elforsyning statistik 2005 for down-load under `http://www.danskenergi.dk/webtech/statistik.nsf/fWEB?ReadForm\&Load=KJEN-5B8F7R` (last checked 11.09.2006).

environmentally benign methods of electricity generation (Act on Electricity Supply, 2005, § 28 para. 2 no. 4). There has to be a minimum of two public representatives on the board of these companies as well as owner representatives that should be elected from the grid companies. Apart from a reasonable return on investment capital, there is no yield allowed. For the price regulation see Act on Electricity Supply (2005, §§ 69-73). Should the present owners wish to dispose of owner shares in main transmission grids, the State has the pre-emptive right (Act on Electricity Supply, 2005, § 35). The Danish State exercised this right in 2004 by overtaking the transmission grid.

Danish power companies (mostly cooperatives) are tax exempt, provided their annual accounts show no profits. Accountancy rules, however, provide generous depreciation allowances, which allow power companies to depreciate 75 % of the cost of new plants five years prior to investment, which effectively ensures that they are tax-free, "non-profit" institutions. Power companies are allowed to collect funds for investment from electricity consumers before investments are made, thus obviating the need for shareholders or other external sources of finance (Krohn, 1998, p. 8).

2.4.3 Ownership regarding RE installations

Danish success in RE development relied to a great extent on public involvement and participation, not only in the decision-making processes by asking for better conditions for RE installations but also in the setting-up of wind turbines. The development is an example of how changes in the power/ownership structure change the overall system and also the public support.

Danish wind turbine cooperatives and the association of wind turbine owners (Danske Vindkraftwærker, formed in 1978) have had a huge effect on the development of wind energy in the country. Prior to the entry of the utilities into the market during the late 1980s, nearly all wind turbines in Denmark were installed individually or by cooperatives. Nearly all the early wind plants were owned cooperatively, and most of the remainder were municipally owned. Some 100 000 Danish households or 250 000 people (5 % of the population) owned a stake in a windmill guild or cooperative (Gipe, 1995, p. 59). The Danish cooperatives are technically general partnerships (Interessentskab or I/S). These partnerships consist of individuals pooling their savings to invest in a wind turbine, and sell the power to the local utility. All partners of wind partnerships are held jointly and severally liable for any debts incurred by the partnership, which means that personal liability extends well beyond the level of an individual's investment. Danish wind partnerships have generally dispensed with this risk, however, by modifying their bylaws to prohibit the partnership from taking on debt. This means that any financing of wind shares is done at the level of the individual, not the partnership (Bolinger, 2001, p. 15).

Originally, electricity consumers could only set up wind turbines in their own installations, and sell the generated surplus electricity to the grid. From the early 1980s, electricity consumers were allowed to install wind turbines in separate installations, and to share the ownership among several consumers within a short distance from the wind turbine (in the beginning only 3 km and then from 1985 on 10 km or in the same municipality as the wind turbine). Each consumer was allowed to own shares not exceeding his/her electricity consumption; thus maintaining the principle that owners were consumers that got a part of their supply from own (shared) wind power production. The government took these steps to ensure that only those bearing the costs (namely noise and visual intrusion) receive the financial benefits of the government subsidies. The intention had been to create broad public involvement and local ownership in the development of Danish wind energy and has led to many small clusters of wind turbines.

In the early 1990s the wind turbine owners' association pushed for inclusion of single turbine installations in an agreement between the government and electric utilities. The utilities and the government planners had wanted to direct turbines into wind farms and clusters, eliminating the individually owned single turbine that had been the backbone of Danish wind development (Gipe, 1995, p. 60).

In 1992, the ownership rules were changed, so that land owners, usually farmers, could install one wind turbine on their land and the limitations for members of wind power cooperatives were relaxed: All inhabitants of the municipality, where the wind turbines were sited and neighbouring municipalities could be members, even if they lived more than 10 km from the wind turbine. Later the municipal councils were allowed to deviate from these criteria on a case-by-case basis. In principle a municipality could allow all Danish electricity consumers to be members of a specific wind power cooperative. The shares available to each cooperative subscriber were limited to 1.5 times the member's domestic electricity consumption, equivalent to about 9000 kWh/year[33].

[33]For the detailed rules see Statuary order on grid-connection of wind-turbines (October 7, 1992 BEK no. 838).

In the mid-1990s the amount of wind capacity owned by individuals grew strongly due to several factors: the declining costs of the turbines and lower interest rates and government incentives for repowering older turbines that were mostly owned by cooperatives—the time period in which the replacement had to be done being very short (less than a year), according to Jane Kruse much too short to form (new) cooperatives (Kruse, 2006).

Besides this, due to a regulatory loophole it was possible to buy a piece of land suitable for windmill installation and add it to one's own property, allowing the small patch of land upon which a turbine stands to be legally detached from the surrounding property and re-registered to another piece of real estate, perhaps located far away, and thereby enabling more individuals to own turbines (Bolinger, 2001, p. 10).

In early 1994, the Parliament debated easing the restrictions requiring that cooperatives members live near their turbines, and raising the shares they may own to 20 000 kWh/year or the equivalent of domestic energy consumption. The new policy required that only half of the cooperative's owners live near the turbine, permitting, for the first time, urban dwellers to participate in wind projects in rural areas (Gipe, 1995, p. 61). In 1996 the geographic eligibility was extended to persons who work or own property in a borough but do not live there, in 1999 to all of Denmark and finally in 2000, the entire EU. Since January 2001 there has been no regulation of ownership any more. Anyone, also investors from abroad, may own windmills in Denmark in accordance to globalisation and liberalisation policies. All this has resulted in a development that is increasingly making investments in windmills sheer investment projects.

In exchange for the relaxed geographic ownership constraints, the government imposed stricter siting guidelines that concentrate future development in the most appropriate windy areas. In conjunction with these siting restrictions, the government offers incentives to encourage owners of older and smaller turbines to replace them with new turbines of higher capacity located at the potentially windier sanctioned sites, see section 2.2. For the problems connected with this policy in regard to public support for RE installations, see section 4.

2.5 Interim results

The most important factor allowing the fast penetration of wind power in Denmark has thus been the regulated feed-in-tariff in combination with local ownership. But without a constant public pressure, especially from the grassroot movements, and an overall positive attitude of the majority in the parliament this RE deployment would not have been possible.

3 Characteristics and dynamics of the RE support and integration into the electricity supply system in Germany

In this section a historical overview is given firstly in order to introduce the RE development in Germany, with a specific focus on the wind power development, and how it has been embedded in the general energy and climate protection debate since its early beginnings.

Secondly, details on the RE support scheme, especially rules of relevance for the respective investors, as well as on the grid conditions and the ownership structure of the German electricity supply system are given in the subsequent sections.

3.1 History of RE development and energy strategies

Germany has a long tradition in promoting RE with feed-in-tariffs and specific market incentive programmes; the most important instrument being a feed-in-law, which first entered into force in 1991 and was amended several times since then. Germany strongly relies on energy imports to cover its energy demand. In the German electricity generation the most striking characteristic is the high share of coal, which accounted for nearly half of the whole production (49 % in 2004). In the EU-25, Germany is the second largest coal producer behind Poland and the world's leader for lignite production. Apart from coal, Germany has very little fossil resources and imports account for the the largest part of oil—approximately 97 %—and gas—around 80 %— (di Nucci et al., 2005, p. 4).

3.1.1 1972–1985. Rethinking the energy supply: Oil crisis and support for hard coal and nuclear power use

The energy crisis of the 1970s—like in Denmark—produced major rethinking of the energy supply strategy in Germany. The main emphasis was on the increase of governmental support for the use of hard coal and nuclear power[34]. The government created incentives for utilities to use otherwise non-competitive domestic hard coal; these incentives were paid out of a governmental fund financed by a surcharge or a special tax on end consumers' electricity prices[35]. From the mid-1970s, nuclear power became increasingly controversial within the public; its rapid expansion led to many bitter confrontations and a policy of repression[36]. Many believed that the government should instead focus on energy efficiency and conservation, and RE.

In 1980, a first Enquete Commission of the German parliament[37] recommended energy efficiency and the use of RE as first priority but also the maintenance of the nuclear option. In the following year, the Federal Ministry for Research and Technology commissioned a five-year study, which drew a strong echo in the public sphere and the media when it was published around the time of the Chernobyl accident. It concluded that only reliance on energy efficiency measures and RE would be compatible with the basic values of a free society, and that this would be less expensive than the development of an uranium-based electricity supply (Jacobsson and Lauber, 2006, p. 261). Against this background and due to the strong pressure from the public, R & D for RES was raised to a significant level, although much of these funds were intended for developing off-grid RE technologies for export, not for the domestic market. But nevertheless the R & D programmes provided opportunities for universities, institutes and firms to do research in many different directions. As what concerns wind power development two different approaches could be noticed: the GROWIAN project in the late 1970s was a top-down approach by government and established research institutions and industry actors, aiming at the installation of a large wind turbine with a capacity of 3 MW from scratch and—eventually failing. The other approach was pursued by a number of diverse small actors in the 1980s, seeding

[34]In 1973 the government projected the needed increase in the capacity of nuclear power plants until 1985 to 50 000 MW, that meant an increase by the factor 20. The nuclear industry even projected a need of 598 nuclear power plant blocks by the year 2050. The government's projection in 1977 already was reduced to 28 000 MW needed until 1985. In reality there were 19 nuclear power plants in operation in 1998, corresponding to a capacity of 22 000 MW (Graichen, 2003, pp. 37–38).

[35]The hard coal production is still highly subsidised, although this support has been subject to numerous discussions at national and EU level. Based on a decision of the EU Council of Ministers in 2002, however, the subsidies will be reduced step by step: in 2005, the government guarantees 2,7 billion € of support, annually diminishing, coming down to 1.83 billion € in 2012 (Grotz, 2005, p. 141).

[36]The protests in 1974 against the installation of an atomic energy power plant in South-Western Germany near Whyl shall be named as one example, for more details see Graichen (2003, pp. 37–39).

[37]Enquete Commissions are Committees of the Bundestag composed half of members of the Bundestag and half of experts which are set up irregularly to deal with major new policy issues turning substantially on scientific expertise.

on a variety of smaller turbines and led to a quite successful increase of newly installed turbines from 10 to 50 kW in the 1980s to an average of 182 kW in 1992 (Wüstenhagen and Bilharz, 2006, p. 1682). In the 1980s, a set of demonstration programmes became part of the R & D policy, and investments in wind turbines as well as solar cells were subsidised by several of these programmes. An early niche market was also formed by the demand for RE electricity from some utilities as a reaction to the requests of their customers. Additionally, a range of various organisations were set up and formed the key actors in advocacy coalitions for wind and solar power: conventional industry associations, such as the German Solar Energy Industries Association, and environmental organisations that were independent of industry, such as the Förderverein Solarenergie. Renewable energies, however, faced a political-economic electricity supply structure that was largely hostile. The electricity supply system was nearly completely dominated by large utilities relying on coal and nuclear generation. These utilities were opposed to small and decentralised forms of electricity generation, which they deemed uneconomic and foreign to the system. The two key ministries responsible for energy politics—the Ministry of Economic Affairs and the Ministry for Research and Technology—offered only little assistance. Both the Social Democratic Liberal (before 1982) and the Conservative-Liberal governments (1982–1998) strongly supported nuclear and coal[38]. These ministries resisted the demands for market formation of RE with the argument that energy technologies had to prove themselves in the market and that they were not prepared to subsidise technologies that were not yet mature (Jacobsson and Lauber, 2006, p. 262).

3.1.2 1986–1998. Chernobyl and its consequences: Public pressure towards a change and RE electricity feed-in law

The accident in Chernobyl in 1986 had a deep impact in Germany; within two years public opposition to nuclear power increased to over 70 %. Based on the dangers of nuclear power as well as the perceived threat of a changing climate, there was a broad agreement in society that energy use had to be profoundly changed (Wüstenhagen and Bilharz, 2006, p. 1682). A series of proposals for institutional change were formulated, including an electricity feed-in law for RE generation. The parliament exerted pressure on the government to take substantial steps in favour of RE, reflecting the high level of public concern with

[38] This is clearly shown in the allocation of R & D funds, where R & D funding to nuclear power and fossil fuels dwarfed that of RE technology (IEA, 2006). In 2001, for example, 80 % more government money went into nuclear energy research than into RE, (Wüstenhagen and Bilharz, 2006, p. 1683).

this issue. The Ministry of Economic Affairs tried to counteract this efforts but failed to persuade all the deputies of the coalition; nor was he able to induce the utilities to create more favourable basic conditions for the RE expansion on a voluntary basis (Jacobsson and Lauber, 2006, p. 264). In 1988, the Ministry of Research and Technology launched two market formation programmes. The first programme of June 1989 was directed at wind power and aimed at installing 100 MW of wind power, later, in 1991, expanded to 250 MW. This programme mainly involved a guaranteed payment of 0.04 €/kWh for electricity produced, later reduced to 0.03 €/kWh. In addition, private operators had the possibility to obtain an investment subsidy. The second programme was the 1000 PV roofs programme, starting in 1991, which provided investment grants for PV units of 60 % in the new Länder and 50 % in Western Germany.

Furthermore, the legal federal framework for electricity tariffs was altered in such a way as to allow compensation to RE generators above the level of avoided costs[39]. On this basis local activists petitioned local governments to enforce such contracts on the utilities, often owned by municipalities. Most Länder expressly allowed such contracts, and several dozen cities opted for this model[40].

StrEG) was adopted in an all-party consensus (Jacobsson and Lauber (2006, p. 264); Bechberger (2000, p. 5)). Surprisingly this law was not confronted with a large opposition by the utilities at this time. This might be explained on the one hand by the relatively small RE sector and on the other hand by the fact that the utilities were absorbed in the taking over of the electricity sector of Eastern Germany in the process of reunification. For details of this law, see section 3.2. Together with the market incentive programme and subsidies from various state programmes, this feed-in law contributed to a market expansion from about 20 MW installed RE capacity in 1989 to close to 490 MW in 1995 (Jacobsson and Lauber, 2006, p. 264). This expansion led to the emergence of learning networks which developed primarily between wind turbine suppliers and local components suppliers and resulted in a growth in the political strength of the industry association organising suppliers and owners of wind turbines. When the feed-in law began to show effects in the diffusion of RE, the large utilities started to attack it both politically and legally[41]. Some utilities complained about the missing provision to spread the burden evenly in geographical

[39] The tariffs themselves were set at the Länder level.

[40] As this process started in Aachen, it is known as the Aachen Model.

[41] See for example the "Preussen-Elektra-Case": The European Court of Justice (ECJ) however judged the feed-in law compatible with the EU law (Case C-379/98). The German Federal Court (Bundesgerichtshof, BGH) judged it as compatible with the German Constitution in its decision from 11 June 2003 (VIII ZR 160/02).

terms. The Ministry of Economic Affairs as a reaction proposed to reduce rates, especially for wind power, and was supported by the DG Competition of the EU Commission. This led to insecurity for investors and stagnating markets for wind turbines from 1996 to 1998. But in the end the utilities' challenge to the feed-in law failed in parliament; in 1997 the Government's proposal to reduce the rates led to a massive demonstration bringing together metal-workers, farmers and church groups along with environmental, solar and wind associations. The government failed even to persuade its own members—in a committee vote, the government proposal lost out by a narrow vote of 8 vs. 7. The feed-in law was incorporated in the Act on the reform of the energy sector of 1997, which transposed the EU Directive 96/92/EC on the internal market for electricity (Directive 96/92/EC, 1996).

3.1.3 1998–2005. Changes in energy politics: Nuclear phase-out, RE and eco-tax

In 1998, the Social Democratic/Green Coalition committed itself to a number of changes in energy politics such as an eco-tax on energy, legislation improving the status of RE, a 100 000-roofs programme for solar cells and a negotiated phase-out of nuclear power in its coalition agreement (Bechberger, 2000, p. 8).

Parliamentary party groups submitted a members' bill about the reform of the feed-in law which the Ministry of Economic Affairs tried to dilute and delay without much success (EEG Draft, 1999). These deputies organised a very large, partly technology specified advocacy coalition consisting of various environmental groups, solar industry associations, the association of the machinery and equipment VDMA, the metal workers trade union IG Metall, solar cell producers and politicians from some of the Länder and even a major utility[42]. The opposition parties were internally divided on many issues and unable to come up with a coherent alternative, though on the whole they argued for more competition and sometimes for state subsidies instead of passing the costs to the final consumers. Finally in 2000 the Renewable Energy Sources Act (Erneuerbare Energien Gesetz, EEG) was adopted subsequent to this members' bill[43]. Details of the EEG can be found in section 3.2. Together with the 100 000-roofs programme, the EEG meant that solar cells became

[42]Preussen Elektra, which testified in favour of the new mechanism equalising the burden of the law on the national level although overall it would have preferred a quota system.

[43]After adoption of the law, DG competition questioned its compatibility with EU rules; it withdrew its objection only in May 2002, even though the ECJ in March 2001 had rejected a similar challenge in the case of PreussenElektra v. Schleswag (Judgment in Case C-379/98).

an interesting investment option[44]; the installed capacity of solar cells raised to 350 MW_p in mid-2003.

In 2001 the treaty to phase out nuclear power utilisation was signed by the government and the electricity suppliers fixing the final amount of electricity to be generated from nuclear power stations. This amount can be distributed freely among the existing nuclear power stations. Altogether, it establishes the term of operation for approximately 32 years. Based on this treaty, the parliament in 2002 passed a law fixing the phase-out over the next two decades.

In 2002 the Green party, which had improved their support in the parliamentary elections in 2002, effectively secured the transfer of the competency for RE from the Ministry of Economic Affairs (held by the Social Democrats, SPD) to the Ministry for the Environment (held by the Greens), which also meant a shift in the parliamentary committee dealing with RE.

Although no longer in charge of this specific policy matter, the Minister of Economic Affairs joined the critics of the EEG from the Federation of the German Industry (Bundesverband der Deutschen Industrie, BDI) as well as the Utilities Association (Verband der deutschen Elektrizitätswirtschaft, VDEW) for creating exorbitant burdens, damaging German competitiveness and driving up electricity prices, and in summer 2003 a hardship clause was adopted to reduce the burden for those firms that could prove serious implications on their competitive standing (Jacobsson and Lauber, 2006, p. 269).

In 2004, however, a revised EEG was adopted, containing inter alia higher tariffs for several RES but also a decline of the tariffs for onshore wind installations. In its amended form, the EEG also implements the EU Directive 2001/77/EC on the promotion of electricity from RES by incorporating all RES in its scope. Payments of tariffs, however, continue to be governed in full by the principle of exclusive use, that is if the electricity concerned is being produced exclusively at an installation for converting RES. Power derived from, for example, co-incineration the biodegradable fraction of waste is thus covered by the provisions of the EEG on obligatory purchase and transmission, but is not eligible for EEG tariffs.

The VDEW in June 2005 introduced a "Discussion proposal on the future support of renewable energies". According to this proposal and the underlying "integrative model"

[44]To secure the continuous growth of the PV industry, an advance law was adopted by parliament in 2003, just before the 100 000-roofs programme ran out.

the EEG shall be abolished and replaced step by step by a quota model with green tradeable certificates in the whole EU. At the same time on the European level, Eurelectric, the Union of the Electricity Industry, was lobbying for the implementation of a harmonised quota system in the EU, while the European Renewable Energy Council (EREC) and several RE associations argued that it was much too early for a European-wide harmonisation. These debates have to be seen in context with the elaboration of the EU Commission's communication on the support of RE in the EU according to Directive 2001/77/EC (2001, § Art. 4 para. 2) due for October 2005. This communication was published in December 2005 and clearly stated that time for harmonisation had not yet come and that instead the existing support schemes should be further optimised and coordinated (COM, 2005). With this the debate on the "right" support scheme came to a temporarily stop.

3.1.4 2005–2006. Renewal of power stations: Energy summit, debates on nuclear phase-out and continuation of RE policy

In November 2005 the new governing parties SPD and Christian Democrats (CDU/CSU) confirmed the phase out of nuclear power and secured the RE expansion on the basis of the EEG—although asking for an extended privilege of the energy intense industry and an increase in transparency of the overall mechanism of the distribution of the additional costs for RE ("Wälzungsmechanismus") as well as a scrutiny of the level of tariffs in 2008[45].

Despite this agreement the discussion on the prolongation of the operation period of nuclear power plants is on the political agenda again and controversially discussed between the political parties as well as the different lobby associations. It is argued by some representatives of the electricity companies that it is not possible to phase-out nuclear and achieve the climate protection goals by relying on RES yet; nuclear power at least is needed as a "bridge" and thus the power plants should be kept in operation until the RE technologies show to be mature and more competitive than at the current stage.

As a result of the "nuclear consensus", 22 000 MW of power generation capacity, or almost 30 % of the present generation capacity have to be replaced by 2025 (Wüstenhagen and Bilharz, 2006, p. 1684). As simultaneously climate protection goals must be considered,

[45]The next large revision of the EEG is due in 2008 on the basis of the outcomes of the progress report of the Ministry for the Environment to the Parliament, see EEG (2004, § 20). In this report the following questions shall be addressed inter alia: adaptation of the tariffs to the current development of RE technology (if necessary), incentives for storing technologies, ecological optimisation of the further RE deployment and optimisation of the RE integration into the grid.

this creates a strong additional impetus for deployment of RE. In the electricity sector, investments in the renewal of power stations will be necessary in the next 20 to 30 years; around 50 000 to 70 000 MW of power capacity have to be replaced until 2020. Most fossil power stations will reach a critical age in the years to come, in 2015, about 22 000 MW of these stations will be operating for over 40 years (Matthes and Ziesing, 2003, p. 12).

In order to discuss the pressing questions on the future energy supply structure, the government in 2006 invited actors of the energy sector to meet for energy summits, the first one has been held in April and the second one will be held in October. The first meeting turned to be a rather "closed-shop"[46] and the results until now were not made public in order to open an overall debate in society. German public opinion, however, seems still strongly committed to climate protection policy, RE support and nuclear phase-out (Wüstenhagen and Bilharz, 2006, p. 1682).

3.2 RE support scheme

By 2050, according to the sustainability strategy of the government (Nachhaltigkeitsstrategie), RE is envisioned to contribute at least to 50 % of the total energy consumption (German Federal Government, 2002, p. 68). To achieve this goal the government builds on a mixture of market incentive programmes and specific legal rules giving priority to RE utilisation, as for example in the federal building code.

The success of RE deployment in Germany, however, relies basically on the feed-in laws: the StrEG, dating back to 1990, required utilities to connect RE installations to the grid and to buy the electricity generated at a rate which, for wind and solar cells, amounted to 90 % of the average tariff for final consumers (household, commercial, industrial, ex. tax). One of the declared purposes of this law was to 'level the playing field' for RE electricity by setting feed-in rates at levels that took account of the external costs of conventional power generation.

In order not to overburden grid operators in areas where there are high rates of RE generation, a limit of 5 % renewable electricity was set from 1998 that applied within each region; above this mark, operators were exempted from the obligations of purchase and refund. As the amount of RE expanded, a number of regions exceeded the 5 % ceiling; an uneven financial burden between regions close to the 5 % ceiling and regions with low

[46]The list of invitees shows a slight predominance of representatives of the prevalent energy supply system.

RE levels occurred. This 5 % ceiling was consequently replaced in the successor law by a system that allows TGOs to share amongst themselves the costs of compensation to RE producers, the so-called nationwide equalisation mechanism.

A decline in electricity prices, and thus the payments to RE generation, prompted in the introduction of a fixed tariff, effective from 2000 onwards on the basis of the amended and reformulated feed-in law, the EEG. This law was revised again in 2002 in order to foster the deployment of PV installations as the 100 000-roofs-programme ran out. The current version of the EEG entered into force in 2004 (EEG, 2004)[47]. Its objective is to provide for the sustainable development of energy supply, especially with a view to climate protection, nature conservation and environmental protection, to reduce the economic costs of the energy supply by incorporating external costs, to promote further technological development and to contribute to the avoidance of conflicts over fossil energy sources. Up to 2010, at least 12.5 % of the electricity supply shall be based on RES, increasing to at least 20 % in 2020 (EEG, 2004, § 1). These objectives are to be achieved through a combination of guaranteed prior access to, prior transmission through the grid and guaranteed minimum feed-in tariffs for a period of 20 years counted from the commissioning of the respective RE installation (EEG, 2004, §§ 4 and 5). The scope of the EEG extends to electricity generated by RE installations situated within the German territory including the German Exclusive Economic Zone in the Baltic and the North Sea.

The EEG is a civil law, ruling the relations between the distribution/transmission grid operators and the RE installation owners. It clearly sets down the priority access of all eligible RE installations[48] to the grid, the transmission and the purchase of the electricity generated out of RES according to EEG (2004, § 12 para. 1) without having the need of a contract (a so-called "gesetzliches Schuldverhältnis"). The grid operators are thus obliged by law to purchase the electricity produced from RE installations within their respective supply areas, at fixed prices. The higher tariffs can be passed on to consumer prices. For the grid connection, extension and reinforcement as well as the respective fees, see section 3.3. For onshore wind energy, the fixed tariff in 2006 is at 8.36 €ct/kWh for the first five years of operation and for the subsequent 15 years a reduced tariff of 5.28 €ct/kWh. An allowance is made for the quality of the site, with plants that fail to meet 150 % of a

[47] The EEG2004 is currently under revision again in order to change the rule for the electricity intense industry and to contribute to a higher level of transparency.

[48] For the eligibility of the installations, see §§ 3 para. 1 EEG; excluded from the purchase of the fixed tariff are large hydro power stations (> 5 MW), large biomass power plants (>20 MW) and waste incineration plants.

reference yield receiving the higher payment for a longer period. To take account of the technological process and incite early investment, the tariffs are reduced by 2 % for each year the investment occurs after the year 2005. For offshore wind energy the fixed tariff amounts to 9.10 €ct/kWh for a period of 12 years for the installations that are operational until 2010 or 6.19 €ct/kWh for the wind power produced in installations that become operational after 2010.

For the other RE installations the minimum fixed prices in 2006 vary between 6.65 €ct/kWh (large hydro-power), 8.15 €ct/kWh (large biomass) and 51.8 €ct/kWh (for PV installations). Several additional tariffs are paid for specific technologies in order to stimulate these innovative technologies[49]. The tariffs thus differ from source to source and location of the RE installation to location. In order to strengthen the incentives for technical innovations and cost cutting the tariffs are subject to annual degressions.

On the basis of the so-called "nationwide equalisation scheme" (EEG, 2004, § 14) the RE electricity amounts and the respective costs are distributed equally through the whole country and between the grid operators. This scheme thus provides for an equalisation of the—due to the different geographic conditions—differing amounts of RE generation, especially wind production. The energy intense industry is privileged through a limitation of the amount of RE electricity and through a price reduction of their electricity purchasing (EEG, 2004, § 16).

The EEG and its predecessor, the StrEG, turn out to have delivered and still deliver a strong and reliable positive incentive for both the technical development and for the respective installations, leading to high growth rates of RE installations. By the end of 2005, 18 428 MW of wind energy have been installed plus 8 380 MW of other RES, amounting to 10.2 % of all electricity generated in Germany (Staiss et al., 2006, pp. 8-12).

3.3 Grid conditions: Connection, reinforcement and respective fees

The grid connection rules generally are laid down in the basic energy law (Energiewirtschaftsgesetz, EnWG2005) with the EEG setting special rules for RE installations and therefore having priority. According to the EEG (2004, § 4 para. 1), the RE installations have a prioritised access to the grid. RE installations have to be connected without undue

[49] For the detailed tariffs, see BMU (2004).

delay from the local grid operator, regardless the grid capacity needed for electricity generated by conventional sources. In cases of congestion generation-side management measures can be agreed upon between the network operator and the installation owner (EEG, 2004, § 4 para. 1 cl. 3)[50].

Based on these rules, the EEG lays down that the installation owners are generally responsible for the costs of connecting their installations to the grid and the grid operators for the extension of the grid as well as for the costs arising if the grid operator obliges the installation owner to use a connection point that differs from the most favourable one in terms of technical and economic reasons (EEG, 2004, § 13). The grid operators have an obligation to extend the grid if this is needed to get more RE electricity into the grid and if it is economically viable (EEG, 2004, § 4 para. 2). The economic viability has to be checked by taking into account the target of overall cost minimisation, that is on the basis of a comparison of the grid extension in question and the connection of the installation at another connection point that does not need such an extension (Müller, 2004). Besides this, it has to be kept in mind that the respective grid operator according to EEG (2004, § 13 para. 2 cl. 3) is enabled to appropriate the emerging extension costs on the grid use fees.

3.4 Main institutions and ownership structure of the electricity supply system

As the knowledge about the main actors and their respective power in the electricity supply system is of importance when setting up the alternative scenario, at first an overview on the most important organs and institutions involved in the electricity supply system in Germany is given. Secondly the ownership rules regarding these organs are described.

3.4.1 Main organs and institutions

These main organs and institutions comprise the ministries and public authorities, the transmission and grid operators, trading and supply companies as well as lobby associations, NGOs and grassroot movements.

[50] During the last years, however, wind turbine owners complained about network operators taking their installations from the grid based on grid congestion reasons without such an agreement and without a compensation for the hereby emerging losses.

The Basic Energy Law of 2005 lays down the following provisions for specific tasks and responsibilities in the electricity supply system.

Transmission grid operators Transmission grid operators (EnWG, 2005, § 3 no. 10) are responsible for the operation, the maintenance and if necessary the reinforcement of the transmission grid. According to EnWG (2005, §§11–18) they are obliged to operate the respective grid in a non-discriminatory way, giving access to the grid under transparent conditions. Besides this, these companies are responsible for the overall security of supply and are obliged and entitled to dispose eventual disturbances and dangers to the overall grid stability. If they apply grid related measures they have to respect the prioritised access and transmission of RE installations and CHP plants (EnWG, 2005, § 13 para. 1 cl. 2).

These tasks are delivered by four large supra-national utilities dividing up the territory of Germany between themselves into four balancing areas.

According to EnWG (2005, § 21) the conditions and the fees for the access to the grid are subject to regulation by the Federal Grid Agency on the basis of a comparison with the respective conditions and fees as set down by the other grid operators.

Distribution grid operators Distribution grid operators (EnWG, 2005, § 3 no. 3) have basically the same tasks as the transmission grid operators in relation to the distribution grid, see EnWG (2005, § 14 para. 1 cl. 3). These operators are obliged to support the transmission grid operators in case of disturbances in or dangers for the grid by applying measures in their own responsibility. According to EnWG (2005, § 14 para. 2) the distribution grid operators when setting up plans for the extension of the distribution grid have to take into account the possibility of including energy efficiency measures and demand side management as well as installations for a decentralised generation.

There are 38 regional and 189 local distribution grid operators; together with the four transmission grid operators responsible for the operation of 85 % of the total electricity grid in Germany (Reiche, 2004, p. 96).

Trading and supply companies As what concerns trading companies (EnWG, 2005, § 3 no. 21) and supply companies (EnWG, 2005, § 3 no. 18) a distinction has to be made between the companies with an universal-supply obligation (EnWG, 2005, § 36 para. 2) and those without this obligation. The supply company with the largest amount of consumers in one defined supply area automatically has the universal-supply obligation and thus is subject to special rules concerning the design of the consumer contracts and the general prices.

There are app. 65 regional and app. 580 local electricity supply companies and around 200 trading companies. Since the liberalisation in 1998 several independent suppliers of "green" electricity (the so-called "Ökostromanbieter") have emerged, the most known of them are Greenpeace Energy, Lichtblick, Naturstrom AG and Elekrizitätswerke Schönau[51]. The large electricity utilities are offering "green electricity" to their customers as well, mostly produced in large hydropower plants[52].

Ministries and regulation agency The responsibility for energy questions and especially RE is divided amongst several ministries:

The general responsibility for RE was moved in 2002 from the Ministry of Economic Affairs (BMWi) to the BMU, also responsible for climate protection and issues related to the environmental impact of energy production and consumption. Other energy policy issues at national level rest within the responsibility of the BMWi.

The Ministry of Food, Agriculture and Consumer Protection (BMELV) is in charge of programmes related to agricultural production and energy. Research in the field of RE is supported mainly by BMU and BMELV through various programmes, as well as by the Ministry of Education and Research (BMBF). The Ministry of Transport, Building and Housing (BMVBW) is in charge of biofuels and is also responsible for planning and building permission of RE plants.

A number of responsibilities in the area of energy and environment rest with the Länder and the respective departments in the ministries and agencies. On an administrative level, the Länder determine e. g. buildings codes and in this respect are responsible for the planning frameworks. This influences for example distance regulations and height limits for wind turbines as well as the siting of the RE installations.

The Federal Grid Agency (Bundesnetzagentur, BNA) is an independent federal authority under the guidance of the Federal Ministry for Economics and is in office since 2005. The authority has the power to supervise and rule on grid fees before they are put in place by the grid operators (ex-ante regulation of network access). Besides this, the BNA has the

[51] For the history of the Elekrizitätswerke Schönau, see Graichen (2003).
[52] For details on the variety of supply and trading companies, see Reiche (2004, pp. 96–99).

power to initiate administrative procedure against grid operators abusing their dominant market position or infringing any energy law (§§ 95–97 EnWG).

Lobby groups, NGOs and grassroot movements On the side of the prevalent electricity supply system one of the most influential associations in the electricity sector is the VDEW. It comprises all large, almost all medium-sized and most of the smaller companies involved in public electricity supply, which is about 750 suppliers or two-third of about 1 000 suppliers in total in Germany. However, in important political questions, the companies usually speak for themselves. As transmission grid operators, utilities are also organised in the Association of grid operators (Verband der Netzbetreiber,VDN). A large part of the local energy suppliers, especially the municipal utilities, are represented by the Association of communal enterprises (Verband kommunaler Unternehmen, VKU). Associated with the VKU is the working group for economical energy and water supply (Arbeitsgemeinschaft für sparsame Energie- und Wasserversorgung, ASEW) with more than 200 members, mainly local energy and water suppliers (Stadtwerke). Many newcomers in the electricity and gas market are represented by the Federal association of new energy suppliers (Bundesverband Neuer Energieanbieter, BNE), working for non discriminatory grid access and growth in competition. The association power systems within the German VDMA represents manufacturers from the wind industry, from bio-energies and hydro-power.

The Federal Renewable Energy Association (Bundesverband Erneuerbare Energien, BEE) is the umbrella organisation of the major RE associations in Germany; the biggest being the Federal Wind Energy Association (Bundesverband Windenergie, BWE), representing wind turbine operators, manufacturers, planners and developers, but also individuals interested in the promotion of wind energy. The Federal Bioenergy Association (Bundesverband Bioenergie, BBE) represents businesses and institutions of the bio-energy sector. The manufacturers, developers, suppliers and traders of the solar energy industry are represented by the German Solar Industry Federation (Bundesverband Solarwirtschaft, BSW). The German Hydro-power Association (Bundesverband deutscher Wasserkraftwerke, BDW) is the association of the operators of small and medium-sized hydro-power plants.

NGOs such Eurosolar, WWF and Greenpeace take an important part in public awareness rising and the RE promotion; the environmental organisations such as BUND and NABU generally support RE development at the national level, at the local levels some of these organisation criticise RE development because of its negative influence on fauna and flora.

The anti-atomic-power grassroot movements play an important role as allies in their efforts for an overall change of the energy system and vice versa.

3.4.2 Ownership regarding the grid and utilities

In Germany there are no specific rules concerning the ownership of the grid and the utilities in the EnWG: The basic energy laws, however, laid and still lay down rules that are of relevance for the ownership. Essentially the ownership and power structure dates from the time of Nationalsocialism[53]: The EnWG was first adopted in 1935 and laid down the framework for a low-priced and secure electricity supply and defined state control over the sector. This act provided for monopolies in power generation, transmission, distribution and supply (Wüstenhagen and Bilharz, 2006, p. 1683). There have been numerous (failed) attempts to reform the energy sector; in the 1990s it was tried to increase the competition in the sector and to increase public control. The reasons for the lack of reforms were rooted in an united sector unperturbed by technological change and new interests, the predominance of coal industry subsidies and the lack of systematic international pressure. The municipal utilities, which had strong political support at regional state level and thus in the Bundesrat, were concerned that liberalisation could result in 'cherry-picking' of the cheapest suppliers by the large users, leaving ordinary consumers with higher prices. The municipalities also feared that liberalisation would mean the end of local energy supply, as small utilities would be swallowed by the large utilities.

Before 1998, the German electricity market was divided between nine interregional power companies that either supplied customers directly or indirectly through a large number of regional or municipal utilities. These interregional companies were integrated upstream with fuel companies (coal, oil, gas) and downstream with many of the regional utilities. Municipal ownership was common among the more than 700 electric utilities (many of them also provided other services such as heat, water, waste treatment and/or public transport) (Wüstenhagen and Bilharz, 2006, p. 1383). In many cases, a profitable electricity division served to cross-subsidise local public transport. In terms of ownership, the largest utilities were typically private companies with some public ownership, whereas local utilities were often owned by the communities. This was a door-opener for local political influence,

[53]For purposes of bureaucratic control, Germany was divided into power districts; they were 13 of these, directed by deputies. The control of the monopoly power was divided between: the National Board for Electricity; the Inspector General for Water and Power (Speer); and the Office for Power in the Speer Ministry (Neumann, 1972, p. 597, 598).

as in the case of local feed-in tariffs for solar energy emerging in several municipalities in the 1990s (Wüstenhagen and Bilharz, 2006, p. 1383). Since the 1998 energy reform, mergers between the interregional companies or their mother companies (REW and VEW, VEBA and VIAG) increased the degree of concentration of the German electricity supply industry, leading to the present dominance of the four supra-national utilities (Olsen and Skytte, 2003, p. 178). The enactment of the EnWG in 1998, however, represented the end of the demarcation agreements, full opening of the grid for all electricity suppliers of free supplier-choice for all consumers. However this law was not accompanied by detailed rules regarding grid access, transmission charges, etc. An initial strong price competition led to an erosion of profit margins and a wave of mergers and acquisitions took place. Large utilities started also diversifying horizontally and took over gas production companies. A number of new participants appeared on the market but only for a short time period due to the market power of the dominant large utilities and continued absence of a strong regulatory authority (Wüstenhagen and Bilharz, 2006, p. 1684). The only competitive innovation that survived five years of deregulated market is a small number of RE electricity marketers. The major large players decreased from formerly eight to four. Eventually, market concentration increased, with an effective national oligopoly of four companies (Bartle, 2005, p. 126/127): after a series of mergers, four supra-national utilities are now owning the transmission grid: Vattenfall Europe, E.on, RWE and EnBW (majority-owned by Electricité de France). These large utilities (the so-called "Verbundunternehmen") own 90 % of the total generation capacity in Germany.

The implementation of the EU Directive 2003/54/EC ended the long time of self-regulation. One of the crucial aspects of the EnWG (2005) is the specification of the rules on legal, operational (management and information) and accounting unbundling, according to the (minimum) provisions of the EU Directives (Bausch, 2004a). In fact, the EnWG does not foresee separate accounting for power generation and marketing activities and—differently from elsewhere in Europe—it does not envisage the creation of an independent transmission system operator. In EnWG (2005, § 13) it is only suggested that grid operators should cooperate with the aim of acquiring balancing power in joint actions. It is expected that the rules will reduce conflicts of interests, cross subsidising and discrimination in grid access. However, given the level of vertical integration of grid operators, the market is still far from being competitive.

3.4.3 Ownership regarding RE installations

The wind development in Germany has been characterised by geographically dispersed wind farms of various sizes, developed by farmers, small enterprises and cooperatives. At present, 90 % of the turbines in Germany are owned by private citizens and app. 200 000 persons own shares in cooperatives or—to give another number—more than 350 0000 people are involved in wind energy investment (Szarka, 2006, p. 3046). The large-scale involvement of small-scale investors in Germany has contributed to broad public support for wind energy projects and has significantly reduced the NIMBY-problem.

The structure of ownership in Germany, however, has changed over the years. In the start up of the market at the beginning of the 1990s most of the wind projects were initiated and financed by single farmers or by small groups of farmers in direct neighbourhood. With the increasing wind industry the wind farms became bigger and more people got involved in the whole business of wind energy. In these cases, the wind farms are usually initiated locally by a group of developers and owned by numerous shareholders. Finally, a third sector of ownership has raised in the last years and started to dominate the wind energy market in Germany. The professionalisation of the wind energy branch led to separate players within the value chain. From initiative to investment out of one hand is not any more typical. Most of actual projects are developed by professional project developers, realised and financed by funds companies and owned by lots of anonymous shareholders. Projects with installed capacities of more than 20 MW and shareholders up to 350 can be seen. In this case public funds are created. The marketing of the investment is done by public and independently proofed brochures. For this brochures there is a liability of the publisher. Normally they are written in respect to regulations of the accounters association. Special agencies organise the distribution of the brochures and collect the shareholder orders. So today, Germany's primary model is more commercial in nature—a limited partnership with a developer's limited liability company as general partner.

4 Success elements and barriers to RE expansion—lessons learned

As has been shown in the previous chapters, RE development in Denmark and Germany has been quite successful and RE are already contributing to a relatively impressive part of the electricity supply in both of these countries. Nonetheless—according to recent studies and evaluations at the national and the EU level, statements of RE associations, and of (potential) RE installation owners and investors—RE development faces barriers that have to be taken seriously because such barriers could impede the achievement of the RE deployment goals. Some of these barriers can be retraced to technological questions and insecurities (and as such addressing the economic level), but most of them are to be found on the political and institutional level. Optimisation possibilities within the prevalent system are laid down and checked on their range.

In the following it is analysed which elements fostered and which elements hindered the RE expansion in Denmark and Germany. The focus is on the most outstanding characteristics in each of the countries. The analysis is backed and extended by the experiences and the perceptions of the interviewed energy experts, as there were: Jane Kruse and Preben Maegaard of the Nordisk Folkecenter for Vedvarende Energi, Sabine Frenzel of the BNA in Bonn, Stefan Wagner of the Gesellschaft für Netzintegration in Dauerthal and Dierk Bauknecht of the Öko-Institut. This part forms the basis for an alternative scenario aiming at an optimised RE support as it draws conclusions from the examples of the RE development in Denmark and Germany and aims at identifying alongside the shortcomings in the prevalent electricity supply system what are the decisive elements for an overall optimisation.

4.1 Success elements for RE development—what worked out well?

Taking the history of the RE development in Denmark and Germany into account we can extract some common elements which are essential for the development of RE, the facilitation of their widespread and the respective innovation process. In both countries a similar step-by-step process could be observed in the historical development; its respective steps being the following:

1. Pioneers and entrepreneurs wanting to experience new RE technologies;
2. Public pressure from grassroots organisations on the parliament, supporting these pioneers as they stand for an alternative energy strategy;
3. Politicians, especially parliamentarians, who are willing to get inspired by innovative ideas and are open to discuss them and consequently set rules to further them;
4. Political targets that is a policy willing to set goals and keep to them, also against lobbying of the prevalent dominant companies;
5. Efficient RE support schemes obliging established utilities to deal with the new entrants and give them access to the grid;
6. High levels of consumer ownership and restrictions on the use of surplus as what concerns the prevalent utilities;
7. Majority of the population in favour of RE deployment and RE installations, namely via common ownership of RE installations on the local level;
8. Beginning of an adaptation of the grid and the overall supply service structure to the needs of basically decentralised generation from RE installations.

A selection of these elements deemed as being the most important ones on the basis of the historical development and the interviews is analysed in the following by drawing it back to the historical development in Denmark and Germany and statements in personal communications and interviews with energy experts from Denmark and Germany.

4.1.1 Pioneers, entrepreneurs and grassroot movements

As already mentioned in sections 2 and 3, the RE development in Denmark and Germany has been affected strongly by early research and development work of idealistic pioneers as well as a continued and widespread public support for these new technologies.

Denmark To give an example for the characteristics of this development stage, the early Danish development is in the following laid down in detail: as mentioned (see section 2.1), the tradition of using wind power to generate electricity in Denmark can be traced back to experiments, research and development works of RE pioneers at the end of the 19$^{\text{th}}$

century and the beginning of the 20$^{\text{th}}$ century (Meyer, 2004, p. 25; Gipe, 1995, p. 54). As a first step, instead of the canvas sails of the so-called Dutch type windmills used for milling grain to flour, adjustable wooden sheets were installed. By this adjustment it was made possible to control the effect of the wind. This type of windmill outstripped the so-called "klapsejler"—windmills with adjustable narrow vanes, which was a further development of the Dutch-type windmills. The "klapsejler" as well as the multi-blade windmills were used to power agricultural machinery and also to pump water to reservoirs, providing water supply for dry periods. In 1931 there were app. 30 000 of such windmills in Denmark. As a second step the teacher Poul la Cour at Folkes High School Askov in South Jutland started a series of experiments in order to achieve a rational utilisation of wind power for electricity production. For this purpose—as the first person in the world—he carried out systematic experiments with artificial air currents in a wind tunnel. On the basis of the hereby gained knowledge on fundamental laws of aerodynamics he developed a number of prototypes that marked a great advance in the design of windmills. Until the end of the 1920s and early 1930s the interest in and the development of the electricity producing wind turbine continued but came to an end when coal and oil began to be imported to Denmark in considerable quantities. One exception is the 200 kW "Gedser Turbine" built with support from the state in the south of Falster, which was in operation from 1957–1967 and produced 400 000 kWh/year. In 1962 the price of a kWh produced by a power station running on oil was half of the price per kWh produced by the wind turbine (without counting the external costs). Hence, despite these exceptional production results, the experiment was stopped and the wind turbine was left to fall into disuse (Tranaes, 1997, p. 2). The experience in the successful use of wind power for electricity generation fell prey to a collective loss of memory, and in 1973, faced with the oil crisis, the government—advised by the large utilities—rejected the proposition to use RE, arguing that this had already been tried and turned out to be insufficient and unreliable, so that one should focus on atomic energy.

But some individuals, partly members of OOA and grassroots movements, did not allow suppression of a differing public opinion and pointed to the historical experiences and the recent developments: a carpenter from West Jutland, Christian Riisager, experimented with a 22 kW machine with a 12 m high tower and blades made of glass fibres. After several attempts he succeeded in creating a prototype, which he asked the local electricity company to approve for connection to the grid and then entered into the marketing of this new turbines. It was purchased by a number of idealistic visionaries from a broad section of the population. In contrast to the large 630 kW wind turbines near Nibe that were installed in 1977 on the initiative of the government in a top-down approach these wind turbines turned out to work well and reliable. In 1978 already 30 of the electricity producing turbines type "Riisager" were installed all over the country. A great variety of wind turbine designs was constructed and tested in the following years: many different actors formed a vital entrepreneurial network, including grassroots entrepreneurs building wind turbines on their own, industrial entrepreneurs transforming prototypes into series of turbines, the idealistic buyers of the functioning but still sometimes unstable wind turbines, and the anti-nuclear power engineers starting a test station for small wind turbines.

In order to give the wind turbine owners a common voice the Association of Wind Turbine Owners (Dankse Vindkraftværker) was founded in 1978. This interest group expressed their common goals as follows: firstly, to be taken notice of the electricity boards, authorities and manufacturers and secondly to work out and distribute serious and reliable information about the possibilities as well as limitations of wind power (Tranaes, 1997, p. 3). In 1983, a new independent research centre was founded with support from the OOA and the OVE, the Nordvestjysk Folkecenter for Vedvarende Energi (Nordic Folkecenter for Renewable Energy)[54]. Its purpose was and is to pave the way for RE by developing, testing, and demonstrating technologies which are designed for manufacturing in small and medium scale industries. The idea is to strengthen the combination of the social vision of local production and responsibility with the design of wind turbines and other RE technologies (Maegaard, 2006).

OVE organised wind meetings (vindtræf) that brought together people engaged in the construction of wind turbines to exchange ideas and information—these informal meetings played a crucial role for the diffusion of knowledge on the most promising technologies in the public sphere (Kruse, 2006).

Germany Compared to Denmark, Germany was a latecomer in wind technology. This can be explained by the failure of the technology top-down approach pursued in the late 1970s that culminated in the multi-million €, 3 MW GROWIAN built in 1983. This 100 m giant wind turbine faced severe technological problems and was operational just about 500

[54]The funds for this centre as well as all other national RE programmes were reduced and completely abolished by the government in January 2002. The establishment of Elfor's new Energy Saving Fund (Elfor being the branch organisation for the Danish power distribution companies) is now providing Folkecenter with funds again. Folkecenter is able to continue its 20 years of progress in the areas of energy saving, renewable energy and integrated energy solutions as a way to reach a future sustainable society, see `http://www.folkecenter.net/gb/`.

hours. It failed due to an unmanageable "all-in-one" approach, weak political support, opposition of the utilities and the absence of interest by Germany's high tech industry. At the official political level no one spoke about windpower for many years afterwards but without much publicity, small turbines coming from Denmark were installed by some farmers. RE development, especially wind energy, was thus furthered by private people in the beginning to an even larger extent than in Denmark. Both wind cooperatives and individual farmers play a crucial role in this respect, especially because of their determination in building up their own RE installations. The first 10 years of RE development in Germany from about 1980 onward were a long and tough game of chance by private pioneers and idealists, who occasionally hardly had the assurance that they could receive payment for the electricity they produced. Even so, app. 25 MW of wind power capacity were installed by 1989, before turbine installation took off after the Federal Government started its market development programs (Krohn, 1998, p. 22).

Interim results To resume, the first steps were done by a multitude of persons interested in developing this new technology and willing to exchange their experiences, backed by and working together with grassroots movements motivated inter alia by the interest in finding alternatives that could be used in opposition to the nuclear energy plans. This phase can thus be classified as a bottom-up strategy based on the principles learning by doing and by interacting. The attempts of installing RE in an top-down approach failed and even led to a backslide in the development.

4.1.2 Public pressure and open and participative discourse in political processes

As the number of RE installations was growing both in Denmark and in Germany the owners of these installations were confronted with opposition by the established electricity companies. In Denmark, for example, a supply company introduced a surcharge fee for wind turbines in its area, other companies deducted 10 % from the normal payment for the produced electricity by a wind turbine, asked for unreasonably high grid connection contributions, or they considered wind turbines as electricity consuming apparatus with subsequent extra duties to fulfil. Several of these cases were brought before the Committee for electricity prices by the Danish wind owners association and won by the wind owner association (Tranaes, 1997, p. 8). It became obvious, though, that the basic conditions in the electricity supply system needed to be changed in order to allow a further RE expansion.

Denmark In Denmark, official energy objectives, strategies and plans have been developed as a result as constant interaction between parliament and public. Alternative energy plans were discussed in the parliament and the grassroots organisations were given the possibility to present their arguments in parliamentarian discussions. Because of the continuous pressure of OOA an official committee, the Energy Information Board (Energioplysningsudvalget), was implemented. This Committee had the tasks to organise public information campaigns in which all interested parties were entitled to discuss energy questions according to the Danish tradition for public information and debate.

Besides this, the grassroot movements and local small heat cooperatives were arguing in the media and "lobbying" at the parliamentary level for the establishment of institutional reforms to pave the road and remove the barriers for the implementation of the new RE techniques. OOA and OVE succeeded in enrolling many other social groups by gaining access to the discussions in parliament through some of the political parties, establishing contacts with researchers, having members in the official steering committees for public R & D programmes and being able to influence energy policy planning processes from their very beginning. The popular debate on alternative energy sources and various public awareness and information campaigns encouraged movement organisations to foster local practical initiatives that gradually became incorporated into Denmark's environmental policy (Jamison, 2001, p. 113). Hence public participation and the awareness of choice has been an important factor in the decision-making processes (Lund, 2000, p. 249). Danish energy policy has been formed as a result of conflicts.

This process led to some fundamental institutional changes in the electricity supply system against the wills of some the established companies. Interestingly, this was not achieved with rigid planning procedures, but by giving pioneers, grassroot movements, the general public and local wind and heat companies the opportunity by parliamentary intervention to introduce and implement their innovative techniques; a process, which according to Hvelplund (2005a, p. 87/88) can be called "innovative democracy".

Germany In Germany specific political conditions in the late 1980s and early 1990s allowed the implementation of the feed in tariff regime which has characterised Germany ever since: The wind power as well as the hydropower and later on the biomass associations managed to constitute themselves at an early stage and to develop stable alliances with farmers and regional policymakers. The concentration of the wind industry in structurally weak regions reinforced these links. RE plants, especially wind turbines, were planned and financed by small associations, initially predominantly farmers. The farmers in many regions were able to influence the local political decision making and also their party representatives in the parliament. A group of parliamentarians seeing RE as a chance to solve the urging energy problems though supported these alliance groups and succeeded in getting the StrEG adopted in Parliament.

In the mid-1990s, however, the growth of wind capacity—with rates of about 80 % per year it was one of the fastest growing segments within mechanical engineering—changed the situation. Utilities lobbied against the feed-in law and business reporters criticised the system. The StrEG could be retained in 1997 only after a big effort by the BWE, which argued that the abolition of this instrument would lead to high job losses especially in structurally weak regions. The BWE joined forces with the trade unions of the metal-workers and the agricultural lobby and protested in many different ways (one of it being a protest march in Bonn with app. 4000 persons) against the abolishment of the feed-in law.

Retail prices started to decline in 1998 due to the liberalisation of the electricity markets. The wind power association therefore called for a legal basis for RE support that would cancel the link to retail prices, arguing that the banks were stopping to lend to wind power projects. Consequently, the Parliament started to discuss a change and in 2000 the EEG entered into force. This was preceded by a hard struggle and dispute between the parties in the Parliament and the Minister for Economics and the Minister for the Environment (see section 3) and could only succeed because of the large, partly technology specified advocacy coalition consisting of various environmental groups, solar industry associations, the VDMA, the IG Metall, solar cell producers and politicians from some of the Länder. Since then the EEG has been under current attack, be it from the side of some members of the Liberals and the Christian Democrats asking for a strong cut of the tariffs, or from the side of the utilities arguing that they had to use up to 7 % of energy produced as "buffer energy" to cover short-term variability of wind and furthermore asking for a political quota system. There is a continuous need to point out the benefits of the EEG and defend this instrument against attacks.

Interim results Thus, the main agents in the successful RE development were entrepreneurs, the RE grassroots movements and associations, the Parliament and the medium scale production companies, all of them being economically independent from the established power companies. In Denmark, the utilities only began to build significant wind power installations because they had been compelled to do so by legislation.

In general, the energy companies in Denmark and Germany regarded the RE technologies as competitors to their large power plants based upon coal and oil, and tried to slow down or hinder the process. Despite the resistance from this established utilities, the RE innovation successes were achieved by means of an active collaboration between some politicians who recognised that an active energy policy was needed and possible, new small private firms with interest and knowledge in RE technologies, and grassroot energy movements as well as RE associations. In this process, a set of institutional reforms was established, furthering a "green innovation" in the energy sector.

4.1.3 Favourable legal framework: feed-in tariffs

In Denmark as well as in Germany, feed-in tariffs (FITs) were implemented to support the RE expansion, see sections 2.2 and 3.2. These FITs are statutory arrangements that regulate the price paid to the owners of RE installations in most systems by the transmission grid operators. They encourage the RE development by securing that a higher price than the wholesale market price is paid to each unit of eligible supply for a predefined time period of several years beginning with the day of commissioning. This results in investor security, reduces risks and is therefore more inclusive of a range of project sizes[55]. In advanced versions of FITs, prices vary by technology, plant location in order to account for technology maturity and resource availability. Besides this, the tariffs are often degressive, that means the later the installation is installed the lower the tariff to enhance the competition on the RE manufacturing level. The cost above the wholesale price is evenly spread among all electricity consumers[56].

Besides these purchasing rules in Denmark as well as in Germany, a priority access of RE installations to the grid was made an obligation of the grid operators as well as the priority distribution via the grid, that is a clear statement in regard to the preference of RE and the will to adapt to their production characteristics.

[55] For the interdependence between risk and support system, see Dinica (2006); Mitchell et al. (2006).

[56] For the discussion on the different support scheme and the preferableness of FITs, see Hvelplund (2001c,b); Butler and Neuhoff (2004); Laube and Toke (2005); Ragwitz et al. (2005). For a theoretical discussion of support systems, see Menanteau et al. (2003).

The respective rules in Germany and Denmark enabled/enable independent producers to pursue RE development outside the electricity utility institutional framework. The support schemes managed to secure very stable conditions and by this helped to establish a strong domestic market for wind turbines and other RE technologies. When the system was changed in Denmark and a long to-and-fro process was going on, connected with complicated transition rules, this led to a strong decline and a nearly total stop of investment in and building of RE installations, see section 2.2.

These support schemes were combined in Denmark as well as in Germany with further fiscal and financial rules favourable for RE installations, a combination of tax exempts or reductions for RE plants owners and investment subsidies for (specific types) of RE installations. These had the side effect of showing the commitment of the government to foster RE expansion and by this increasing the investor security.

Interim results The combination of a favourable legal framework consisting in an efficient support scheme and respective obligations in the basic energy laws with clear target-commitments of the governments was thus crucial to foster the necessary investor security and subsequently the constitution of a domestic RE industry and a rapid growth of the number of RE installations.

4.1.4 Public support—ownership structure: common ownership on the local level

In Denmark and in Germany public support for RE is relatively high. In Germany 81 % of the citizens are in favour of an expansion of the use of RE for the energy supply, according to a recent poll conducted by a broadcasting corporation in January 2006[57]. According to a recent study from 2006 made for the Danish Wind Industry Association the Danes strongly support the wind industry and want more wind power in DK. 91 % of the respondents agree that Denmark should continually install new wind turbines, so that an increasing share of electricity production is covered by wind power. And 77 % of the respondents favour that 50 % or "as much as possible" of the consumption ought to be supplied by wind power (AC Nielsen A/S, 2006). Furthermore, 91 % of the respondents express pride in relation to the Danish turbines and the Danish wind turbines industry. The study additionally concludes that 96 % of the respondents favour wind power, and also that the people who live close

[57]See under `http://www.tagesschau.de/aktuell/meldungen/0,1185,OID5007866,00.html`

to wind turbines are more favourable to wind turbines in their near surroundings, than people that do not already have wind turbines in the area close to their home.

This outcome is interesting especially as it seems that it stands in a certain contradiction with the so-called “Not-In-My-Backyard”-syndrome or in short “NIMBY-ism”. According to this theory people support RE and wind power on an abstract level but are objecting specific local projects in their neighbourhood because of the expected negative consequences on themselves, concerning primarily noise and visual impacts (Damborg, 2002, p. 4). But according to recent reasearch the NIMBY-explanation seems to be a too simplistic way of assessing people’s attitudes. Even though some individuals’ attitudes towards local wind power plants can be characterised by NIMBYism, it seems to be a minor factor for most people opposing local projects (Damborg, 2002, p. 5). The study of Wolsink (1996) concludes that people in areas with significant public resistance to wind projects are not against the turbines themselves, but primarily against the companies or private persons that want to establish the turbines. Another study draws a similar conclusion, pointing out that the attitudes to the RE project developers, local decision makers, and the decision making procedure itself have significant influence on the public attitude towards the specific RE project (Erp, 1997). Especially in the cases when the local inhabitants have the impression to be or are effectively kept out of the decision making process, already existing hostile attitudes towards the developers, “the bureaucracy” or “the politicians” on beforehand can be reinforced. Thus, attitudes towards concrete projects are site specific and are primarily formed by the interaction of the actors.

Thus, a way to explain the relatively high public support in Denmark as well as in Germany is the tradition of common ownership at RE installations, especially wind turbines, as described in section 2.4.3 for Denmark and section 3.4.3 for Germany, respectively[58]. This is backed by an opinion poll in the region Sydthy as well as the interview with Jane Kruse on her experiences with a wind cooperative in the same region (Kruse, 2006).

Damborg (2002) shows that people with a high degree of knowledge about energy generation and RE tend to be more positive about wind power than people with less knowledge. Those who do not favour RE in general tend to find wind energy less acceptable when it comes to noise and visual impact. The NIMBY syndrome seems to have the strongest effect in areas where there is no or very little knowledge about wind power (Simon, 1996). Sydthy has around 12 000 inhabitants and more than 98 % of the total electricity consump-

[58]For other forms of local involvement and engaging persons in a debate over the use of RE, see Elliott (2003, pp. 238-248).

tion is covered by wind power. In the Sydthy municipality about 58 % of the households at this time had one or more shares in a cooperatively owned wind turbine; of the total population in the Sydthy municipality four out of five do not feel bothered at all by the noise made by turbines. People who own shares in a wind turbine thus are significantly more positive about wind power than people having no economic interest in the subject and members of a wind cooperative are more willing to accept that their neighbour erects a turbine (Damborg, 2002, p. 3/4).

According to Kruse (2006) there are a number of decisive conditions and the following procedure to be respected for making common ownership on the local level possible: it is first very important that people interested in setting up a wind cooperative can choose the place where to put the windmills by themselves. In the case of the wind cooperative that she was chairwoman of the selection of the site was done on the one hand relying on the experience of local people with the wind conditions and on the other hand on the basis of an expert opinion on the wind conditions of the preselected sites. Therefore it should not be decided beforehand by planning authorities that a wind turbine is only to be installed at one specific point on one farmer's property, but to allow for a certain variability of the siting. Secondly, the local electricity company must be willing to discuss with the cooperative members and must be obliged to connect the RE installations. The wind cooperative members in a third step will speak with all the neighbours to the planned wind turbine, offer them to join the cooperative by buying a share and getting to know if they consent to the planned installation. This procedure needs to be backed by the legally binding rule that in general local people or municipalities are to be asked first if they want to own shares in the prospective wind turbine, before private owners or companies not residing in the surrounding of the planned installations are allowed to buy shares. The shares in the wind turbine should be set according the following rules:

- restricted to the average household's consumption plus an additional 35 %;
- exceptions in case a person can prove that his/her household has a higher electricity consumption but capped on a maximum level;
- put a maximum number on the shares.

This basically corresponds to the geographic and share restriction as implemented in the Danish support scheme during the 1980s and early 1990s, see section 2.4.3.

Interim results Ownership and direct economical participation in the installed windmills create a tolerance to the visual impact of windmills in the neighbourhood as well as towards other (negative) effects of the windmills. Because the sympathy increases the closer you live to the windmills, there is a clear indication that in order to obtain a high share of wind energy, involvement by joint ownership paves the way for maximum utilisation and thereby transition to RE without causing conflicts in the local community. The big advantage of the RE modularity is, that it permits this necessary local participation in the ownership and operation of RE installations. The clear stipulation of the priority right of local people to commonly own shares of the RE installations, may avoid the conflicts encountered when developers, viewed as outsiders, propose projects that primarily benefit absentee owners. As one Dutch farmer has said, “your own pigs don’t stink” (Elliott, 2003, p. 240). The “new” technologies have to be made a part of local people’s everyday life, thus not only serving local development and the (global) environment, but also as a manifest instance of how the individuals and the households may play an active part in changing the overall electricity supply system and create a model reaching out far beyond the borders of the local area and the country (Elliott, 2003, p. 240).

4.2 Barriers to further RE and DG expansion—what/where are the problems?

Even though the RE development in Denmark as well as in Germany is impressing, the barriers were and are manifold and can be traced back basically to the fact that the prevalent energy supply system is stamped by the use of fossil fuels and uranium and an energy supply system is never neutral to the fuel used in it. For this reason RE were and are confronted with the following situation:

- adaptation of the electricity supply system, especially the grid, to needs of RE and decentralised generation slowly and hindered;
- concentration processes in the electricity sector of the companies that use fossil fuels and uranium (and partly own the respective generation plants);
- prevalent dominant electricity companies hindering RE expansion, which makes sense from their viewpoint as they lose market shares and therefore earn less profits;
- politicians being influenced more by the established companies than by innovative

companies and grassroot organisations—behind this, national interests in furthering atomic and fossil fuel industry, precisely because this means owning the whole value added chain (and in case of atomic energy this includes the weapon technology) can partly be suspected;

- discussion on the future electricity supply focused on market efficiency and prices, leaving out environmental aspects, democratic and participative elements and security of supply as what concerns decentralised generation;
- support schemes being attacked by the prevalent dominant electricity utilities and their lobby organisations;
- growing "acceptance problems" especially on the local level towards RE installations, due to declining common ownership on the local level.

Obstacles for RE expansion can thus be found at all levels: the political discourse levels, the level of institutional reform and the level of political balance between lobbyists in the energy scene, the technological level, the economic level and the legal level. Basic reasons for this are the institutional and economic motivation structures of the fossil/uranium based energy companies, in combination with a political system, which is often unable and unwilling to free itself from its dependence upon financially/politically established electricity companies. So, these are not at all trivial problems, as they involve a battle over the whole paradigm of technological development in the electricity sector.

In the following, examples for these barriers are given relying on the historical development in Denmark and Germany and analysed on their reasons. These analyses are again supplemented by the interviews with the energy experts.

4.2.1 The influential power of the established companies

Politicians, according to Hvelplund (2005a, p. 97), often seem to be trapped in a kind of "ideological path dependency" with the established electricity companies/utilities, believing that the bigger the better. Basically there are two concepts that can be drawn on in order to explain this phenomenon: the concept of path dependency and the concept of the value-added chain.

Path dependency The concept of path dependency describes institutions not as statically existing at any given point of time but rather as evolving over time and by this basically self-reinforcing. Especially economic but also technological processes do not progress steadily towards some predetermined and unique equilibrium, so that the nature of any equilibrium achieved depends partly on the process of getting there; shortly described by the expression: "history matters". The existing literature relies on a number of factors to explain this phenomenon, such as a restricted time horizon of decision makers, unintended consequences, and a lack of knowledge about long-term effects[59]. A path dependent economic process is one in which specific contingent events—and not just fundamental determinative factors like technology, preferences, factor endowments, and institutions—have a persistent effect on the subsequent course of allocation (Puffert, 2001, p. 2). With this dynamic view the concept of path dependence delivers a contrasting model to the standard neo-classical model, which in its simplest form assumes that only a single—necessarily efficient—outcome could possibly be reached, regardless of initial conditions or transitory events (David, 1985; Arthur, 1989). With path dependence, in contrary, both the starting point and 'accidental' events can have significant effects on the ultimate outcome[60].

Regarding technological change, the crucial idea is that of increasing returns. High investment costs are likely to create increasing returns to further investment in the same technology, hence leading to a situation of lock-in (Puffert, 2003). Thus, a certain technology may persist in spite of the availability of superior technologies. Besides this, the following conditions also give rise to path dependency: durability of capital equipment; technical interrelatedness; increasing returns to the extent of use (Puffert, 2003). The electricity supply system can be regarded as highly path dependent due to its large infrastructure investments.

In the present electricity supply systems these path dependencies are having an influence on the design of

- the market, as the dominant electricity companies are exerting market power;
- the supply system, as the overall system is built for the use of fossil fuels and uranium in central power plants and a subsequent transmission and distribution via the grid;

[59] See, amongst others, Weber (1999, p. 40), Pierson (1996), North (1990)

[60] For critics of the concept of path dependence, emphasising the view that forward-looking, profit-seeking agents steer allocation processes to the best outcomes possible given the constraints of foresight and transactions costs, see Liebowitz and Margolis (1995).

- the ownership structure, as a large part of the infrastructural elements (the power plants, the transmission/distribution grid and the supply companies) is often owned by a small number of large powerful companies and hereby are exerting their ownership power;

- the legal framework, as the lobbyists of the large electricity companies are able to exert a significant influence on the rule making procedures[61].

- the public regulation, as there are interlinkages between politics and industry in the electricity sector (such as politicians sitting in the supervisory boards of electricity companies etc.)(Bartle, 2005, p.119). It cannot be excluded that these interlinkages are having influences on the regulation processes. Besides this, the municipalities receive concession fees from the electricity distribution companies. It gives them a considerable degree of common interest with the established electricity companies.

In this strong version of path dependency, path transformation is highly unlikely. A fundamental change in the system is thus necessary, that is a change that breaks the influences of the established path on the design of the overall infrastructure and the institutions and allows for a transformation to a system adapted to the use of RE in mainly decentralised generation.

Value added chain Another concept that can be used to explain the dominance of the established companies as well as their unwillingness to contribute to the expansion of RE on the basis of a multiowner principle is the value added chain of the present electricity supply scheme. Before liberalisation took place, the electricity utilities generally owned the whole value chain from fuel extraction, power generation until transmission, distribution

[61]As an example, the setting of the national allocation plan and the respective allocation law (Zuteilungsgesetz) concerning the allocation of the CO_2 certificates under the EU emissions trading scheme in Germany shall be named: The Federal Ministry for the environment, with its primely responsibility for climate protection and emissions trading, in 2004 was aiming at forcing the industry to reduce their CO_2 emissions from 505 million to 480 million tons until the year 2012 and at setting a strict benchmark for new power plants on the basis of modern gas power plants as what concerns CO_2 emissions. Due to an intervention of the industry especially on the Ministry for Economics that had to consent to these goals, however, these goals were reduced to 503 million tons from 2005–2007 and 495 million tons until 2008 (Reiche, 2004, p. 193). A similar development took place with the setting up of the national allocation plan in Germany this year; the plans to implement an auctioning of a part of the CO_2 certificates were abolished mainly because of powerful protests of the (electricity) industry, see `http://www.tagesspiegel.de/politik/archiv/21.06.2006/2610966.asp`

and sale of electricity to the consumers[62]. Therefore, a large share of the value added, often even the whole direct electricity supply system, belonged to the same owner. This system behaves in a different way than a system in which the different parts belong to different organisations. The high degree of vertical integration, that is the ownership of the production and distribution chain, causes very low short-term marginal costs in the organisation. The short-term marginal cost will in this highly vertical integrated system appear far lower, than in a system, where the different levels of production are embedded in different organisations. The high degree of vertical integration causes, in times with spare capacity, a high degree of economic incitement for establishing economic "barriers to entry" against technological newcomers (Hvelplund and Lund, 1998b, p. 544).

In the Danish electricity sector the introduction of RE installations led to a loss of 9,3 % of the total value added for the established electricity utilities; if independent organisations replaced capacity at the power plants level this loss amounts to 34 % loss in turnover. In Germany, with its ownership integration of fuel extraction, power production, transmission and distribution, a change to a RE based electricity supply system would mean a decrease in value-added share from 50-60 % of the electricity price to around 20 % for the established electricity companies (Hvelplund, 2001c, p. 89). As illustrated in figure 3, in a RE value-added chain, the fossil fuel value-added part (the box "fuel" in the direct electricity supply system) would disappear and be replaced by investment in RE capital equipment, belonging to the indirect electricity supply system. Besides this, the power production value-added in a direct electricity supply system organisation based on fossil fuels and uranium and (the box "power generation") would be replaced by "RE system automation", where it is probable that the maintenance, at least at the level of the consumers and for the decentralised generation level, would be performed by the suppliers of the RE installations. The need for a specific power production organisation might decrease or completely disappear, as the day to day work on a power plant would be replaced by electricity producing automatons requiring maintenance from the suppliers of the RE installations (Hvelplund, 2001a, pp. 62/63). The added value directly linked to the power sector would be at least halved in comparison to the fossil fuel and uranium based value added chain. Consequently, the direct electricity supply system organisation might therefore decrease until it only consists of the transmission and the distribution grid organisation and service. The consumer level also would gain importance, as a high share of consumers would be

[62] Generally three levels of value added are distinguished in the electricity industry: generation, transport and sale, see Bausch (2004b, p. 31) and Hermes (1998, p. 21).

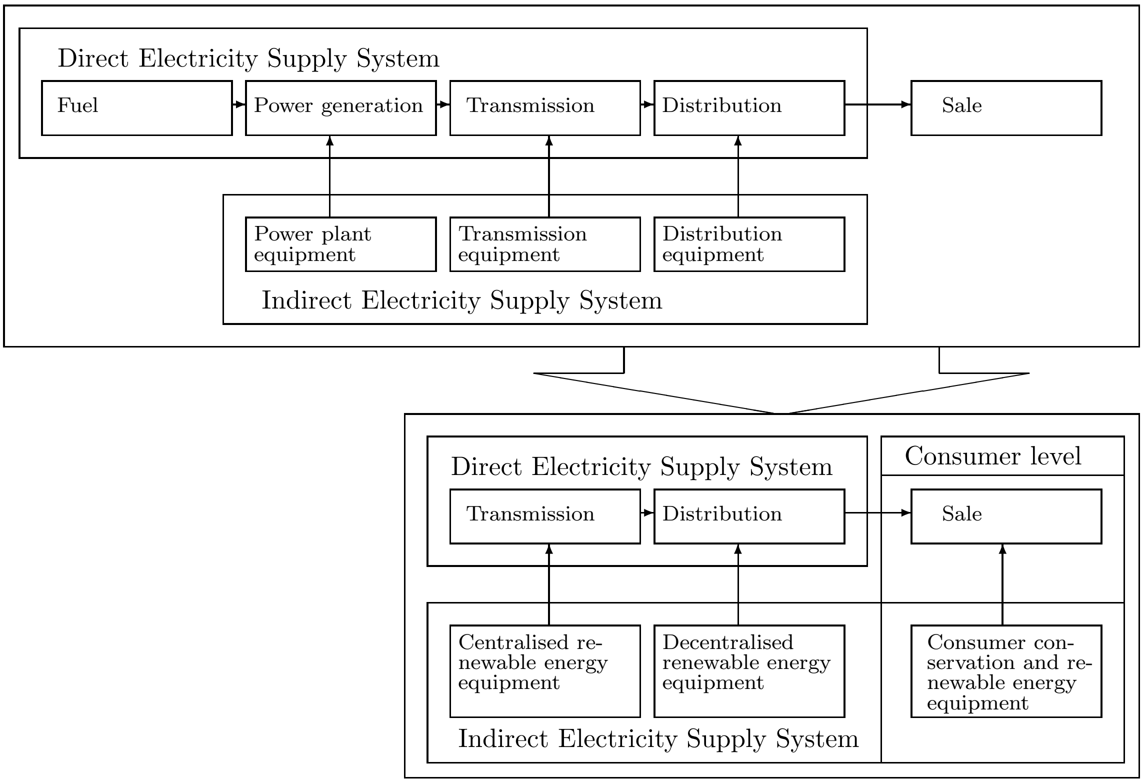

Figure 3: Value added chains. Source: (Hvelplund, 2001c, p. 46 and 50)

given the possibility to operate their own RE installations and take over the responsibility to contribute to electricity conservation by adapting their consumption to the availability of RE generated electricity (box "consumer level").

Companies linked to the established system are thus losing value-added in a transition to a RE based electricity supply system, since their organisations have no comparative advantage when dealing with the new technologies. The jobs and profits go to the new systems with different value-added profiles and organisational needs. The established companies will constantly try to and already do fight against these changes in their own interest as the changes mean losses and less profit against their shareholders' interests[63]. Thus, new organisations and companies that are (economically) independent from the fossil fuel and uranium extraction and power production based on these fuels and deliver the respective elements and services for the technological change to a RE based electricity supply system, need a strong and continuing political support against the power of the established com-

[63]For details on the causes furthering resistance from the established electricity companies against RE technologies, see Hvelplund (2001a, p. 67).

panies. The consumers by themselves are not powerful enough to change the electricity supply system only by their power as sellers on the market. Besides this, consumer ownership of distribution companies or utilities by itself does not guarantee for the transition to a fundamental different electricity system based on RE and decentralised electricity generation and supply. This can be demonstrated by the development in Denmark, where—as has been shown in section 2.4.2—there is a high rate of consumer ownership.

The electricity supply system in Denmark has been very democratic because of the directly voted consumer representatives in the boards of the distribution companies as well as the consumer profit and ownership structure. In the last years, however, more and more large power plants have been built and the direct consumer control has decreased; the direct elections have been widely replaced by indirect ones. More hierarchic structures have been implemented and consumers less and less are aware of their possibilities to exert an influence on the politics of these companies (Maegaard, 2006). Generally the consumers elect their representatives in the distribution companies. These representatives elect each their board of directors and these boards of directors elect their representatives from the power plant companies. The director and the deputy director from each power plant are automatically members of the power plant association in the respective zone, the power plant association is the coordination unit and the organisation which elaborates the political strategy for the electricity system. The elected board of directors in the power companies thus has normally a preference for large centralised power plants, there is no independent administration linked to the elected board of directors. A set of indirect election procedures squeezes out any minority groups (Hvelplund and Lund, 1998a, pp. 77/78). Minority groups wanting to implement new technologies in the power production sector are confronted with this situation and have to follow their interests against the majority of the established companies in the power plant association and the board of the directors.

4.2.2 Declining local support for RE installations

As has been demonstrated in the analysis of the success elements in section 4.1, there is a clear indication that in order to obtain a high share especially of wind energy, involvement by joint ownership paves the way for maximum utilisation and thereby transition to RE without causing too many conflicts in the local community.

In Denmark, however, the changes in the RE support since 1999 according to Kruse (2006) and Maegaard (2006) are leading to the contrary: The changed rules, especially the replacement obligation for new wind power installations (see section 2.2), are followed by the closing down of wind cooperations, an arbitrary placement of wind turbines, the dominance of large wind turbines leading to a RE electricity production dependent on centralised structures and result in an overall decrease of the public support for RE installations, especially on the local level. The abolishment of the geographic eligibility criteria and the restrictions on the number of shares that can be owned by a single person (see section 2.2) as well as the drastic cuts in the guaranteed payments[64] have inter alia the consequence that cooperatives are no longer the most suitable form for wind power projects. Because of the to and fro in the Danish RE support scheme, it is more and more difficult to receive loans from (local) banks to good conditions for single persons or cooperatives. The banks are demanding a security to get the risk down that people will not be able to pay back their loan; a precondition that before 1999 was delivered with the guaranteed payment for RE electricity production[65]. In addition to this, an increasing amount of capital is needed to get a wind turbine project started nowadays: the investor has to afford firstly the replacement, that is, for each new turbine she/he has to prove that the equivalent capacity of old and small windmills is abolished (for a turbine with a capacity of 2 MW around five old turbines have to be pulled down). Thus, the still existing cooperatives often are addressed by investors wanting to buy their wind turbines. Members of cooperatives, according to Kruse (2006), are often tempted by the money offered to them, especially when amounting to the initial investment sum, so that even well-running and efficient wind turbines are sold and pulled down[66]. Secondly, the investor is often asked by the political representatives of the local municipalities neighbouring the sites of wind turbines for compensation measures at the local level, such as extra payments for the construction of a local harbour etc., to guarantee "local acceptance" with regard to the RE installations. According to Jane Kruse and Preben Maegaard these compensation measures, however, quite often are not corresponding to the will and the needs of the local inhabitants, that have not been asked by the representatives of the municipalities. Thirdly, the investor has to make sure that the turbines will produce enough electricity to be compatible on the market; as the turbine owner is responsible for the sale of the production on the electricity market and for the related costs. These conditions are bringing the investment costs for wind turbines

[64]For the wind cooperative that Jane Kruse was a chairing, the fixed prices went down from 60 øre/kWh in 1998 to 30 øre/kWh in 2004—that meant that the yearly income for the cooperative members fell from 250 000 DKK/year to 60 000 DKK/year.

[65]See Dinica (2006) for a detailed discussion of these elements.

[66]If there is no investor willing to buy the old windmills, the state will—until the year 2009—step in and pay the bonus to the cooperatives that will take the wind turbine down by themselves.

up; the windmills often are largely overpriced, making it nearly impossible for members of cooperatives to own new wind turbines, as they are not able to invest such a large amount of money at once, before the wind turbine even is installed and operating (Maegaard, 2006). This is followed by a decrease in the local support because the neighbours to RE installations are no longer able to take profit out of these installations by owning parts of them. Local opposition is likely to grow in Denmark as well as in Germany, until a way is found (again) to address the feeling of powerlessness that local inhabitants evidently feel in the face of wind projects imposed on their communities, especially when wind projects are owned and controlled by a few large companies.

4.3 Ways for optimisation within the prevalent system—what to do? where to go?

As has been elaborated in the previous section, the most important barriers for an expansion of the share of RE in the electricity supply system lie in the areas of

- the power structure and its influences on the design of the infrastructure and the political, institutional and legal/regulative processes and
- the ownership structure of the grids, the transmission/distribution grid operators and the utilities.

The question is whether it is likely to overcome these barriers within the prevalent system with its power structure dynamics and ownership characteristics or whether a fundamental change turns out to be necessary. In the following I describe examples for possibilities of changes within the prevalent system that contribute to an optimisation of the RE share that were given by the energy experts in the interviews and analyse them on their dimensions and limitations.

4.3.1 Adaptation of the electricity supply system to the RE needs

On a technical level, discussions about the feasability of a large share of RE in the electricity system have been going on for some years, and a high penetration is generally regarded as possible, see for example Lund and Münster 2003b, 2006; Lund 2005, 2006.

Integrated regulation strategies It is necessary to design integrated regulation strategies of the overall electricity system; the wind turbines and other RE installations need to interact with the rest of the production units in order to make it possible for the system to secure a balance between supply and demand[67]. Denmark is leading, in terms of integrating distributed production and RE into the national electricity production system: CHP units operate in order to integrate wind power by reducing their electricity production in hours of excess production and small CHP units are included in grid stabilisation tasks (Lund, 2005, pp. 2406–2410).

Feed-in grids The grid extension in the midvoltage grid is in parts of Germany not advancing at the celerity needed by the expansion especially of (offshore) wind power installtations. In Eastern Germany—in the Land Brandenburg—there exists a model project of a so-called "feed-ingrid" ("Einspeisenetz"), built by RE installation planners who are directly connected to the high-voltage line of the TSO (in this case: Vattenfall Transmission). This grid does not need to follow the n-1 rule as it is a feed-in grid only and is not for the direct suppply of end consumers. The RE installations, mostly wind power plants and several biomass power plants, are all connected via this feed-in grid to a common master display, with which the fluctuating RE generation is regulated by an intelligent combination of the electricity production of wind power installations and biomass power plants before the connection to the transmission grid. This constellation led to a fast RE extension in the model region, because it firstly was built in the own initiative of the RE installations planners and thereby avoid the distribution grid operators in this region reluctant to extend the distribution grid (although they are obliged to do so by specific rules in the EEG). Secondly there was only little public protest against the powerlines as they were planned and built as earth cables. Such feed-in grids according to Stefan Wagner of the Gesellschaft für Netzintegration (Stefan Wagner, 2006) make sense for a minimum quantity of 500-1000 MW of RE electricity produced. The plan is to build more of these feed-in grids in different model regions. The RE electricity fed in via these grids shall be combined with storing technologies and load/consumption management in order to allow an electricity generation and a supply that is adapted to the consumers' needs. The idea is to make the RE electricity production and the respective distribution step by step more

[67]For the EnergyPLAN model developed by the Aalborg University, Department of Development and Planning, Division of Technology, Environment and Society for the purposes to analyse and design suitable national strategies for the integration of electricity production from RES into the overall energy system and its results, see Lund et al. (2004), Lund (2006), Lund and Münster (2003b).

independent from the prevalent grid operators. Besides this, a new independent sector of electricity system operation services will be built up that is responsible for the coordination and adjustment of the electricity feed-in.

Interim results The technical and system concepts thus are available and already being implemented; in the following a check of the current legal and institutional regulative framework on its incentives for an adaptation of the necessary network structures to the needs of RE and decentralised generation is done.

4.3.2 Liberalisation, de-/re-regulation of the electricity sector and RE needs

During the first liberalisation period in 1998 the deregulation in Germany focussed strongly on the role of retail competition; in contrast to most other European member states Germany opted for complete eligibility from the beginning of the liberalisation in 1998. Around mid-1999 retail competition started reducing the price level significantly, reaching the lowest price in spring 2000. Since then, however, new entrants have left the markets or increased their prices and prices consequently rose continuously. This development led to a shift in public attention from the retail markets to the role of access to the electricity grids. In particular, the complaint was that because of excessive access charges the price levels of competitive retailers did not guarantee market survival (Knieps, 2004, p. 16/17). The current version of the basic energy law (EnWG 2005) thus concentrates on the regulation of the network access charges by the Federal Grid Agency[68]. Following the liberalisation of the electricity markets the network and generation activities have to be separated, the so-called "unbundling". The Directive 2003/54/EC concerning common rules for the internal market in electricity, however, does not oblige the Member States to implement an ownership separation, but only a legal, organisational, informational, accounting and separation in decision-making (Bausch and Rufin, 2005). In Germany the electricity companies are not obliged to unbundle the electricity producing, distribution and purchasing companies (see section 3.4.2), with the consequence that the interlinkages between generation, transmission and sale of electricity and the related possibilities to give

[68]The Federal Cartel Agency (Bundeskartellamt) deals with competition restraints issues on the basis of the Act against restraints of competition (Gesetz gegen Wettbewerbsbeschränkungen, GWB) and the European Competition Law. Very recently a possible change of the GWB has been discussed in order to allow for a continuous electricity price control of the Federal Cartel Agency, as the electricity prices in Germany are constantly rising during the last years—whilst the large utilities are showing ever rising profits.

preferential treatment to their subsidiary companies to some extent still remain.

In view of the challenges to regulate the grid access charges, according to Sabine Frenzel of the BNA, the adaptation of the grid to RE needs is not in the focus of the regulation activities (Frenzel, 2006), although there is a general awareness of the importance of decentral and RE based electricity generation and supply. The rule in StromNEV (2005, § 18), that owners of decentralised power plants receive a special payment from the grid operators, that has to correspond to the avoided grid use because of the decentralised feed-in (compensation for avoided network costs or "vermiedene Netznutzungsentgelte"), does not seem to give a sufficient incentive for a significant growth of decentralised electricity production[69]. As what concerns the grid extension the BNA is committed to an overall optimisation and according to Sabine Frenzel does not pay specific attention to RE needs (Frenzel, 2006). As a general rule, the grid operators are obliged to extend the grid "according to the needs, if this economically reasonable" (EnWG, 2005, § 11 para. 1 cl. 1) and have to report on their extension plans to the BNA every two years, which is a relatively weak basis to force the grid operators to follow far-sighted grid extension strategies oriented on the needs of RE development.

Recent studies on the German national level (Leprich et al., 2005) as well as on the European level Skytte and Ropenus, 2005; Jörßet al., 2002 have developed several ideas on how to get distributed generators fully integrated as essential parts into networks and markets. The current rules in the basic energy laws, especially the EnWG in Germany, however, according to Dierk Bauknecht (Bauknecht, 2006) are only giving little incentives to the actors in the electricity sector for an integration of RE into the network; some of the rules are even contraproductive in regard to RE and decentralised generation (Leprich et al., 2005, p. 100–110)[70]. The problem is that the focus of the discussions about future electricity supply lies primarily on cost efficiency without taking into account the "value added" of the electricity generated decentrally or from RES in regard to the protection of the environment and the climate (Bauknecht, 2006). From a RE and DG perspective it is important that the incentives to cut costs do not lead to a short-term persepective that would undermine the efforts to connect additional RE installations and DG plants or develop an innovative network structure that is able to accomodate more RE and DG

[69]This rule does not apply for decentralised RE and CHP generation, as according to the EEG and the KWKG these special payments are to be used to lower the electricity prices for the end consumers, see EEG (2004, § 5 para. 2 cl. 2) and KWKG (2002, § 4 para. 3 cl. 1).

[70]In contrary to the UK, where an extension of decentralised generation is a an explicit regulation goal, see Leprich et al. (2005, p. 38).

installations. One of main challenges is to better integrate RE and DG plants, into both networks and markets. The EEG in EEG (2004, § 4 para. 1 cl. 2 and 3) has made a first step into this direction by stipulating that "[...] plant operators and grid system operators may agree by contract to digress from the priority of purchase, if the plant can thus be better integrated into the grid system [...]". Moreover, in the 2004 amendment of the EEG a rule has been introduced in EEG (2004, § 4 para. 3), that in the case of the network being used to full capacity, the obligation of the grid operators to give a prioritised access is made dependent on the RE installations having a technical facility for reducing the feed-in in the event of grid overload. These approaches for a better integration are continuously developped further. But on the other hand it has to be taken into account that the energy and ancillary service markets are still far from being fully competitive and transparent. As for RE and DG participation in balancing markets, the minimum capacity for plants should be reduced from the current 30–50 MW[71]. However, as it is relatively difficult for small plants to participate in balancing markets on their own and transaction costs are high, improving the conditions for virtual balancing plants, so that DG and RE plants can operate jointly to offer balancing services, would be even more important than reducing the capacity threshold (Ragwitz et al., ress, pp. 23–27) and (Skytte and Ropenus, 2005, pp. 36–37). Besides these integration and adaptation questions, according to Bauknecht (2006) there is a lack in co-ordinated and strategic planning of the overall electricity supply system in Germany, which involves all important actors and is open for innovative ideas[72]. The situation for RE and DG in Germany, thus, is characterised by relatively strong support mechanisms on the one hand and weak regulation of the prevalent electricity sector on the other hand.

In Denmark, the situation is different: As what concerns decentralised generation the politics follows a cooperative approach and has been successful in a smooth and relatively fast transition of the supply system (Leprich et al., 2005, pp. 33/34). The Danish electricity supply system is characterised by a large share of DG and a large share of CHP production for district heating; today more than 50 % of the overall electricity is generated in DG plants including wind power installations. The state-owend TGO Energinet.dk with the so-called "System21"-programme is pursuing the goal of a much higher percentage of DG in order to contribute to an overall security and independence of the electricity supply. In

[71] For details on the prerequisites for a participation on the balancing market in Germany, see Brodersen (2006).

[72] In the UK, for example, a network strategy group was installed, gathering all actors around a table in order to develop common future strategies

the context of this programme measures are developed and discussed on how to bring in distribution grid operators to the tasks of guaranteeing overall electricity system reliability and quality[73]. The questions, however, of the regulation of these "intelligent" decentralised network systems are not solved (Leprich et al., 2005, p. 36).

Interim results The support of RE and decentralised generation, and the regulation of the networks are until now two separate action fields that need to be coordinated. The growth of RE installations is having an influence on the networks and an optimisation of the RE share can only be achieved if the TSOs and DSOs are not torpeding the processes. Of the three key objectives of energy policy—market efficiency, security of supply and environmental protection—market efficiency, however, seems to be prioritised in the liberalisation process without adequate empirical evidence that this will effectively achieve the policy objectives (Bartle, 2005, p. 183). The existing electricity system shall function from a technical point of view, but at the same time it is necessary to keep the innovative perspective alive. It therefore is necessary to be able to discuss solutions which go beyond "end of the pipe" thinking; the implementation of such solutions demands not only technical changes but also changes in organisation, knowledge, infrastructures, law etc.

5 Cornerstones of an alternative scenario for an optimised RE expansion

As has been demonstrated above, the needed technological change/the energy transition is confronted with barriers that make it doubtful that it can be achieved by an adaptation within the prevalent system at all, or at least can be achieved in time. The pace of climate change does not allow for tedious to-and-fro-processes[74]. Nowadays processes prevail, in which each single step of change and adaptation to the RE needs is bargained with the

[73]For details on the history and current developments in the field of DG expansion in Denmark, especially the integration in the market structure, see Leprich et al. (2005, pp. 33–36).

[74]According to a recent report of Tyndall Centre for Climate Change Research in Manchester, climate change might happen even quicker as previewed because governments did not include green-house-gas emissions from international flights and navigation in their calculations. An enhancement of the climate protection goals up to 50 % until 2050 is therefore needed, see (Tyndall Centre, 2006). A climate scientist at NASA, Dr. James Hansen, calls for prompt reductions in emissions of greenhouse gases linked to global warming as the time-frame to avert changes that constitute practically a different planet and will be unstoppable by then accounts to less then 10 years, see Hansen (2006).

established power companies (see section 4.3) and thereby missing to face that an overall and fundamental change is needed. We are facing a so-called "window-of-opportunity" because in Germany as well as in Denmark large capacities of power stations have to be replaced in the next years. It is therefore decisive to politically set the courses to achieve the transition to a RE based energy supply now. Due to the path-dependencies and the characteristics of the value-added-chain as well as the power structure, electricity supply systems are not and will never be fuel-neutral (see section 4 above)[75]. One cannot change one of the main components of the electricity supply system, the fuel used, without changing the others (Scheer (2005, pp. 73, 152–154), Scheer (2002, pp. 43ff)).

The basis for the approach is formed by a model of the current electricity supply system; its goal hierarchy and its macro- and micro-structure. This model is described as a starting point and then forms the framework for the analysis of the goals hierarchies, the powers, their interlinkages and their influences on the political processes. It is the starting point also for the elaboration of the alternative scenario and is then finally contrasted and adapted to the requests of the alternative scenario in the conclusion section.

The focus lies on the cornerstones of a radical scenario consisting of the following elements:

- Open and participative goal setting and decision-making procedures, resulting in
    1. Public involvement;
    2. Goals that are widely supported by society;
    3. Investor security due to long-term perspectives.
- Separation of powers in the electricity supply system, resulting in
    1. Independent actors/organisations;
    2. Competition of concepts in political processes;
    3. Adaptation of the overall electricity supply system;
    4. Adaptation of the ownership structure.

So, firstly, I elaborate on the targets of a future electricity supply system and how the target-setting process can be designed.

[75] For a detailed analysis of the stamping of the economic, social and cultural development by the resources used see Smil (1994).

Secondly, building on the analysis above, the powers in the electricity supply system are described. Their position in the current system as well as their interlinkages in and their influence on the current system are shown and analysed. The theory of the separation of powers as coined by Montesquieu is transferred to the electricity system and the respective reasons for this demand are checked on their applicability in the electricity system.

As a third step these two basic changes—the participative goal setting and decision making procedure as well as the separation of powers—are analysed on their consequences on the overall system of electricity supply and on ways of their practical implementation. These consequences are subsequently visualised by a respectively adapted figure of the macro- and micro-structure of the electricity supply system the concluding sectoin 6. This shall form a scenario of how an alternative system could look like and can thus be of use for strategies for a future energy supply system.

5.1 Structure of the electricity service supply system: Goal hierarchy, actors and inter-linkages

In order to understand the possibilities and limitations of ways for optimisation there is a need to first deliver an overview of the current electricity supply system with its relevant actors, their relationships and interdependencies.

The structure developed by Hvelplund (Hvelplund, 2001a, p. 34) allows for an analysis of the institutional dynamics within the electricity supply system, is contrasted with a set of overall goals for the electricity supply system and shows the relationship between the electricity supply system and the political system. As such it is a suitable structure to start from when developing an alternative scenario. Figure 4 describes the macrostructure of the electricity supply system by means of showing the interlinkages between the political goals, technical scenarios, institutional reforms and the political processes. This 'global' structure corresponds to the overall organisation of the electricity supply system in a given country, featuring organisations, social groups, institutions and their respective properties, relations and interlinkages. The prevalent energy supply system (Who are we?) is illustrated in the box named "Electricity service supply system", including the value-added chain in the direct electricity supply system that influences the processes of changes as described above under 4.2. The overall goals of the electricity system (What do we want?), the historical situation (Where are we?) and the external relations (How are the others?) are to be found in separate boxes on the right hand side.

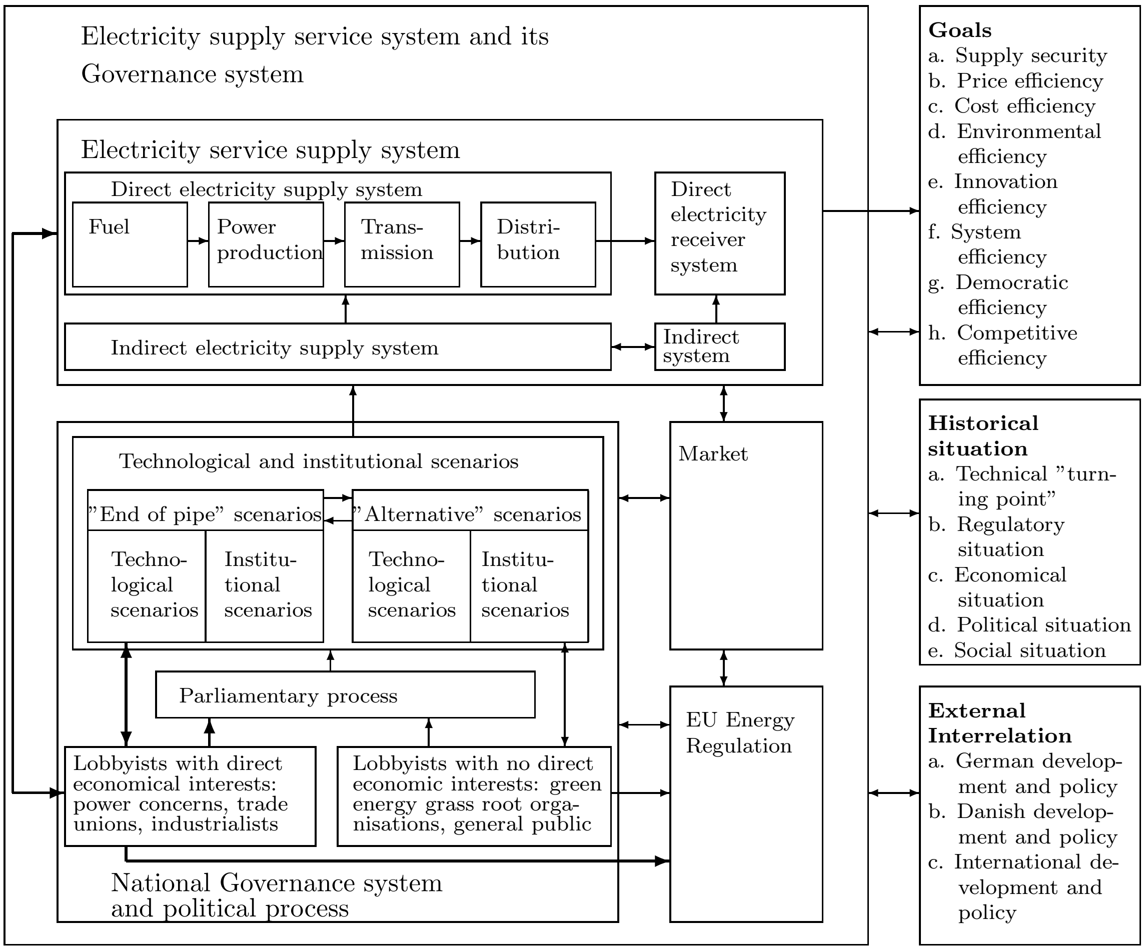

Figure 4: The electricity supply service system and its Governance system. Source: Hvelplund (2001a, p. 34)

The figure additionally shows the targets against which the optimisation suggestions should be measured, the character of alternative technical scenarios, the institutional reforms needed in order to implement a given scenario and the political process behind the design and implementation of institutional reforms. Changes in this structure address different actors and the governance system/political processes (parliament, regulatory power, lobbyists with direct economic interests, e.g. energy companies, and lobbyists with no direct economic interests, e.g. the general public and grass root organisations).

5.2 Goals and goal setting procedure

The scenario has to be elaborated starting from the goals strived for in the electricity supply system. By describing the goals, a prioritisation process between various alternatives can be supported, that is, which goal can best be achieved with which alternatives.

The process of goal setting itself is also very important: By organising this process in a participative, open-ended and transparent way, involving different actors with their ideas, there is a high chance to on the one hand obtain a bigger variety of choices and alternatives for future strategies and on the other hand gain public support for the hereby resulting goals. By looking at a variety of possibilities one comes closer to shaping the future, rather than merely predicting it.

5.2.1 Goals

The overall goal is a sustainable and democratic electricity supply system that contributes to stabilise the climate system. Sustainable means that it also has to take into account the fundamental rights of life, health and guarantee of the subsistence level of future generations[76], including their interest in access to affordable electricity supply services. Democratic mainly means participation of the members the society—in the goal setting, the design of the respective policies and measures as well as via consumer ownership in the utilities; this is especially relevant when basic needs such as electricity services are at stake.

The following sub-goals can be derived from this overall goal and are included in the macro-structure of the electricity supply system described above[77]:

- ensuring supply security;
- environmental efficiency;
- price and cost efficiency;
- democratic efficiency;

[76]For the derivation of these future fundamental rights ("Zukunftsgrundrechte") from a liberal theory of equity as well as from the fundamental rights in Constitutions, especially the German Constitution and the Charter of fundamental rights of the European Union, see Ekardt (2004b, p. 143ff, resp. 272ff).

[77]For a description of these aims, see Hvelplund (2001a, pp. 36-38).

- innovation efficiency;
- system efficiency and
- competitive efficiency.

At first, a definition of the term "efficiency" is given, followed by a short description of what is understand by these sub-goals:

Efficiency Efficiency is defined in this context as an advantageous relation between the costs and the benefits of a measure, not only in monetary terms. Thus, it is the balancing between all pros and cons of a measure. By this it is not only addressing the concept of preference-sovereignty (as expressed by the Pareto-condition "Efficiency" in the concept of "Pareto optimality")[78]. As a broader concept of "efficiency" or as a concept of "optimal", in an ethical sense, the Pareto-optimality is not sufficient[79]. Pareto-optimality is merely a descriptive term, it says nothing about the distribution of wealth, only of the allocation of resources and there are no ethical propositions about the desirability of this allocation inherent within that notion (Bishop, 2004, p. 125). An economy can be Pareto-optimal, yet still refusable by any ethical standards. It is important thus, to include this ethical element in the term of "efficiency" by adding the necessity of guaranteeing the elementary conditions for liberty, that means a economic, ecologic and social subsistence level (Ekardt, 2004a, p. 545), when discussing a future electricity supply system.

Supply security The electricity sector within the EU-25 is still dominated by large centralised power plants using fossil fuels and uranium. Only 7.3 % of the coal, 2 % of the gas, 0.6 % of the oil and almost none of the world's uranium lie within the EU-25, with the consequence that the EU is heavily reliant on fuel imports (Teske et al., 2005, p. 3).

Thus, the electricity supply relies on resources that are all finite and for some of them the global peak production point has been reached[80]. Besides this these resources are in

[78]A situation is pareto-optimal if by reallocation you cannot make someone better off without making someone else worse off.

[79]The concept of Pareto-optimality besides this knows only a balancing and steering level but no normative level, in contrary to what is suggested by the "three-level-approach", see under 5.2.2.

[80]When the global peak will occur is a controversial issue. Production peaks are difficult to predict, and generally the only reliable way to identify the timing of any production peak, including the global peak, is in retrospect. Estimates for the date of Peak Oil range from the end 1990s/beginning 2000 to dates after 2025-2035. Natural gas production may have peaked on the North American continent in 2003, with

regions of the world that have unstable regimes and there is a constant struggle, consistently resulting in wars, to secure the access to these resources. The prevalent electricity supply system is thus not able to guarantee future long-term supply security.

Environmental efficiency The fossil fuel and uranium based electricity sector is responsible for the emission of more than 1.2 billion tons of CO_2 and over 2600 tons of dangerous radioactive waste every year (Teske et al., 2005, p. 3)[81].

Besides this, enormous water amounts are needed for the extraction of coal, oil, and uranium as well as for the operation of the fossil fuel and uranium power plants. The emissions of the fossil fuel based power plants as well as the of the nuclear power plants create serious health risks for the population (Scheer, 2005, pp. 47–48). The prevalent electricity supply system can thus not be called environmental efficient.

Cost and price efficiency Both price and cost efficiency are mentioned here, as the cheap production of RE electricity is not sufficient if market power enables the producer to make excess profits (Hvelplund, 2001a, p. 27).

As what concerns price efficiency it has to be taken into account that an obsession with obtaining low prices can be counterproductive when it comes to developing new energy technologies. It makes little sense to try to decide on longer term energy options using early estimates of costs based on prototypes, or first generation technologies. Prices fall as the technology improves—assuming that someone has the courage or foresight to fund its

the possible exception of Alaskan gas supplies which cannot be developed until a pipeline is constructed. Natural gas production in the North Sea has also peaked. UK production was at its highest point in 2000, and declining production and increased prices are now a sensitive political issue there. For the discussion, see for example Campbell and Laherrere (1998) and Bentley (2002). Peak coal is still far, of the order of two hundred years; Hubbert had recoverable coal reserves at 2500 109 metric tons and peaking around 2150 depending on how the usage graph is drawn (Hubbert, 1956). But we can observe the example of anthracite in the USA, a high grade coal, that has peaked in the 1920s. For uranium the situation is as follows: Nuclear energy provides around 7 % of the world's energy supply, and at this rate there is enough uranium to keep thermal reactors running for 100 years. However, if you significantly increase the amount of energy produced by thermal reactors the lifetime of the resource shrinks accordingly. For example, if nuclear were to provide in excess of 30 % of global energy supply then uranium resources might only last two decades. The only way to significantly extend the life of uranium reserves is to develop fast-breeder reactors. These are able to convert the unused uranium into plutonium, which can then produce energy by the same process as thermal reactors. The problem is that the design challenges of developing a fast breeder reactor mean that no safe and commercially-viable system has yet been developed, see Mobbs (2004).

[81]For details on the impact of global warming on life on earth, see IPCC (2001).

continued development. There are well established learning curves showing how technologies improve in performance and cost over time that should be included in these estimates.

Democratic efficiency The sub-goal of democratic efficiency addresses different aspects: the political dirigibility of the market actors and the possibility of public participation as well as the consumer power in the electricity supply system. The first aspect deals with the governability, that means the relations between the public authorities, parliament, government and the organisations and institutions and how they can be steered (Hvelplund, 2001a, pp. 117–118).

The second aspect deals with the possibilities of the public sphere to influence the processes and the design of the system, via consumer ownership, public debates, elections etc. As electricity supply services belong to the basic needs of persons, it is in the interest of the society to be involved in future strategies and vice versa to take over responsibility. Electricity supply is an example of public service goods or service of general economic interest (Bartle, 2005, p. 41). There is also a normative sense of the notion: Some goods should have the characteristics of a public good, that is, they should be available to all, at an affordable price if not free, and their consumption by one or more should not reduce the availability to others, especially future generations. Public utilities are essential to the basis of well-being of individuals, society and the operation of the economy and therefore should have the characteristics of a public good (Bartle, 2005, p. 41). I come back to these aspects in detail under 5.2.2.

Innovative efficiency As has been shown above under 4.1, entrepreneurs, who apply new techniques or new combinations of factors of production or 'innovators', play a central role for development and changes in the system. According to Schumpeter, the pioneers in the field of new technologies, new products and new markets, carry out innovations and, joined later on by imitators, are at the heart of the short and long cycles observed in economic life in a capitalist system (Schumpeter, 1950, p. 132). Thus, society, politics and market have to be open to these innovative forces, allowing them to enter the systems to fair and non-discriminatory conditions as well as support their initiatives.

System efficiency When regarding the system efficiency it has to be taken into account that what people want and need is not the electricity itself but the related services, such as lighting and heating. This is a distinction that is ignored by many conventional economists.

The same energy service can be delivered by combining lower energy consumption with greater investment in energy-efficient technology. This can be achieved without any increase in costs if the cost of investments in energy efficiency is no greater than the cost of the energy that is avoided (Toke, 1995).

Competitive efficiency When dealing with competitive efficiency it has to be taken into account that the asserted superior efficiency of the current fossil fuel and uranium stamped electricity supply system results out of a sectorised view on the basis of calculations that cannot easily transfered to the RE based electricity system (Scheer, 2002, p. 35). When looking at the whole energy recovery chain of the fossil fuels use, the superior efficiency remains a myth. RE have a much shorter energy recover chain.

There is a number of studies on the national as well as on the European levels[82], which tried to put a price on the environmental and social impacts of electricity use in the EU. The EU ExternE study came to the conclusion that the cost of producing electricity from coal would double and the cost of electricity production from gas would increase by 30 % if external costs such as damage to the environment and to health were taken into account; the damage caused by global warming yet not included. Besides this, before speaking about competitive efficiency it has to be checked if the relevant markets are competitive; the electricity markets, however, are not perfectly competitive, no matter how competitive the supply side of the market may be. In order to have a competitive market there must be equal competition. Yet electricity producers (whose interests lie in selling electricity) and electricity consumers (whose interests lie in using electricity efficiently) do not have equal access to either information or capital. The electricity producers know all about electricity supply while the electricity consumers have little knowledge of how to use electricity efficiently, and little time or money available to find out. Even more crucially, electricity consumers will invariably require a much quicker pay-back on their investments than electricity suppliers. Besides this, it has to be kept in mind that the coal and atomic power sector were and still are highly subsidised. These aspects, inter alia, have to be respected when discussing the competitive efficiency of RE and will mostly lead to the conclusion that the general statement that RE are not (yet) competitive is too simplistic.

Interim results When looking at the current situation we come to the conclusion that it is at least doubtful that these goals can be achieved efficiently by relying on the prevalent

[82]See for example ExternE 1997; Hohmeyer 1989, 2001.

electricity supply system. An overall change in the electricity supply system seems to be inevitable when taking the achievement of these goals seriously. The electricity sector dominated by fossil and nuclear fuel use currently stands at a crossroads: More than half of Europe's operating power plants are over 20 years old and will be decommissioned within the next ten years. The power sector will decide whether this new capacity will be based on fossil and nuclear fuels or the efficient use of renewable energy. Taking this into account the current political decisions and target settings will largely decide whether the energy shift will be achieved or not. Ambitious, legally binding, national targets for RE expansion would demonstrate the EU's long-term commitment to RE, and would enhance investors' confidence significantly.

5.2.2 Goal setting and decision-making procedures

The target setting process is crucial for getting the necessary public support for the further implementation of the targets in an effective and efficient way. The public in general as well as the different actors affected by the resulting measures ideally have to be motivated to achieve the goals. Sometimes in our multifaceted society and especially concerning the protection of common goods it is nevertheless necessary to enforce measures against the will and the (economic) interests of some of the members of the society. This is especially the case when a fundamental change is needed with the consequence that the established companies have to adapt to completely new conditions. In this case, it is of huge importance to have a wide-spread and continuous public support for the goals strived for. Public involvement is needed to keep the political process going and to keep a constant pressure that politicians and the public authorities can rely on when they are executing and implementing the measures to achieve the goals. Public pressure, especially from grassroot organisations and other independent organisations, is also important as an independent control over the (promised) speed and rate of the achievement of the targets.

When it comes to future strategies and goal setting in the electricity supply the processes have thus to ensure a public involvement and participation. The processes have to be organised in a way that guarantees open and participative discourses and exchange of ideas and allow for alternative scenarios. Persons involved in processes and discourses are more willing to accept the results/outcomes as they include parts of their interventions and ideas.

In contrast to this, the current discussions about the future energy supply mostly are only conducted between specialists and do not allow for a broad and interdisciplinary exchange of views and strategies. This proceeding is an element of the prevailing scientific-technical era as characterised by Habermas: The disintegration of the overall coherence into a multitude of single operations that are dealt only by specialised capacities under the aspect of technical or economic problems and detached from values, interests and ideas (Habermas, 1973, pp. 112ff.). In order to create a choice awareness there is need for a general societal debate on the different alternatives for a future electricity supply. It is necessary that all key stakeholders are involved from an early stage in the policy development process and in the formulation of the problems to be addressed. Furthermore, all relevant information should be available and communicated in a clear and accessible form, including information regarding the scientific uncertainties associated with the scientific evidence (Sutherland, 2006, p. 625). In the specific case of RE the political debate deals in most of the cases with the question of an integration into the current system only, without opening the debate to the aspect that a change in the system could be the more suitable solution.

The goal setting process should thus be designed in a way that allows this open debate; the following distinction of different levels of decision-making processes to be passed through successively could be of avail to structure this debate. According to the "three-level-approach" as developed by Ekardt (Ekardt, 2004b, pp. 29ff.), (Ekardt, 2004a, p. 533) these levels are the following:

- the level of the normative decree ("Gebotenheitsebene");
- the level of appraising balancing between the respective normative goal and other principles and goals ("Abwägungsebene") and
- the level named governance or regulation level ("Steuerungsebene" or "Handlungsebene").

On the level of the normative decree the relevant arguments that are arguing for the goal have to be gathered and discussed on their importance. The question behind this level is "What do we want?", transferred to the subject under observation in this paper "Which future electricity supply system do we want?".

The discussion about the transition to a democratic electricity supply system with independent actors and the setting of the ambitious RE expansion target have to be placed on the first level, as these elements contain the normative question which future electricity supply system we want. The conflicting principles and goals touched by this fundamental change have to be discussed on the second level, but not as single economic interests of stakeholders but as part of the competing prevalent electricity supply system as a whole.

The problem is that often these levels are not distinguished or just denied to be existing and thus not passed through. The political process is then restricted to the third level, with the result that the discussion is only turning around the efficiency of the different possible measures and the enforceability. These processes then result in a dead-lock of the path-dependencies and do not allow a discussion on the normative necessity of fundamental changes.

If goal setting procedures simply produce results which are in accordance with the prevailing power relations they are not valid for the whole society. As far as possible, procedures must ensure that the content of the chosen solutions are rational. This is where the communicative basis of Habermas theory plays in, for as there is no a priori blueprint for the best solutions, the issue has to be decided through a deliberate process, where all the involved parties have the same fundamental right to have their voices heard. It is the institutionalisation of such argumentative procedures which ensures the legitimacy of democracy (Eriksen and Weigård, 2003, p. 7).

In Denmark during a relatively long period of time this has been done through an array of governmental and independent alternative energy plans. These reports have been used in a relatively systematic and open public debate. The Ministry of Energy organised conferences, symposia, one-day meetings, etc. in order to further the public debate. At these meetings, the participants were grassroots organisations, the Association of Danish Civil Engineers and different more specific organisations linked to the different types of RE (Hvelplund, 2005a, p. 91), see above under section 4.1.

Granted that the decision on the future electricity supply system will turn out in favour of the democratic and sustainable electricity supply system based on RE and decentralised generation, the effective and most efficient ways to implement this fundamental different electricity supply system have to be found on the third level of the "three-level-approach" as a consequence of this decision. Respective ideas for an optimisation of the RE support and its implementation possibilities are developed in this paper.

5.3 Separation of powers and check of balances

In order to allow for the above described forms of decision-making procedures/target setting processes it is necessary to change the current power structure in the electricity supply system which itself influences the decision-making processes. The dominant energy interest groups influence governmental policies, and by their own activity they determine the nature of the market (Toke, 1995, p. 1). Therefore, the following sections deal with the separation of powers in the electricity supply system. The associated changes in the system address all actors and organisations, so firstly an overview is given on the power structure in the prevalent electricity supply system.

5.3.1 Power structure in the electricity supply system

The following three powers can be identified in the electricity supply systems[83]:

- Market power or buyers' and sellers' power;
- Public regulation power or parliamentarian power and
- (Consumer) Ownership power.

This division has the particularity that it includes the (consumer) ownership power, whereas most of the other models dealing with the powers in the energy sector emanate from the dualistic market and the public regulation paradigm. When looking at Denmark and Germany, however, it is obvious that this power has to be included due to its crucial role it played and still plays in the RE development. Denmark has, as described above under section 2.4.2, a long tradition of consumer ownership in many sectors and especially in the electricity sector and both in Germany and in Denmark the ownership structure of the RE installations is coined by common and private ownership by a multitude of single persons.

Correspondingly to these three powers three types of regulation can be distinguished as illustrated in figure 5: self-regulation, public regulation and market regulation—and most societies are regulated by a mix of all three[84]. Public regulation is the regulation the public authorities are exerting, this can be for example command and control measures but as well the use of economic/market or communicative instruments. Market regulation relies

[83]For this division, see Hvelplund (2001a, p. 73).
[84]For the model of regulation, see Dalberg-Larsen (1988, p. 190).

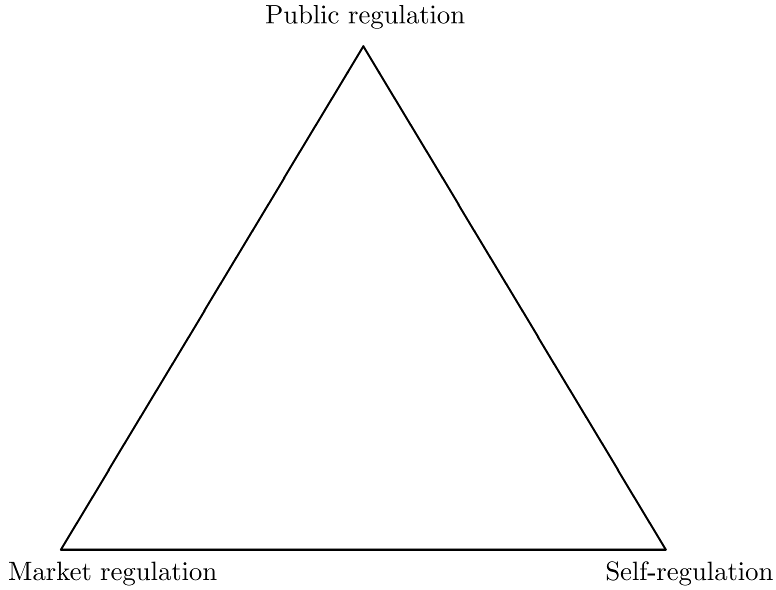

Figure 5: Regulation model

on market pressure resulting of the interactions between the different market actors, such as consumers, suppliers, social groups, private companies etc. Self-regulation is mostly a supplement to public regulation, it can be made as an agreement between the industry and the government or between the industry, the government and a third party, e. g. a public interest group. But in relation to the three powers model, self-regulation also can be defined as the whole complex of self-organising, that is a process in which the internal organisation of a system, normally an open system, increases in complexity without being guided or managed by an outside source and thereby addressing the process how the entities try to maintain a stable and constant condition also in relation to their ownership.

The three powers as illustrated in figure 6 are defined consecutively in the following in order to form a basis for the discussion of their properties, their mutual interferences and finally the elaboration of the need for a change in the power structure or their “separation”.

Market power Market power in general is defined as the ability of one buyer or seller in a market to exert significant influence over the quantity of goods and services traded or the price at which they are sold. A firm usually has market power when it controls a large part of the market. In monopolies it is one seller that controls the entire market; oligopolies are formed by several sellers that each have significant market power and by this are capable to dominate the market. Market power gives the respective actors the ability to engage in

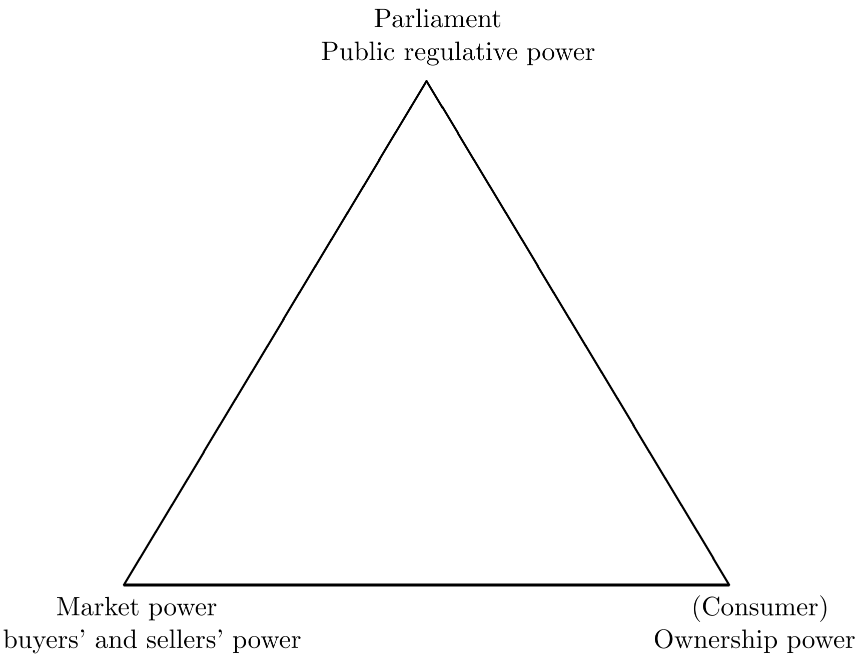

Figure 6: Model of powers in the electricity sector

unilateral anti-competitive behaviour, such behaviour may include incommensurate pricing and creation of excess supply or other barriers to entry for competitors. In the model of a perfectly competitive market, however, market power does not exist.

In the electricity sector, monopolistic and oligopolistic market structures are prevailing, although there has been some changes in the last years due to the liberalisation process. The network, however, is still seen as a natural monopoly, essentially because it makes no sense to have a competing network established (Bausch, 2004b, pp. 39–40). So, the network is the bottleneck and whoever owns it, generally has market power.

Market power allows the respective firms to first charge lowest prices, driving competitors from the market. Once there is no competition any more, the firms can in a second step charge monopoly/oligopoly prices, reducing quantity and social welfare. Besides this the utilities can exert market power by manipulating the network to the disadvantage of competing generators or by asking their competitors disproportionally high conditions and/or charges to access the network.

Public regulation power The public regulation power consists of the public authorities, in the electricity mainly the regulation authorities (the BNA in Germany and Energistyrelsen in Denmark) as well as the government and the parliament. Besides this, there are cartel agencies or competition authorities that are responsible for the control of the electricity tariffs.

Although regulators' objectives differ across countries and sectors, their primary objective is to protect the short-run and long-run interests of consumers by promoting economic efficiency. The most direct way to achieve efficiency is to encourage or mimic competition. However, economic regulation must be used where competition is not feasible, for example, in sectors that have natural monopoly characteristics or in situations where externalities have not been internalised, like it is the case in the electricity sector. Under restructuring and liberalisation, only high-voltage transmission, distribution, and system operation exhibit natural monopoly characteristics. There are several solutions to this problem, including government ownership of the industry, with a mandate to provide adequate output at reasonable prices and private ownership with government regulation to ensure adequate output and a reasonable return on private investment (Rothwell and Gómez, 2003, p. 4). The introduction of competition in the electricity sector requires the separation of competitive from still regulated functions. In most restructuring experiences the transmission grid has been separated in ownership and in operation, from generation companies by creating a regulated transmission owner and operator. Sometimes also new entities are created to control the operation of the interconnected transmission grid. This forms an attempt to prevent a utility from manipulating its grid to the disadvantage of competing generators.

Another key regulatory issue concerning system operation is how to maintain reliable operation under the unbundled structure, regulated, vertically integrated utilities cooperated voluntarily to operate a reliable system by coordinating their resources with neighbouring utilities, knowing that regulated tariffs would cover bundled costs.

The power is exerted through legal obligations set by the parliaments and the respective rights of the regulation authorities to enforce these obligations via investigations, orders, and penalty payments in case of non-compliance.

(Consumer) Ownership power The term property or ownership never indicates what kind of object and what kind of power lies behind it, whether it is restricted to control over things or whether it also gives control over the fate of other persons. Property of the means of production gives power: power over workers, power over the consumers, power over the state (Neumann, 1972, pp. 255–256).

Consumer ownership refers to either a consumer cooperative (direct consumer ownership) or a municipal utility (indirect consumer ownership). It is as such one specific form of public ownership and has to be distinguished from state ownership, that is government ownership of any asset, industry, or corporation at any level, national, regional or local. A consumers' cooperative is a business owned by its customers for their mutual gain. It is a form of free enterprise that is oriented towards service rather than pecuniary profit. The customers or consumers of the goods and/or services the business provides are also the individuals who have provided the capital required to launch or purchase that enterprise. As mutually-owned businesses, each member of a society has a shareholding equal to the sum they paid in when they joined.

Consumer power, through ownership, supplements the overall governance structure in areas where the market and the public regulation display obvious weaknesses: the strongest interests in the market can capture the government, parliament and/or the regulator and markets degenerate into monopolistic or oligopolistic structures (Hvelplund, 2001a).

5.3.2 Separation of powers and check of balances according to Montesquieu

The separation of powers is a model for the governance of the state. Although the doctrine of the separation of powers has it origins in the ancient world, evolved slowly over many centuries and emerged for the first time in seventeenth-century England as a coherent theory of government[85], it was the French political thinker Charles de Secondat Montesquieu who coined this term. Montesquieu thereupon influenced the framers of the Constitution of the United States, who in turn influenced the writers of $19^{th}th$ and 20th century constitutions.

Montesquieu proposed the division of political powers between an executive, a legislature, and a judiciary—as illustrated in figure 7. Under this model, each branch has separate and independent powers and areas of responsibility; however, each branch is also able to place limits on the power exerted by the other branches. In "The Spirit of Laws" he states, that

> "[...]In each state there are three sorts of powers: legislative power, executive power over the things depending on the right of nations, and executive power over the things depending on civil right. By the first, the prince or magistrate makes laws for a time or for always and corrects and abrogates those that have

[85] For the history of the doctrine of powers and institutional theory, see Vile (1998).

> been made. By the second, he makes peace or war, sends or receives embassies, establishes security, and prevents invasions. By the third, he punishes crimes or judges disputes between individuals. The last will be called the power of judging, and the former simply the executive power of the state" (Montesquieu, 1989, pp. 156–157).

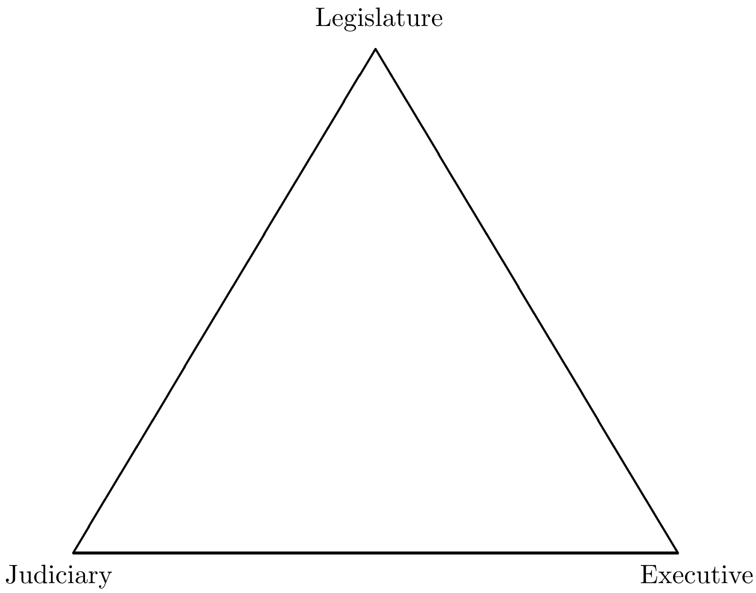

Figure 7: Separation of powers according to Montesquieu

The reasons why a separation of these three powers is necessary, are to be found in the preservation of the political liberty. According to Montesquieu without such a separation the situation would turn out to be as follows:

> "When legislative power is united with executive power in a single person or a single body of the magistracy, there is no liberty, because one can fear that the same monarch or senate that makes tyrannical laws will execute them tyrannically. Nor there is liberty if the power of judging is not separate from legislative power. If it were joined to legislative power, the power over the life and liberty of the citizens would be arbitrary, for the judge would be the legislator. If it were joined to the executive power, the judge could have the force of an oppressor. All would be lost if the same man or the same body of principal men, either of nobles, or of the people, exercised these three powers: that of making the laws, that of executing public resolutions, and that of judging

> the crimes or the disputes of individuals. Observe the possible situation of a citizen in these republics. The body of the magistracy, as executor of the laws, retains all the power it has given itself as legislator. It can plunder the state by using its general wills; and it also has the power of judging, it can destroy each citizen by using its particular wills" (Montesquieu, 1989, pp. 156–157).

Thus, in order to prevent abuse of power, another element has to be respected according to Montesquieu: the system of check of balances within a mixed form of government. The phrase of "check of balances" was also coined by Montesquieu. In a system of government with competing sovereigns (such as a multi-branch government or a federal system), "checks" refers to the ability, right, and responsibility of each power to monitor the activities of the other(s); "balances" refers to the ability of each entity to use its authority to limit the powers of the others, whether in general scope or in particular cases. Keeping each independent entity within its prescribed powers can be a delicate process. Public support and pressure, traditions, and well-balanced strategic positions do help maintain such systems. Checks and balances makes sure not one branch is too powerful.

Montesquieu formulates as follows:

> "Political liberty is found only in moderate governments. But it is not always in moderate states. It is present only when power is not abused, but it has eternally been observed that any man who has power is led to abuse it; he continues until he finds limits. Who would think it! Even virtue has need of limits. So that one cannot abuse power, power must check power by the arrangement of things. A constitution can be such that no one will be constrained to do the things the law does not oblige him to do or be kept from doing the things the law permits him to do" (Montesquieu, 1989, pp .155–156).

From a normative and systematic point of view, a decisive reason for separate branches in state governance is that to enforce its decisions—and execute the law—the judiciary enlists the means of repression provided by the state apparatus. Because it thus has administrative power at its disposal, the judiciary must be separated from the legislature and prevented from programming itself. This explains the principle of binding the judiciary to existing law (Habermas, 1996, p. 172). The separation of executive, legislative, and judicial powers is an important institution in order to prevent the abuse of political power by office holders. The general presumption is that the separation of powers gives voters in liberal democracies a greater degree of control to discipline elected officials. If there is a competition by division of powers among government agencies, society members can not only voice their opinion in the next elections but also exercise an exit option should they be dissatisfied. According to Ekardt (Ekardt, 2004b, pp. 386–387), the separation of powers also has an effect on the discourses in society; possibly leading to rational, impartial and multilevel discourses on the correctness and substantiation of political decisions.

Legislature Under the doctrine of separation of powers, the law-making function is primarily the responsibility of the legislature. However, there are situations where legislation is enacted by other means. These other forms of law-making include referenda and constitutional conventions. The term "legislation" is sometimes used to describe these situations, but other times, the term is used to distinguish acts of the legislature from these other law-making forms.

A legislature is a type of representative deliberative assembly with the power to adopt laws. Legislatures are known by many names, the most common being parliament and congress, although these terms also have more specific meanings. In parliamentary systems of government, the legislature is formally supreme and appoints the executive. In presidential systems of government, the legislature is considered a power branch which is equal to, and independent of, the executive. In addition to enacting laws, legislatures usually have exclusive authority to raise taxes and adopt the budget and other money bills. The consent of the legislature is also often required to ratify treaties and declare war.

The legislature, however, is not entitled to abolish the basic principles of the democratic state, to which belongs inter alia the separation of powers.

Judiciary Under the doctrine of the separation of powers, the judiciary is the branch of government primarily responsible for interpreting the law. The courts are entitled to resolve action conflicts on the statutory basis. The interpretation of law by the judiciary has been contended by some to be law-making, particularly when the judicial branch must address laws that appear to conflict (such as constitutional and statutory law). The extent to which the courts may be seen to "legislate" in this manner informs the ongoing contemporary debate concerning judicial activism (which may be contrasted with judicial restraint).

The judiciary is appointed to control if the laws enacted by the legislature are implemented and executed in a way that the herewith intended goals are achieved efficiently.

Executive The executive is the branch of a government charged with implementing, or executing, the law and running the day-to-day affairs of the government or state. The executive may be referred to as the administration, in presidential systems, or simply as the government, in parliamentary systems. So, in parliamentary systems, the executive is generally comprised of a prime minister, a cabinet and other ministers for specific areas of responsibility.

It is usually the role of the executive to:

- Enforce the law. To achieve this, the executive administers the public authorities, the prisons and the police force, and prosecutes criminals in the name of the state;
- Appoint state officials, including judges and diplomats;
- Administer government departments and public services, including the work of government agencies and similar public bodies and public authorities;
- Issue executive orders (also known as secondary legislation, ordinances, edicts or decrees).

Most constitutions require that certain executive powers may only be exercised in conjunction with the legislature. For example, often the consent of the legislature is required to ratify treaties, appoint important officials, or to declare war.

Also, some countries' laws will empower the executive branch or other government agencies to issue regulations or decrees which can carry the force of law, although this is also generally not considered legislation, per se. Legislation can also be created at provincial and local levels of government (which have their own legislatures), where separation of powers may be less formal and complete.

The principle of the legality of administration clearly brings out the central meaning of the separation and balancing of powers. The institutional differentiation displayed in the separate branches of government has the purpose of binding the use of administrative power to democratically enacted law in such a way that administrative power regenerates itself solely from the communicative power that citizens engender in common. The requirement of statutory authorisation (Gesetzesvorbehalt) has the effect of nullifying regulations, ordinances, agency rules and guidelines, orders and other administrative acts that contradict a legal statute. The priority of law legitimated in democratic procedures has the meaning that the administration does not have its own access to the normative premises underlying its decisions. In practical terms, this means that administrative power may not be used to intervene in, or substitute for, processes of legislation and adjudication (Habermas, 1996, p. 173).

5.3.3 Transfer to the electricity supply system

As has been demonstrated in section 4.2, the dominant electricity companies exert their (oligopoly/monopoly) power on the market and influence the design of the supply system—partly owning the fuel extraction facilities, the generation plants and the transmission/distribution networks—as well as the legal/institutional framework and the public regulation—having a large number of lobbyists with direct economic interests in the prevalence of the current supply system at their disposal. Thus, the three most important powers in the electricity sector are all more or less exerted directly or indirectly—at least influenced—, by the same power groups. Power groups that are not willing and not entitled to control and monitor each other on their activities and its respective boundaries, as long as these activities are not touching their own interests or fields of activities[86].

The idea is to apply the same arguments used for the separation of powers in the governance theory in

1. legislature,
2. executive and
3. judiciary

for a separation of powers in the electricity supply systems in

1. public regulatory power or parliament,
2. (consumer) ownership power and
3. market power or buyers' and sellers' power.

[86] This can be demonstrated by the development in the German electricity sector from the end of the 1990s on (see also section 3.4.2): after an initial strong price competition, that led to an erosion of profit margins and a wave of mergers and acquisitions, the resulting large electricity companies combined to follow a common strategy as what concerns their price policies and positioning in regard to the government.

By this the demand for independent organisations and actors in the different power sectors is strengthened.

The distinction into the three powers in the electricity sector and the respective assignments to the governance powers are not conclusive and one could argue for other divisions or assignments, however, in the following some reasons are given for the specific approach. The division depends on the setting of the system borders and the assignment is made here mainly by looking at the specific tasks each single power fulfils or should fulfil in the borders of the respective three-power constellation.

In order to illustrate and clarify the division and the assignment of the powers the following elaborations are accompnanied by the example of the allocation of CO_2-certificates to the electricity industry and its consequences on the electricity price under a emissions trading scheme.

Public regulation = legislature The parallel between public regulation power and legislature is obvious in the sense that both powers have the functions of preventing the other powers to exploit their goods to the detriment of persons/consumers and organisations that are dependent on the use of these goods and services. Although the regulation authorities in the classical Montesquieu separation of powers could also belong to the executive or the judiciary, the tasks of these authorities in the electricity sector mainly fall within the legislature: The regulation authority sets binding and generally applicable rules for the electricity sector and is accountable to the electricity consumers for its activities and the outcomes of the regulation. Like the parliament as addressee of the legislature, the regulation authority is committed to take care of a balancing of the different powers in the respective sector; to listen to the different arguments and to organise participative processes in which choices/alternatives are made transparent. Like the parliament the public regulation is committed to the achievement of the goals as laid down in the basic law—the constitution for the parliament; the basic energy law for the regulation authority—and is not there to defend single economic interests. The public regulation in the electricity sector thus is to be set as an independent institution; independent from the other two powers in order to be able to regulate their activities committed to the objectives of the basic energy law only[87] as well as control them on their compliance.

[87]According to the German EnWG (2005, § 1 paras. 1 and 2) the most secure, inexpensive, consumer-friendly, efficient and environmentally friendly supply of the general public as possible as well as a regulation that is to secure an effective and unaltered competition in the electricity supply as wells as an efficient and

In the example of the CO_2-certificates, the public regulation authority is responsible for the setting of allocation rules of the certificates to the electricity industry and the respective monitoring of the emissions and check on the availability of the corresponding amount of CO_2-certificates.

(Consumer) Ownership = Executive Ownership in the electricity sector is the power exerted via the possession of the power plants, the network, the fuels, the knowledge etc. With these possessions, the owner on the basis of her property rights can decide on who can use the respective goods, what to do with them and exclude others from using them. Besides this, the owners via the specific use of their physical assets, implement the rules that are set on them from the public regulation authority. In this implementation and enforcement of the legal rules as well as the conferring of exclusive rights as well as the exercise of control on the related institutions and/or assets lies the parallel to the executive power. The executive power for example has the exclusive right to make use of the institution "police" and to exert the control on this institution.

It has to be taken into account, however, that the executive in the governance theory has to implement, enforce and execute the laws in the interest of the society as a whole and based on the respective goals as set down in the respective laws; the executive power has to abstain from following single interests or their own interests. This is where, in the assignment of the executive power to the ownership power in the electricity sector, consumer ownership of the enterprises delivering essential facilities and services—that is the distribution and transmission network—steps in. A transfer to the electricity sector means that the owners of the respective assets have to bring them in and make them work in the interest of society. This is best done via a consumer ownership at least as what concerns distribution and transmission networks; that is an ownership of those, who have provided the capital required to launch or purchase these enterprises.

reliable operation of the electricity supply networks on a long-term basis. The Danish Act on Electricity Supply (2005, § 1 paras. 1 and 2) states the objectives as follows: "[...] to ensure that the electricity supply of the country is organised and implemented in accordance with consideration for supply security, the national economy, the environment and consumer protection. The Act shall therefore ensure consumer access to inexpensive electricity and continue to allow consumers to exercise influence over the administration of the electricity sector's assets. In accordance with the objectives specified in paragraph 1, the Act shall in particular promote sustainable energy use, including energy saving and use of CHP (co-generated heat and power), renewable and environmentally friendly energy sources, shall ensure efficient use of financial resources and foster competition on the markets for electricity production and trade".

This is backed by a specific model of property law—the law in context model: this model stands in contrast to the private law model, which tends to divorce any connection between legal categories of ownership, property and possession, and their socio-economic background (depolitisation), having the effect of making juridical categories, such as ownership and possession, appear as though they are somehow absolute (Doupé and Salter, 1999, p. 76). The private law model is particularly attuned to protecting supposedly "natural" and "inalienable" private property rights of individuals from legal controls that facilitate public sector regulation (Doupé and Salter, 1999, p. 80). The law in context model tends to analyse property law as an instrument for achieving social policy goals (Doupé and Salter, 1999, p. 85) and therefore emphasizes the public good characteristics of property.

As what concerns the example of the CO_2-certificates, the possible mechanisms can be described as follows: according to the rules set up by the regulation authority, the respective owners of power plants decide upon how to take these allocation rules into account. They decide how many certificates they need to acquire, and via production technologies, the type and the quantity of power plants they can influence the amount of certificates needed at the end of the day. Furthermore, it depends upon them who has to pay the additional value of the certificates, e. g. the consumers via higher electricity prices.

Market power = Judiciary The market functions over a constant balancing of supply and demand and by this over interactions of the sellers and buyers; the optimum is reached in the point where the supply and the demand curve cross each other. In Adam Smith's words the equilibrium is reached through the "invisible hand" which describes what is now known as the market-mechanism (Vedder, 2003, p. 21). Via this mechanism the market gives its participants a signal if they are behaving and interacting according to the market rules.

Similarly, the courts as adressees of the judiciary power are entitled to control if the members of the society behave according to the laws and its respective goals; if the judges detect a breach of the laws they will sanction this behaviour on the basis of the existing laws in their judgements.

The market reacts over its participants—the customers and the suppliers—to the rules as laid down by the public regulation authorities. Buyers and sellers act strategically rather than communicatively inasmuch as they make decisions according to their own interests and external market conditions.

The market, however, is "blind" as what concerns normative questions, as for example the allocation equity; and here lies a fundamental difference to the judiciary power. The judiciary power is not entitled to replace the rules that it judged not in line with the constitutional law with own rules, but it has the power to send back the respective non-compliant rules to the legislature in order to get them adapted.

The market in contrary to this can only check whether market participants behave according to the given rules but cannot decide on the compatibilty of a single rule with the overall goals. If the state does not intervene in order to achieve these goals, the "invisible hand of the market" could eventually even destroy community, the environment and human values generally.

If a company does not act according to the rules as set out by the regulation authority regarding the CO_2-certificates, this company might face one of two problems: either it did not incorporate the whole value of the certificates into the retail prices for the electricity produced and, due to the relatively lower price, could sell more than planned. Hence it lacks certificates and has to acquire them at the market. Or the company based its calculations on too high a value of the certificates, leading to higher retail prices and hence lower sales because of relatively higher prices. In both cases, the company in question would have received signals from the respective markets.

5.4 Implementation and consequences of the separation of powers in the electricity sector

In this section an analysis is done on necessary changes in the institutional and political setting as the consequences of the implementation of the separation of powers concept into the electricity sector. The three powers—the public regulation power, the ownership power and the market power—with their specific dynamics and characteristics representing the legislature, the executive and the judisciary as a general rule must be independent and committed to control each other on the correct and responsible fulfilment of their specific tasks in order to achieve an overall optimisation of the electricity supply based on RE and decentralised generation in the public interest.

5.4.1 Public regulation power

The implementation of the separation of powers in the field of the public regulation power could be pursued inter alia by the following instruments:

- guarantee independence through rules that prevent interest conflicts;
- make decisions and regulation processes transparent and public, especially concerning the influence of lobby groups;
- open decision processes for alternatives and create choice awareness by an obligation to commission at least two different and independent studies and/or scenarios when important future decisions are at stake;
- have own scientific knowledge at disposal in the public regulation authority in order to be able to understand the studies and scenarios;
- democratisation of the regulation processes. That is, allow for an involvement of a broad variety of members of the society via the respective participation rules (public hearings, discussions etc.) and
- financial empowerment of independent consumer groups to enable them to buy consultancy support and perform an efficient control of the regulator itself.

These are results of the separation of the public regulation power from the market power as they contribute to break the influential power of the dominant market players on the public political and regulative processes.

Independent public authorities Because of the importance of balancing powers between the powerful electricity companies and the regulation authorities it is essential to ensure independence between the regulator and—on the one hand—other branches of government to reduce the political influence in setting tariffs and allowing entry into potentially competitive industries. On the other hand independence between the regulator and the utilities must be ensured in order to reduce the possibility of maximising utility profits at the expense of consumers by, for example, prohibiting members of the public authorities to be members of the supervisory boards of utilities etc.

The public authorities in general should be regarded as organisations which are able to establish a process of innovative democracy, making it possible for the "majority", which is economically independent of narrow economic interests in the energy scene, to design, choose and implement new technological solutions, if necessary, against the interest of the "minority", consisting of strong and concentrated economic interests in specific fossil fuel- or uranium-based technologies.

Transparency of the decision making processes The public regulation body has to follow a policy of openess with regard to the bases of their decision-making processes. If a specific decision of a public regulation authority does rely on a study or a consultation paper of a lobby organisation then this should be made transparent and public as a supplement to the respective decision.

Creation of choice awareness Public regulation authorities should be obliged with both financial resources and established independent information networks, to obtain a strong and well-articulated "second opinion" on development possibilities. Examples are networks with publicly supported energy offices, that supply public authorities with new and alternative policy options, and make it easier for politicians to make a choice, as they will have a number of differentiated and qualified solutions to choose from.

5.4.2 Ownership power

In the field of ownership power a strict implementation of the separation of powers concept could be implemented inter alia by the following, partly alternative, measures:

- ownership unbundling of grid operation and electricity production and supply;
- creation of an independent system operator that operates the transmission/distribution system and that is independent from all market participants;
- direct consumer ownership of the distribution and transmission grid operating companies and indirect consumer ownership of the municipalities;
- reinvestment obligation of the surplus of these companies (non-profit or consumer-profit organisation) and
- secure common ownership on the local level regarding RE installations via an obligation of the respective investors.

These measures stand for a separation of the ownership power from the power of the prevalent dominant companies on the markets, that resulted in a design of the market mechanisms as well as the overall structure of the electricity supply system to their needs—the needs of a electricity supply system stamped by large central power plants running on fossil fuels and uranium.

Ownership unbundling As it makes sense under the viewpoint of economic efficiency that the transmission and distribution networks remain technical monopolies[88], the most fargoing way of the implementation of the separation of powers is to resocialise the grid. The resocialisation of the grid could be the most promising way to achieve the necessary transition to a RE based electricity supply system in consideration of the existing market structures and the respective ability of electricity supply companies/private grid operators to exercise market power and consequently their unwillingness to optimise the integration of RE, as has been shown in section 4.2. This can be explained by the fact that RE growth mostly means loss of market power of the big electricity companies/grid operators that are not completely unbundled due to the missing ownership-unbundling under the liberalisation of the EU energy markets.

Another possibilitiy is thus an ownership unbundling with a strong public price control authority, as there will be a constant shareholder motivation for trying to achieve monopoly rents: a separate ownership of the transmission and distribution grid operators from other activities in the electricity sector thus is to be made obligatory. Transmission and distribution networks are to be operated under a different ownership than generation/production and supply of electricity; that is, not necessarily state ownership but two different owners of network and generation plants. This will firstly lead to the introduction of competition into this still mostly vertically integrated industry, where transmission grid owners or their subsidiaries typically also own generation power plants and may for example be tempted scheduling transmission maintenance to raise generation prices. Secondly, as the grid operators will no longer act in the interest of their subsidiary generation power plants, the adaptation of the grid to the RE needs will be less rejected by the respective grid operators.

Another question is, if the transmission ownership and the system operation should remain together. Usually, there is a national transmission company that acts as the system oper-

[88] At least for the transmission grid and the largest part of the distribution grids it is much too expensive to build separate, parallel grids; the initiative of building feed-in grids as shown in 4.3 is a sign for the still missing adaptation of the infrastructure to the needs of RE

ator. Defenders of this scheme argue that it is difficult to implement strong performance incentives on an entity (an independent system operator) with no assets and little accountability. Under this scheme, the transmission system's part of the company continues to be regulated through performance-based ratemaking, allowing it to make profit. This level of profitability could be used to reward good performance[89]. Another possibility is to establish a new institution in the form of an independent system operator, responisble for the overall optimisation of the network use. This independent system operator should fulfil the following conditions: a fair, nondiscriminatory governance structure, no financial interests by any power market participant, a single open-access tariff for the entire area, responsibility for system security, system control for pool or bilateral dispatches, identification and resolution of transmission constraints, incentives to act efficiently, transmission and ancillary service pricing that promotes efficiency, transmission availability in real time on electronic bulletin boards, coordination with adjacent control areas and a dispute resolution procedure; these being the prerequisites the U. S. Federal Energy Regulatory Commission requires before approving of a new independent systen operator (Rothwell and Gómez, 2003, p. 108). In any case, it is necessary to discover ways in influencing or forcing the grid operators to see themselves as service providers with the goal of an optimisation and adapting the grid to the respective electricity generators and act accordingly.

Consumer owned and consumer-profit grid companies Consumer power over transmission and distribution monopoly networks can only be exercised by means of consumer ownership control or public regulation. The Danish electricity supply system has been characterised by the successful use of consumership power as control mechanism hindering the development of monopoly profit in the transmission and distribution networks, as well as in the power sector. The pursuit of private profit and power by the distribution and transmission grid operators is not in the interest of the majority of citizens. Thus, these companies should be designed as consumer ownership and consumer profit organisations. The profits of these companies remain with the electricity consumers in form of lower electricity prices. There are no shareholders whose shares drop when the electricity supply market becomes smaller due to a transition to a RE based electricity supply system—and thus the resistance against such a transition would be reduced.

[89]This unified scheme with a single entity as transmission owner and system operator has for example been adopted in the UK, where the National Grid Company performs both activities

RE installations: Common ownership on the local level As has be shown under section 4.1, the common ownership of RE installations on the local level is a crucial element not only to secure public involvement and participation on the local level and by this maintain the public support for the RE expansion, but also to create a variety of owners and entrepreneurs. This is backed by the RE development in Denmark as well as in Germany, where the impetus to start with RE came from single persons interested in experiencing new technologies and thereby bringing innovative elements into the electricity supply system.

This local ownership should be guaranteed by an obligation of the respective RE investors to first ask the local inhabitants if they want to buy shares of the RE installations, then the municipalities and only then be allowed to sell shares to single persons or companies that are not neighbouring the RE installations.

5.4.3 Market power

In the market power field the following measures inter alia could enforce the separation of powers concept and thereby leading to separation of the market power from the ownership power:

- remove all barriers to entry on the markets or at least recognise these barriers as market failures and
- create transparent market mechanisms.

In case of the implementation of the separation of powers, changes in the market institutions are needed. In the classical econometric models there is no such thing as systematical institutional mistake in the economic process. This premise is wrong, it is necessary to see the economy as an institutional economy, where the present situation very probably may not be socioeconomically optimal at all (Hvelplund and Lund, 1998a, p. 15–16). The real market is the market with its specific institutions as they are in reality, regarding private market power, public regulation, the infrastructure, information accessibility, business structure etc. Also the free market premise of the public sector being neutral with regard to the market allocation process is not fulfilled. This has to be recognised as a first step. As a second step the market mechanisms have to be checked on their barriers for newcomers; these barriers have to be made transparent and then step-by-step be removed. The goal is the creation of a market with transparent mechanisms. Market failures, such as the missing internalisation of external costs, have to be addressed and ways have to be found to deal with them—on the market itself or in the field of the other powers.

5.4.4 Public pressure

Only the "right" balance between the three powers—the public regulation power, the market power and the consumer ownership power—makes it possible to pursue the aims of an optimisation of the RE expansion. It is also a necessity that the communication context in which these governing mechanisms are used be endowed with a democratic standards, including extensive public access to information and public participation. In order to achieve ambitious RE goals and the overall optimisation of the RE expansion, however, public pressure is needed, as this fundamental change addresses all actors, being used to the traditional system that might not be motivated intrinsically to go the way of this transition.

6 Conclusions

The main focus of this paper has been the analysis of the political and institutional settings of electricity systems and what has to be taken into account when dealing with changes. The intention was to deliver an answer to the question

> *How can the electricity governance system be optimised politically and institutionally in order to reach the necessary expansion of Renewable Energies?*

In order to achieve this aim, the historical RE development in Denmark and Germany has been analysed as this delivers important hints on what was decisive for the success and what hindered the deployment. It also is important to know who the actors and organisations of relevance are, how they interact and what their interests and motivations are. The analysis of previous experience gave an understanding of the problems encountered in implementing policies to encourage RE development, and the obstacles that prevent the realisation of policy objectives.

Conclusion 1 RE need a fundamental different structure than fossil-fuel or uranium based electricity supply systems. The overall electricity supply system, and especially the political and institutional processes, should be changed in order to facilitate the necessary energy turnover.

Conclusion 2 The transition to an electricity supply system faces resistance from the large electricity companies of the prevalent electricity supply system as they loose parts of their value added to fields where they do not have comparative advantages. Therefore a strong political counterforce and public support is needed.

The theory of path dependency was elaborated on as one reason why the change to an alternative electricity supply system is confronted with barriers and cannot be achieved by only integrating RE into the current structure, as this structure was developed to be used with fossil fuels and uranium in central power plants. Electricity generation based on RES needs a completely different structure as it can be used best in decentralised structures and needs to take into account other criteria for eligibility, for example site efficiency. The therefore necessary fundamental change in the (technical) system will not occur by itself as this change is against the interests of the dominant actors of the prevalent electricity system: The transition to a decentralised electricity supply system based on RES and energy conservation contributes to a growing importance of the equipment market as well as maintenance services and a dwindling in the traditional electricity markets. An increasing part of the value-added is thus allocated at the equipment producers. Thus, currently dominant actors of the electricity supply system are loosing value added and are trying and will try to influence the political process against this transition.

Conclusion 3 As the electricity supply service is an essential good for the society, the related debates on future strategies, goals, and measures to achieve these goals should not be restricted to expert circles but made transparent and public. Alternative scenarios and approaches should be encouraged and debated by involving a broad variety of members of the society.

Conclusion 4 The goal setting process should thus be designed in a way that allows for a participative and open debate. By involving different actors with their ideas, there is a high chance to obtain, on the one hand, a bigger variety of choices and alternatives for future strategies, and on the other hand to gain public support for the hereby resulting goals and the respective implementation measures.

It is not only necessary to achieve the transition to an electricity system relying on RE and energy conservation but also to gain the support of the society for such an alternative system and especially for the transition to this system that goes along with an overall change of electricity consumption habits. From the experiences in Germany regarding the heavy battles that escort(ed) the implementation and use of atomic power we can learn that it is important to involve the society in the decision making process on the future electricity system well beforehand its implementation.

The target setting has to be organised as a participative, open-ended and transparent process. The distinction of the levels of the normative decree, the level of appraising balancing and the implementation level to be passed through successively could be of avail to structure this process. The problem is that often these levels are not distinguished or just denied to be existing and thus not run through. The political process is then restricted to the practical implementation level, so the discussion is only turning around the efficiency of the different possible measures and the enforceability. These processes often result in a dead-lock of path dependencies and do not allow a discussion on the normative necessity of fundamental changes in the electricity supply system.

Conclusion 5 One crucial element in the alternative scenario is the guarantee of common ownership on the local level in the shape of an obligation of the project developer to first give local inhabitants the possibility to commonly buy and own shares at RE installations, before shares are sold to private persons or companies in order to maintain and further the public support for RE installations especially on the local level.

It is crucial to gain the support of the local people towards the RE installations in their neighbourhood and thus confronted with the effects of these installations. This is demonstrated by the fact that in Denmark with its tradition of cooperative-owned RE installations and its generally high public support for RE the atmosphere changed into opposition when the electricity companies tried to install wind turbines without giving the local population the possibility to own shares at these installations. Current results of the research on "acceptance" back this result by pointing out that the NIMBY-phenomenon alone is too simplistic to explain people's behaviour towards RE installations. The analyses are to be completed with aspects whether people do have the possibility to (financially) participate in the RE installations. The ownership involves the development of a positive relation to the respective installations. A side effect of the possibility to own shares of RE installations is that this contributes to an overall awareness raising with regard to the electricity consumption. According to the explanations of Jane Kruse of the Nordic Folkecenter for Renewable Energies (Kruse, 2006) it is common that the members of the wind cooperatives meet at least once a year to discuss the results of their wind turbines, the yearly production and its change over the years, the maintenance costs etc. and by this have a illustrative example how electricity is produced and how much is needed to cover their consumption.

Conclusion 6 The powers in the prevalent electricity supply system consisting of market power, public regulation power and (consumer) ownership power should be separated and be subject to a mutual control on the correct fulfilment of their respective tasks in the electricity supply system. These independent actors and organisations should be committed primarily to the overall system functionality.

Conclusion 7 In order to assure public participation in the overall electricity supply system as well as to prevent the abuse of monopoly power in the sectors of the so-called natural monopoly—the transmission and distribution network—consumer profit and consumer ownership should be implemented. It can be expected that the resistance against the transition to a RE based electricity supply system of these consumer-owned companies will be much weaker than the one exerted from shareholder owned large companies.

This is a result of the transfer of the concept of the separation of powers to the electricity supply systems—the ownership power representing the "executive" and the market power representing the "judiciary"—and stands for a true liberalisation defined as consumer control via purchasing power. Besides this, this conclusion is backed by the experiences in Denmark with its consumer owned distribution companies. The profits of these companies remain with the electricity consumers in form of lower electricity prices. There are no financial shareholders whose shares drop when the electricity supply market becomes smaller due to a transition to a RE based electricity supply system.

The influence that consumers can exert on corporations through their own market interactions, or the buying and selling of their goods, services, or even shares, has a limited extension only, and organisation of collective consumer action is difficult in a market economy. The theoretical possibility of the state interfering for the benefit of the public is unlikely—more often it is the other way around. Being huge agglomerations of economic power, large corporations tend to interfere with the decision-making of states by lobbying for legislation and policy that suits their interests, or by financing huge propaganda campaigns for the success of some political candidate who would support the corporation's interests. The pursuit of private profit and power by these kinds of corporations, however, is not in the interest of the majority of citizens. Thus, corporations should be designed as consumer ownership and consumer profit organisations.

To sum up, the research question can thus be answered as follows:

A democratic sustainable electricity supply system that builds on

- a fundamental different structure than the fossil-fuel or uranium based electricity supply system;
- a political force willing to lead public debates that allow for alternative future scenarios and thereby create choice awareness;
- participative and transparent decision-making and target setting processes involving a great variety of members of the society;
- economic participation of private persons in RE installations through common ownership on the local level;
- electricity companies, especially distribution and transmission grid operators, designed as consumer ownership and consumer profit institutions;
- a general separation of market power, public regulation power and consumer ownership power and a mutual control of these powers on the correct fulfilment of their respective tasks

facilitates the achievement of the necessary RE expansion.

The results of these changes are illustrated in figure 8, the adapted figure of the macro- and microstructure of the electricity supply system: The possibilities of the prevalent electricity companies to exert an influence on the design and the structure of the electricity service supply system and the technological and institutional scenarios (as symbolised by the arrows in the figure 4) are no longer there or at least significantly reduced. This has its reasons in the following changes: In the value added chain the fossil fuel and uranium value-added part disappeared and is replaced by investment in RE capital equipment; besides this, the power production value-added is replaced by"RE system automation". The consumer level is much more important, as responsible for conservation and RE by itself and by owning shares of RE installations. The different organisations are committed to their respective tasks, as distribution, transmission of electricity or overall system operation and no longer bound by the interests of their subsidiary companies in the generation sector.

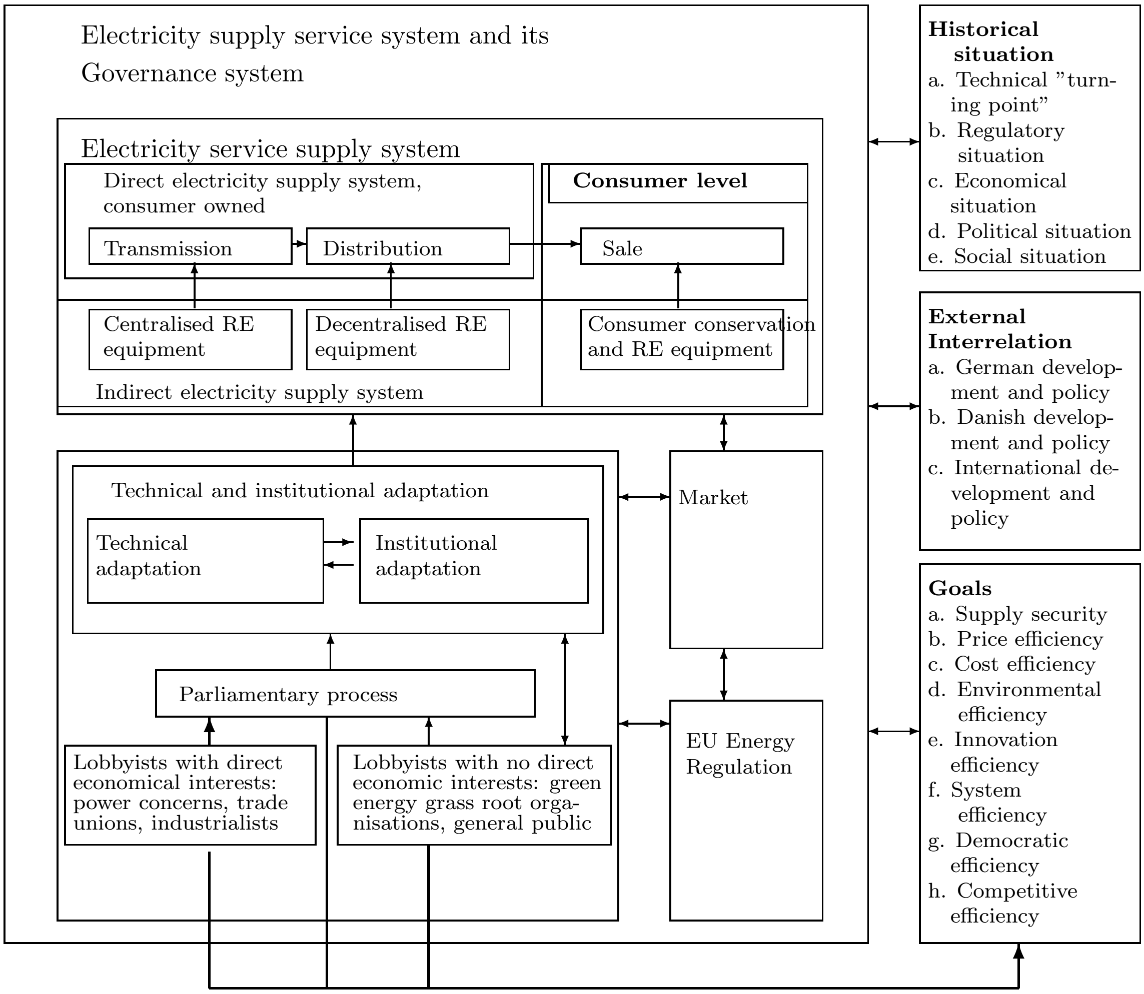

Figure 8: Alternative scenario: adapted macro- and microstructure

7 Limitations and outlook

As mentioned above, the challenge when dealing with the electricity supply system with its complex interlinkages between the technical, the economic, the legal, the institutional and the political fields of action is to avoid "muddling through". The strategy to deal with the complexity was to concentrate on the elaboration of a political and institutional scenario and hereby focusing on two essential aspects: the transfer of the separation of powers into the electricity supply system and the democratisation of the target setting and decision making processes.

The transfer of the concept of separation of powers into the electricity supply system with its respective assignments as well as the division of the three powers itself face several limitations and is not absolute. A further discussion of a specific concept of separation of powers for the electricity suppply system and its implementation might result in diverging divisions and assignments.

The crucial question if and how the elaborated scenario, once completed and implemented, can survive under the pressure of "liberalisation" is material for further research. One solution might be to interpret this term as asking for full transparency and in that way enabling the consumers to buy the best and cheapest products.

The check of the proposed political and institutional changes on their compatibility with national, European and international law might could also form the basis for further research.

All in all the elaborated cornerstones need more building blocks, while avoiding existing stumbling stones, to form the fundament of the democratic future electricity supply system based on RE in basically decentralised generation and energy conservation.

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Erklärung:
Hiermit erkläre ich, dass ich die vorliegende Arbeit selbständig verfasst habe und keine anderen als die angegebenen Hilfsmittel und Quellen verwendet habe.

Berlin, den 30. Oktober 2006

Mit der Weitergabe meiner Master Thesis durch die Universität Koblenz-Landau an Dritte (z. B. Bibliotheken, Behörden, Unternehmen, interessierte Privatpersonen) erkläre ich mich nicht einverstanden.

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