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Innovative Democracy, Political Economy, and the Transition to Renewable Energy. A full-Scale Experiment in Denmark 1976-2013

Frede Hvelplund
Department of Development and Planning, Aalborg University

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Position paper
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The period 1976-2002 can be regarded as the first phase of renewable energy and conservation (REC) development, as the REC technologies were still a supplement to energy systems mainly based upon fossil fuels (here named FFU technologies). In this first phase of the Danish development, a ”Green energy cluster” consisting of renewable energy technologies such as wind power, solar energy, and biomass and energy conservation technologies was developed. This development was implemented despite a systematic resistance from the Ministry of Finance, the industrial establishment and the established fossil fuel-based power companies, which regarded the new "Green energy technologies" as competitors to their large power plants based upon coal and oil. Independent lobbyists such as energy grass roots organisations, new companies within the green technology cluster and some active politicians were able to give political momentum to a development of a spectrum of green energy technologies. This process of organisations independent of existing economic interests being given democratic influence is here defined as the innovative democracy process.

In the period 2000-2013, Denmark entered a second phase with REC technologies substantially increasing their share of the energy supply and on their way of becoming the main energy technologies.

Meanwhile from 2002- 2008, a right-wing government lead by Anders Fogh Rasmussen (AFR) closed down innovative democracy process and a "non-policy" relying on existing market actors and existing market conditions was implemented. In this period the development of renewable energy was almost brought to a halt.

But in 2008 AFR made a political u-turn, and declared his support to a 100% Renewable Energy future.

In 2012 a new center left Government made an energy plan with the goal of 100% Renewable Energy in 2050. This goal was supported by a large majority in the Parliament in an agreement in 2012.

The conclusion of this paper is that both in the first phase of renewable energy development, and in the second phase, "market conditions" are political constructions. As the competition between FFU and REC technologies is becoming more tough in the second phase than it was in the first phase, there is an increased need for a strong innovative democracy process in order to avoid REC technologies being pushed back by strong FFU organizations now fighting for market survival. In addition to this, the character of the second phase development entails a need for a new infrastructure at the consumer level that can handle an increasing amount of fluctuating REC technologies. Therefore, a successful second phase transition from FFU to REC energy technologies requires an introduction af a second phase innovative democracy process with increased ownership shares of wind power capacity by consumer- and municipality owned cogeneration plants. In that way the owners of the wind power integration infrastructrure such as district heating systems, heat storage facilities and heat pumps will be given a part of the responsibility of integrating "their own" wind turbines in the power and heat grid systems. Furthermore there still is a need for independent NGO commitment and financially empowered participation from groups that are independent of the FFU organizations.

1. Transforming Renewable Energy and Conservation (REC) from Supplementary to Main Technology

The development of renewable energy and energy conservation (REC) technologies in Denmark from 1976-2013 is interesting, because two models of political economy have been competing at a time when the Danish energy system is undergoing a transformation. REC systems have increasingly shifted from being minor energy alternatives to becoming the main technologies, while fossil fuel energy systems are increasingly becoming the supplementary options.

Danish development of REC systems can be divided into two phases:

- During the first phase, from 1976 to around 2002, REC technologies were supplementary to energy systems mainly based upon fossil fuels. In this first phase, a "green energy cluster" consisting of renewable energy technologies such as wind power, solar energy, biomass and energy conservation technologies were developed. Furthermore, the remarkable success of REC development in this period can be credited to the innovative democratic public regulation approach, which characterized this phase.
- The second phase, from 2002 onward, has been marked by fossil fuel based heat and power production increasingly becoming supplementary to fluctuating renewable energy technologies. In this period, it is important to not only support the implementation of single REC technologies but also to establish an infrastructure that supports increasing amounts of fluctuating energy sources, such as wind, wave and solar power.

During this same period, a right-wing government, led by Prime Minister Anders Fogh Rasmussen (AFR), removed financial support from REC technologies and replaced the former innovative democratic policy with a neo-liberalistic energy policy, relying predominantly upon "market tools" such as CO_2 trading, Clean Development Mechanisms (CDMs) and Joint Implementation (JI). After six years, AFR made a political U-turn in 2008 and admitted that his policy had been erroneous and that the government had suddenly incorporated a 100 percent renewable energy policy goal. Until 2011 this political goal was only incorporated into an active policy to a very modest degree and the policy still was neo-liberalistic and relying heavily on market tools embedded in the present institutional settings. In 2011 a new center left Government came into power. In 2012 they introduced a set of clear policy goals, such as 100% renewable energy supply in 2050, no fossil fuels for heat and electricity in 2035, 50% wind power of electricity consumption in 2020, and 40% reduction of CO2 emission in 2020, seen in relation to the 1990 emission. It still in 2013 has to be shown that a sufficient policy to pursue these goals will be implemented.

In summation, Denmark is in the initial stages of the second phase of REC development, with:

(a) a need for further expansion of REC technologies.
(b) a need for the development and implementation of a new infrastructure that can integrate large amounts of fluctuating REC technologies.
(c) a neo-liberalistic energy policy that relies mainly upon present market actors and the present institutional market construction.

Presently, important questions to consider are:

(a) to what extent can the experiences regarding market and public regulation from the first phase be used to support the second phase of development and
(b) what new types of markets and public regulation amendments will arise as REC technologies start to replace fossil fuel based energy technologies? And in general: Will the neo-liberal approach be able to manage this transition from first to second phase or will it be necessary to reintroduce a version of the innovative democracy regulation model from the first phase of development?

To answer these questions, it is necessary to analyze both the characteristics of the technological change that is currently underway and public regulation from the period 1976-2002. Following these analyses, the policies required to further develop REC technologies in the second phase of development will be explored.

2. The Radical Technological Change from Fossil Fuels and Uranium to Renewable Energy and Conservation

When examining Danish energy planning development, all political and economic theories behind the energy policies must be considered in relation to both the type of technological change in question and the concrete politically designed institutions and market conditions present at the time (Hvelplund 2005a),(Hvelplund 2001a).

Therefore, it is problematic that neo-classical economics and its proponents neither distinguish between different technologies nor analyze the different characteristics of the various political and economic processes of technological change. Neo-classical economics considers technology to be purely capital and claims that technological change only occurs when new technologies are competitive in the marketplace. In this paradigm, companies are simply regarded as identical "dots" in the market; all behaving rationally and in the same manner. In neo-classical economics, various motivations within different companies are not at all taken into consideration.

Contrary to this, one should distinguish between the inherently diverse motivations and motivational structures of different companies and also explore the various aspects of different processes of technological change (Hvelplund 2001a). To accomplish this, the terms *technology* and *technological change* must first be defined.

For the analytical purposes of this chapter, technology is defined as consisting of technique, knowledge, organization, product and profit and technological change occurs when at least one of these five areas is changed considerably. *Radical technological change* is defined as a situation where at least two of these five areas are changed considerably.

In the first phase (1976-2002), an array of REC technologies was developed. The cost of electricity generated from wind power, for instance, was reduced from 25 Eurocent per kWh (kilowatt hour) to around 5 Eurocent per kWh. Wind power was introduced by new organizations such as cooperatives, where those neighboring the wind turbines invested in the ownership of the turbines, thus keeping profits within the locality instead of seeing them disappear to distant power companies. This was a new innovation that was to a large extent owned by new organizations, profited new owners and required the use of new knowledge and technology. Thus, it was classified as a radical technological change. Although the share of wind power was still relatively low during this phase one should bear in mind that the "product" was a fluctuating one and therefore unlike fossil fuel based products.

In the second phase (from 2002 onward),"fluctuating energy" has become an important characteristic, as wind power now covers 20 percent of electricity production in Denmark and is projected to cover 50 percent by 2030. During periods of maximum production and low consumption, wind power already 2013 accounts for more than 100% percent of all electricity consumption in Denmark, and will be expected in several hours per year to produce 200% of Danish power consumption in 2020. Therefore, it is necessary to introduce an infrastructure that is able to manage large amounts of fluctuating energy. Among other things, this infrastructure should encompass such technologies as flexible cogeneration units, heat pumps with heat storage and electrical cars. If these technologies are introduced, it becomes possible to incorporate considerable amounts of wind power into the market without the need for additional power storage systems (Lund 2009).

3. The Character of the Technological Change from Fossil Fuel Based to "Green Energy" Technologies

To understand the distinction between various types of technological change and how they relate to different energy companies, the concrete characteristics of the alterations must first be described.

The main alternative to FFU based energy is a combination of electricity and heat conservation, renewable energy and cogeneration technologies. Some of the discrepancies between these new REC technologies and the traditional FFU technologies are described in Table 1.

Table 1. Some public regulation consequences of changing from FFU to REC technologies

Character of change from fossil fuel and uranium (FFU) technologies to renewable energy and conservation (REC) technologies.	Consequences of the change
From scarce stored energy sources to abundant fluctuating energy sources. Increased long term- and reduced short term security of supply.	Reduced need for strategic security policies linked to energy supply. Increased need for infrastructure that integrates the fluctuating energy sources. Increased need for coordination of supply and demand side (Smart energy systems).
From CO_2 polluting technologies to zero CO_2 technologies imposing visual- and noise impacts on local residents.	Reduced need for green house gas abatement activities. Increased need for solving concrete local REC visual and noise impacts.
From solutions that are independent of local environmental context to technical solutions that are dependent on the local environmental context.	Need for a bottom-up public regulation approach adapting REC technologies to their specific local ecological and sociological conditions.
From grid based Electricity Infrastructural Systems (EIS) to EIS based upon grid systems in combination with integration technologies such as heat pumps, electrical cars, etc.	Need for development and implementation of a new electricity infrastructure with electrical cars, heat pumps, heat storage systems etc.
From capital intensive with long technical lifetime embedded in existing supply organisations to very capital intensive technologies also linked to new organisations.	Need for stable prices when selling electricity to the grid, enabling new and financially weak local organizations to borrow money and consequently invest in REC systems.
From economically and politically strong to economically and politically weak technologies.	Need for an "innovative democracy" political approach that gives influence and power to actors that are independent of FFU technologies.
From relatively few concentrated large power plants to many visible and distributed REC activities.	Need for local and regional influence upon the location agenda and ownership of REC plants.

The above mentioned characteristics of the REC and FFU technological alternatives indicate a change in technological paradigm from scarce, stored energy resources to abundant, fluctuating energy sources and from technologies that are independent of local, natural conditions to technologies that are dependent upon environmental conditions. The transformation also indicates a change from economically and politically well established technologies, to economically and politically vulnerable ones.

In the seventies and eighties, few people were employed in the Danish wind power industry. The industry, therefore, had no membership in the Confederation of Danish Industries nor any support in the Danish trade unions. Consequently, there was resistance against wind power both from the Confederation of Danish Industries and from the metal trade unions, as these organisations strongly supported building new coal fired plants. Nevertheless, despite resistance from these strong organizations, institutions and regulations supporting wind power were established during this time period, largely due to the activism of renewable energy NGOs.

Since the 1970s, the above mentioned situation of change from conventional FFU- to REC technologies have resulted in a multi-faceted FFU economical and institutional path dependency, where new technologies mostly meet tough resistance from FFU companies and their support organizations in both, phases 1 and (Hvelplund 2005a).

This resistance to innovative technologies has been continuous in Denmark during the last 25 years and is further substantiated in the succeeding discussion of the changes in profit and value added when adjusting from FFU to REC technologies (Hvelplund 2005a), (Lund 2009).

4. The Value-Added Chain and the Transformation from FFU to REC Technologies

Contrary to neo-classical economic theory, the main understanding in this chapter is that the motivation for developing and implementing new technologies varies from company to company. Furthermore, this variation, in addition to the differences shown in Table 1, is also a function of the cost and value-added structure described below and referred to as the profit component, in Figure 1.

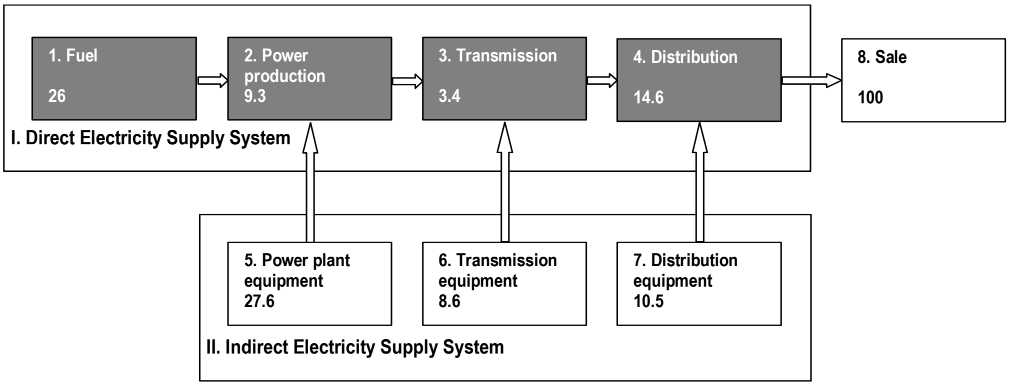

Fig. 1. Value-added distribution in a coal fired electricity system[1,2]

[1] *Source calculated on the basis of SØ89-112, 10 April 1989 ELSAM, Statistic 1991, DEF, and Statistisk tiårsoversigter 1980-1989. The cost distribution between production and transmission is calculated on the basis of SØ89-112, ELSAM. In this calculation, an interest rate of 1 percent is used, which was the inherent interest rate in the cost structure at that time. With a higher interest rate, the indirect electricity supply system would have a higher proportion of the 100 value-added units.*

[2] *It is worth remarking that future electricity systems with no fuel consumption will, all other things being equal, have a higher proportion of the value-added chain within direct and indirect power production, transmission and distribution. Furthermore, it is probable that a higher proportion will be in the indirect electricity system.*

The value-added chain of FFU systems

The question to consider is: What are the general value-added characteristics of the present fossil fuel and uranium based electricity supply systems, which at present control between 80 and 90 percent of the world's electricity market? Answering this question is crucial, as the FFU system must, to a large extent, be replaced with renewable energy and energy conservation systems within the next 20 to 40 years. Figure 1 illustrates the value-added flow in a typical FFU system, as it was in Denmark in the mid-nineties. In this case, it is represented by the Danish system and is based upon large coal fired power plants. It should be noted that the data has been extracted from the Danish system in 1989-1990, when the whole value chain was still a non-profit system. The Danish power and distribution system was a consumer and municipality owned non profit system from 1920-2004, when the power plants were sold to Vattenfall and DONG.

In this FFU electricity supply system, electricity is delivered to the consumer for 100 value units (100 DKK, for example). In a non-profit system, this is the consumer price of electricity. Looking at I, the Direct Electricity Supply System, it can be seen that out of 100 DKK, 53.3 DKK is paid to the direct electricity supply system as a whole, with 26 DKK disbursed for coal, 9.3 DKK paid to the employees at the power plants, 3.4 rewarded to the employees of the transmission system and 14.6 paid to the employees of the distribution system. Thus, of 100 DKK, a total of 27.3 DKK is paid to the Danish employees of the direct electricity system.

Looking at II, the Indirect Electricity Supply System, a total of 46.7 DKK is disbursed to the indirect electricity supply system. Of this amount, 27.6 DKK is paid to power plant equipment producers, 8.6 DKK to producers of transmission equipment and 10.5 DKK to producers of distribution network systems.

The Value-Added Chain of REC Systems

The present Danish electrical system includes wind power production, as well as some development of biomass and waste based electricity production. Forthcoming developments will probably also include the extensive use of photovoltaic and wave energy based electricity production. Furthermore, there is a political agreement to increase the wind power capacity to around 30% wind power in 2012 (21 February 2008 agreement). The increased utilization of wind power will require the introduction of regulation facilities that will synchronize wind power production with consumers' consumption needs. But what are the typical value-added characteristics of these "new" non-fossil fuel and non-uranium technologies? Figure 2 attempts to answer this question. It should be underlined that this value-added profile can be implementet with the needed intermittency infrastructure consisting of an integration of the heat, electricity and transportation markets (Lund 2009, and Lund 2009b).

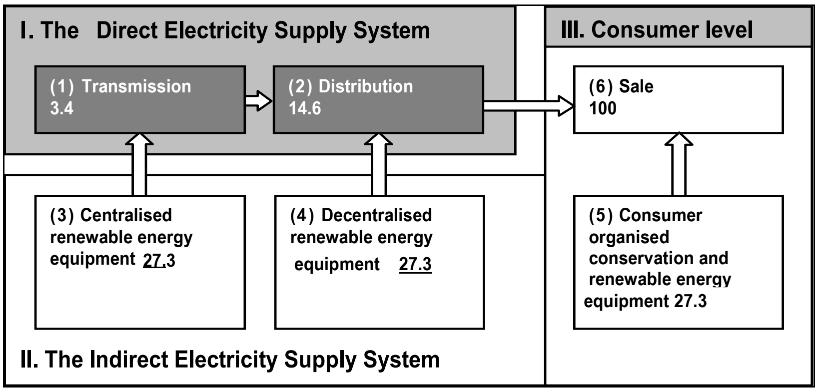

Fig. 2. An example of a value-added chain of future renewable energy and conservation systems [(1) ; (2)]

[1)] Source calculated on the basis of SØ89-112, 10 April 1989 ELSAM, Statistic 1991, DEF, and Statistisk tiårsoversigter 1980-1989. The cost distribution between production and transmission is calculated on the basis of SØ89-112, ELSAM. In this calculation, an interest rate of 1 percent is used, which was the inherent interest rate in the cost structure at that time. With a higher interest rate, the indirect electricity supply system would have a higher proportion of the 100 value-added units.

[2)] It is worth remarking that future electricity systems with no fuel consumption will, all other things being equal, have a higher proportion of the value-added chain within direct and indirect power production, transmission and distribution. Furthermore, it is probable that a higher proportion will be in the indirect electricity system.

The assumption is that the renewable energy system can produce energy at the same price while using the same transmission and distribution grid as the current FFU system. This will be achievable if the necessary infrastructure to regulate the fluctuating REC energy system is in place. A further assumption in this example is that the renewable energy technologies are distributed in such a way that one-third of the indirect electricity supply system will be linked to the central transmission level, one-third to the decentralized distribution level and one-third to the household level.

The characteristics of the value-added change from FFU to REC energy systems can be described by combining Figure 1 with Figure 2.

Figure 3 illustrates the consequences of establishing such a transition.

It should be underlined that there also is a change in infrastructure in the figure 3 transistion (Lund 2009).

In the traditional fossil fuel based power system, a 100 DKK sale at the consumer level will divide the value added cost between the different levels of vertical integration, as shown in the figure 3.

The bottom figure demonstrates an example of a the value-added distribution in an energy conservation and renewable energy system.

Figure 3 illustrates that the value-added chain of REC technologies clearly differs from the value-added chain in an FFU based system within two areas:

a. In the REC value-added chain, the fossil fuel resource value has disappeared and has been replaced by investment in renewable energy capital equipment.
b. In the REC value-added chain, the power production value in a specific direct electrical supply system organization has been replaced by "renewable energy system automation."

In this system, the maintenance functions, at least at the decentralized and consumer levels, will be performed by the manufacturers of windmills, solar cells, wave energy plants, hydrogen production systems, the electricity battery charging system, etc. The need for a specific power production organization will be reduced considerably or disappear entirely as the day-to-day work on the power plant has been replaced by automatons requiring maintenance from the manufacturers of the single technologies in the REC energy system.

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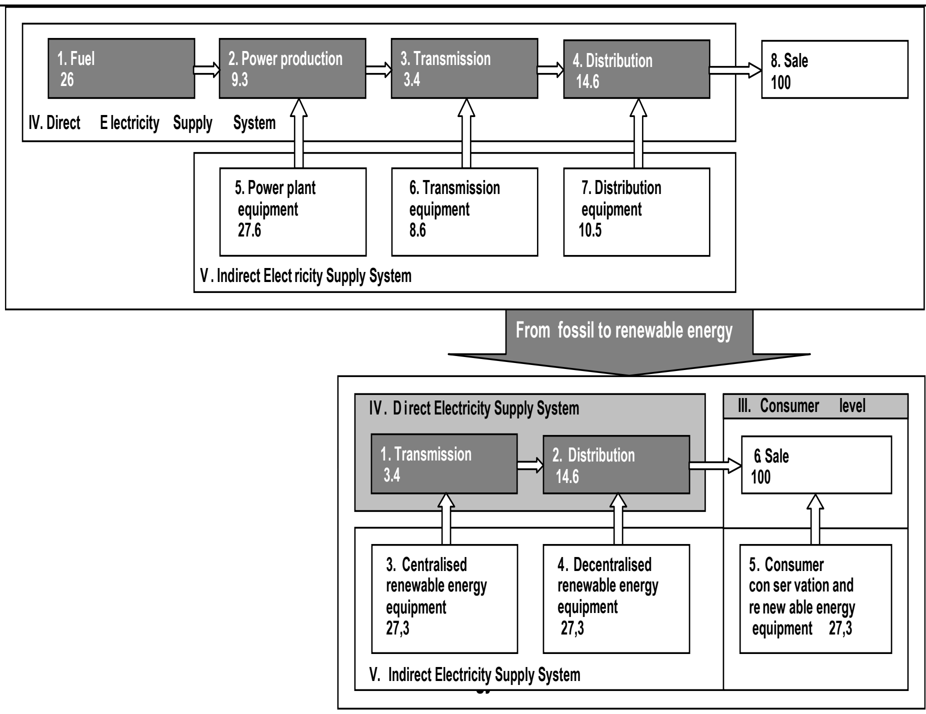

Fig. 3. The change in value-added profile connected to a change from FFU to REC energy systems

Naturally, it is possible that the existing power companies will take over some of the maintenance functions of the renewable energy automatons, especially those connected to large, offshore wind power plants. But even then, the added value directly linked to the power sector will be halved compared to the value-added in an FFU system. Only by directly purchasing the actual factories producing renewable energy equipment will the power companies be able to maintain their present value-added level.

Therefore, the combination of points (a) and (b) may reduce the direct electricity supply system until it only consists of the transmission organization and the distribution network organization. As the transmission system in Denmark is owned by the state owned organization, Energinet.dk, almost no value-added would be assigned to the power production organizations, DONG and Vattenfall.

Consequently, a main characteristic of technological change, as illustrated in Figure 3, could be the increase of the share that the indirect electricity supply system consists of the whole value added in the electricity system. In Figure 3, the indirect electricity system linked to power production, transmission and distribution increases from 46.7 percent of the total value added in the FFU system to 81 percent of the added value in an REC system. This is primarily due to the fact that fuel import is replaced by REC energy equipment and capital.

In an electricity system like the German one, with ownership integration of fuel extraction, power production, transmission and distribution, the value-added share would decrease from 50-60 percent of the price of electricity to around 20 percent, if a 100 percent REC energy system is introduced. As the above example deals with the Danish non-profit system, the costs are equivalent to the price, and includes no profit. If, however, a renewable energy monopoly is established, this reduction in value-added share will likely be off-set by the establishment of high prices. If a monopoly is not established, a shift to 100 percent renewable energy will significantly reduce the profit base of the FFU energy companies, due to the considerable reduction in value added shares.

In an electricity system like the Danish one, a change from FFU to REC systems would result in a considerably lower value-added reduction; namely, from approximately 27 percent to around 18 percent of the price of electricity**.** But as electricity transmission is presently managed by government controlled organizations and the distribution network principally by municipal and cooperative organizations, the value-added share assigned to the power companies is reduced by an even greater degree - in some cases to almost zero.

From the above discussion, it can be concluded:

a) That due to the differences between the institutional characteristics of FFU and REC technologies, the FFU based energy companies encompass internal, economical and organizational resistance against REC technologies (Table 1). This resistance first emerged in the seventies.

b) That companies based on FFU energy systems are rapidly losing market shares in the transformation from FFU to REC technologies. Since the FFU companies have no comparative advantages in regards to REC technologies, they cannot expect to achieve 100 percent of the market shares for the technologies. The power companies also have a comparative disadvantage in regards to maintenance functions concerning REC technologies.

c) Even if the FFU companies could attain100 percent of the REC technology market shares, they would lose in value-added, as the value-added share in the direct electricity system is heavily reduced in the transformation from FFU to REC technologies.
d) That FFU companies have invested in traditional power plants and will lose portions of these investments in the transformation from FFU to REC energy systems.
e) That a successful transformation to REC technologies will therefore result in massive reductions in the share values of present FFU companies.

Thus, a transformation from FFU to REC energy systems will result in a considerable transfer of jobs and profits from the FFU companies to the actors within the REC energy systems. Therefore, the transformation from FFU to REC technologies represents a win/lose situation at the company level, where the FFU companies will "lose" and the REC companies will "win." Consequently, the political system should be aware that a transformation to REC energy systems, which in the Danish case has represented a win/win situation at the societal level with regards to jobs and economic welfare, will meet very strong and systematic resistance from the FFU companies (Hvelplund 2005a), (Hvelplund 2001a), (Lund 2009).

Consequently, the general political problem is manifested in a transformation where the politically and economically strong should lose and the politically and economically vulnerable should win. Politically, this is a difficult change. How should the political process then be designed in order to cope with such a challenge? This question is focused upon in the preceding section.

5. Public Regulation, Economic Paradigm and the Transformation from FFU to REC Technologies.

The established associations in the market neither have the organizational comparative advantage nor the economic interest to invest in new REC technologies. Historically, in Danish development, traditional FFU companies have worked against the introduction of REC technologies during the period from 1976-2002.

Considering this long period of resistance, it is imperative to analyze which type of public regulation and thus political and economic paradigm would be the most efficient to advance the change from FFU to REC technologies.

In order to understand some of the underlying forces behind Danish energy policy, it is important to be aware that the construction of a concrete market design has occurred in a political setting consisting of various ministries, different lobby groups and a specific power balance within the Danish Parliament. Furthermore, these actors all have different political economy paradigms - in their beliefs about how the economy functions. The conflict has historically been and continues to be, between different interest groups, each with their own understanding of political economy. The "interest groups" that have been important in the studied time period are: The Ministry of Finance, the Ministry of the Environment, the Ministry of Climate and Energy, the trade unions, Danish Energy Association (mainly FFU-based energy production), the political parties and the green NGOs. As previously mentioned, these groups can each be associated with their own paradigm of political economy, which they employ to argue their case.

The contending political economy paradigms have been and still are:

a. The neoclassical approach,
b. The concrete institutional approach and
c. The innovative democracy approach.

The Neoclassical Approach

In this approach, there is usually no direct support for REC technologies and the general attitude is that new technologies should enter the market when they are ready to be competitive. However, this approach acknowledges that there are external environmental costs and that these should be internalized in the energy prices via carbon quotas. The public regulation tools linked to this paradigm are CO_2 caps and trade systems, Clean Development Mechanisms (CDMs), some CO_2 taxation, etc. All these tools influence the development of REC technologies by influencing the price in existing markets.

Comment: In box 2 all five technology components: *technique, organization, knowledge, product and profit* are changing, which is symbolized by the five balls changing color from grey to green.

Source: (Hvelplund 2014).Fortcoming book on Renewable Energy and Innovative Democracy , and (Mendonca et al, 2009).

This approach is generally the paradigm adopted in econometric models and in the policy suggestions from the Ministry of Finance and is used in arguments by Danish Energy Association and right-wing political parties in the Danish Parliament. Clearly, fragments of this paradigm are employed by other actors, as well.

In this approach, the role of the Danish Parliament is to maintain order in the free market institutions and the role of a climate and energy policy is to make sure that the external costs of energy production are internalized in the market prices. This is illustrated in Figure 4. Once the market is considered to be functioning in accordance with the free market institutions, the outcome of the market process is regarded as representing an economic optimum. In this approach it is assumed that the economy is in an optimum, and an energy policy should simply be regarded as a policy where a few “market failures” are corrected. One of these failures is that environmental consequences, such as climate effects from greenhouse gases are not automatically internalized in the market prices.

Thus, an energy and climate policy only consists of an internalization of these external costs by means of a system of CO_2 taxes, CO_2 trading and CDM and JI market tools. This is mainly achieved by applying the “Grandfathering Principle” where established energy companies are awarded a free CO_2 quota that provides them with a financial advantage, compared to newcomers on the energy scene. The theory is that if these tools are successfully introduced into the market (Box 3, Figure 4), then societal goals will be achieved automatically through this well-functioning market. In Denmark, this way of thinking has been dominant in several strong institutions since 1974, and the Ministry of Finance, for example, has always advocated this paradigm. The Danish Ministry of Finance and the Danish Economic Council do not systematically examine the character of required technological changes. According to the paradigm of this economic school of thought, all companies behave identically in the market and the motivation for developing new technologies is the same for all companies, regardless of their present activities.

But in long periods of time, there was a majority in the Parliament that did not accept this way of understanding economy. Because of this, all existing wind power-supportive institutions, as described below, have been introduced despite resistance from strong proponents of the neoclassical approach.

The Concrete Institutional Approach

This is a technocratic approach, which realizes that merely applying a neoclassical approach to energy planning is too simple. It thus recognizes that the market is embedded in an artificial, concrete, institutional setting that can be modified by men. However, this approach does not go into details regarding the various motivations of FFU and REC companies.

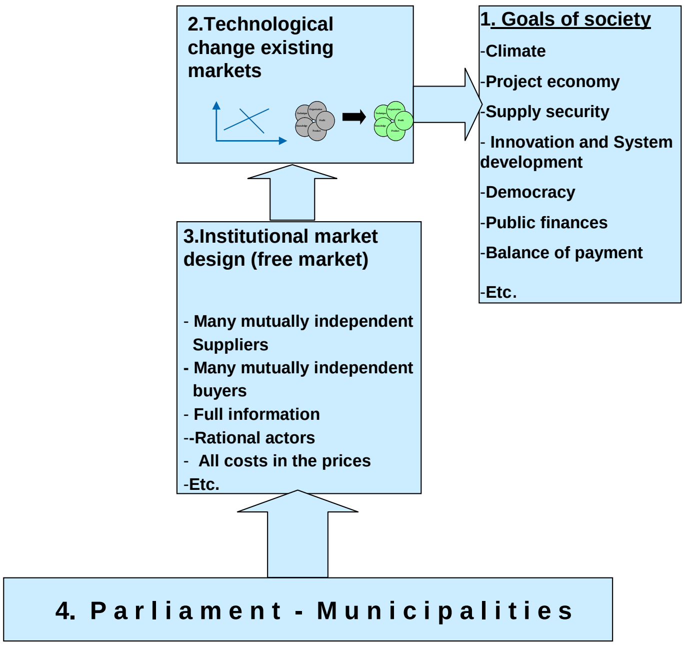

Fig. 4. The neoclassical approach

This approach tends to apply an ecological modernization approach that assumes that at a certain stage of development, all companies will begin implementing REC technologies because they are modern and create a base for any sound business. Thus, this approach does not expand on the different political incentives of the FFU and REC interests and therefore does not offer any active redesign of the political process in the direction of political liberalization, either. It assumes that we are currently in a process of ecological modernization where all actors are motivated to introduce innovative REC technologies, including the FFU companies. As this approach does not assume that the transformation will meet much resistance from traditional power companies, there is no need to strengthen the political process in order to cope with any opposition. Therefore, this approach does not support changes in the political process behind the redesign of market rules. Consequently, the public regulation tools will be the same as those in the neoclassical approach, with the addition of an active support policy for new REC technologies, mainly to be implemented by existing ecological, modernized FFU companies.

The Innovative Democracy Approach

This paradigm also appreciates that market rules are designed in political processes and recognizes that this process has to be redesigned in order to overrule the fossil fuel path dependency inherent in present-day market conditions. It argues that in the current political situation, the transformation to REC technologies will meet strong resistance from FFU companies and their supporters [2].

The neoclassical paradigm illustrated in Figure 4 does not acknowledge the political processes that construct the market conditions at a given period of time. Therefore, a framework describing the political process is added to Figure 4, thus introducing Figure 5, that visualizes the framework of a process, here named *innovative democracy*.

Innovative democracy can be said to exist when the political process establishes alternative goals (Box 1) and technological possibilities in technical (Box 2), institutional and market condition (Box 3) scenarios, in an unbiased manner.

In an innovative democracy process, the rules for the interaction between the political process (Box 4, Figure 5) and the various lobby groups (Boxes 5, 6 and 7) are designed in such a way that the influence from independent lobbyists carries at least the same weight in the political process as the influence from the dependent lobbyists (an independent lobbyist is characterized by having no direct economical interest in the different technological alternatives on the agenda; a dependent lobbyist is characterized by having direct economical interest in one or more of the technological alternatives on the agenda). In the energy case, this would imply a level playing field for political competition between FFU and REC interests.

This also includes bestowing funds to independent actors, hypothetically, enabling them to develop and establish prototypes for new technologies and to develop concrete and well-designed policy suggestions, including energy plans, etc. Hence, establishing a level, political playing field on the energy scene means granting both an equal "voice" and equal economic "means" to FFU and REC actors. Figure 5 illustrates the paradigm of innovative democracy.

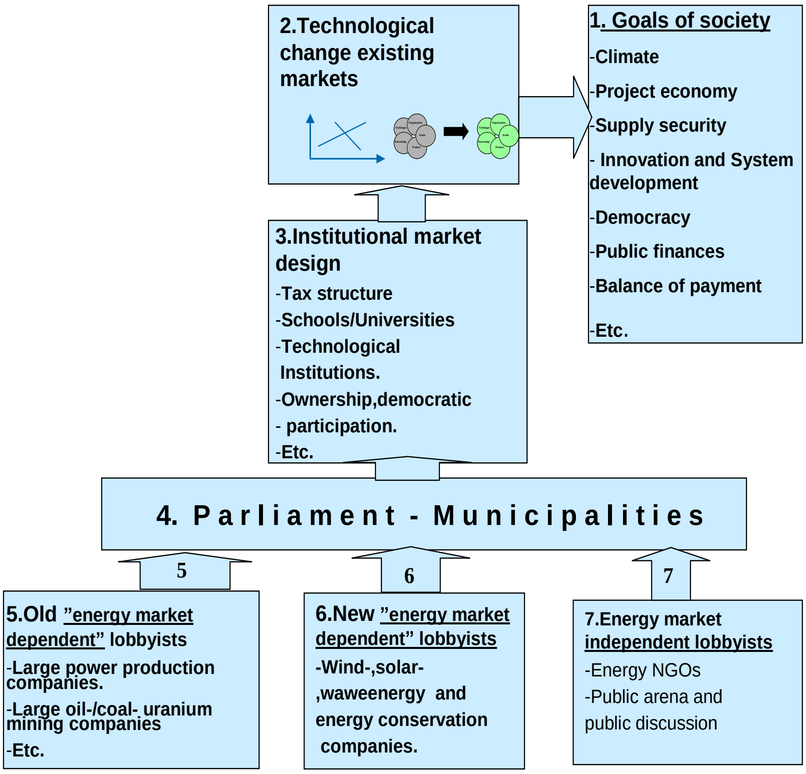

Fig. 5. Energy policy and innovative democracy
Comment: In box 2 all five technology components: technique, organization, knowledge, product and profit are changing, which is symbolized by the five balls changing color from grey to green.
Source: (Hvelplund 2014), forthcoming book on Renewable Energy and Innovative Democracy, and (Mendonca et.al 2009).
In box 1, the discourse regarding goals and norms is performed.
In box 2, the discourse regarding realistic technical scenarios is carried through.
In box 3, concrete institutional and market reforms are discussed.
In box 4, the design of political institutions is discussed.
In boxes 5, 6 and 7, the design of the information and resource balance between dependent and independent is made. For instance, between lobbyists linked to the old fossil fuel interests, box (5) and the lobbyists that are economically independent of the interests of the uranium and fossil fuel companies, boxes 6 and 7.

All concrete, Danish development from 1975-2001 has been influenced by an active policy design at each of these levels. This chapter chiefly discusses level 4 (the political processes) and levels 5, 6 and 7 (the information and resource balance between economically dependent and economically independent lobbyists).

Based on the Danish experience of the first phase of development, it can be concluded that if parliamentarians aspire to have different political scenarios to choose between, they must establish a resource and information balance between the dependent and the independent lobbyists. The establishment of this balance is essential, if a successful transformation from uranium and fossil fuel technologies to energy conservation and renewable energy technologies should take place. The associations constituting this balance can be termed the "institutions of innovative democracy."

They include:

1. The presence or establishment of independent research units, such as universities, which have the freedom and necessary resources to design technical scenarios that are independent of the government, central administration and the large energy companies. Such independent universities have been present in advanced Danish energy development and proposed alternative energy scenarios in (Blegaa et al, 1976, Hvelplund et al. 1989 and 1995, Lund 2009).
2. Easy accessibility to information regarding public plans and the cost and capacity of existing energy plants. There is a law in Denmark (law regarding openness in political and administrative processes) requiring that any information between a public organization and any other organization is accessible to the public.
3. The establishment of independent energy offices and locally accepted test centres that can advise the public regarding the possibilities and potentials of energy conservation and renewable energy. In Denmark, such energy offices and the Nordic Folkecenter for Renewable Energy received modest funding and have played an important role in the technology innovation process. The Nordic Folkecenter for Renewable Energy has played an important role despite relatively modest funding, by working on renewable projects at the practical research level.
4. The distribution of public funds to institutions whose boards are independent of traditional fossil fuel interests. In Denmark, this was accomplished by means of an institution (Teknologirådets styregruppe (the steering committee for the Danish Board of Technology), which played an important role by distributing funds to renewable energy pilot projects and performed critical research work within the energy sector)) that had the resources to support a set of renewable energy pilot plants.

The above public regulation tools should be established in order to grant political access to people and organizations that have no invested interest in the present FFU companies. These tools are also needed to introduce some of the neoclassical market tools in combination with giving active support to new REC technologies. It can be achieved, especially by implementing fixed feed-in prices for renewable energy sold to the heat and electricity grid [5],[6]. Furthermore, this approach focuses on bestowing funds to new REC organizations and encouraging local ownership of REC technologies.

The bottom line in these proposals is that the Danish Parliament should ensure that independent groups and the general public have access to information regarding the energy scene and the financial resources necessary to develop alternative technical and institutional scenarios. If these "political liberalization" reforms are introduced and secured, the public and parliamentarians will be granted the "freedom of choice" between different technological and organizational scenarios on the energy scene.

In the Danish case, the three political economy paradigms and their supporters are described in Table 2. The innovative democracy approach initiated some remarkable developments within wind power and combined heat and power (CHP) in Denmark. In 2013, wind power thus accounted for 30 percent of total electricity consumption and more than 50 percent of electricity consumption was supplied by the combination of wind power and small natural gas and biomass based heat and power plants.

Table 2. "Political economy" paradigm in Denmark from 1974-2013

	1974-1979	1980-1983	1984-1989	199019 91	1992-2002	2002-2007	2007-2011	2011-2013
Government	Right/ liberal	Center/ Left	Right/ Green	Right	Center/ Left/	Right	Right	Center/ left
Neoclassical approach	XX	X	(-)	XX	X	XXXX	XXX	X
Concrete Institutional approach	X	X	X	X	(-)	(-)	X	XX
Innovative democracy approach	X	XX	XXX	X	XXX	(-)	(-)	X

(-) means no influence, one X indicates some influence, two Xs connotes considerable influence, three XXXs implies strong influence and four XXXXs indicates a very strong influence.

The policy from 1980-2002 is characterized by an innovative democracy approach, although there are intermittent periods with a tendency towards a neoclassical approach. From 2002-2011 the neoclassical approach replaced the innovative democracy approach almost totally. Since 2011 the new government with its rather ambitious energy policy goals has not yet developed a new innovative *democracy version, and is still relying relatively on the approach of the association of power companies. Though in Denmark this means that the association of these companies, "Danish Energy" officially supports the increased use of Renewable energy. This policy is also supported by the Danish TSO, Energinet.dk, which has several activities aiming at establishing an infrastructure that can handle the increasing share of fluctuating renewable energy sources.*

Altogether, total wind energy industry production by Danish manufacturers increased from around 500 mill. EUR in 1995, to around 10 billion EUR in 2012. Danish export of wind industry products amounted to approximately 7 billion EUR in 2012 (Danish Wind Industry Association, 2006 and 2013). The export of the “green cluster” of energy technologies linked to Danish energy policy (including wind turbines) increased from 530 million EUR in 1992, to 9-10 billion EUR in 2012.

Thus, it is probable that the active Danish energy policy influenced by an innovative democracy approach was one of the most important reasons for the relative success of the Danish economy from the mid-nineties up until 2001 (Hvelplund 2005a), (Lund 2009). It should be emphasized that this development was implemented despite systematic resistance from the Ministry of Finance, the industrial establishment and the FFU based power companies, which regarded the new “green energy technologies” as competition to their large coal and oil based power plants. These actors succeeded in delaying the innovation process but fortunately, some political power was seized by a “coalition” of organizations that were independent of the existing fossil fuel based energy companies. These independent lobbyists, such as energy grass root organizations, new companies within the green technology cluster and some active politicians were able to generate political momentum for the development of a spectrum of green energy technologies. These organizations, independent of existing economic interests, that have gained democratic influence have been analyzed. They are a manifestation of the innovative democracy process, as previously defined.

Yet, in 2002, a right-wing government led by Anders Fogh Rasmussen (AFR) was elected and support for green energy technologies was removed. The political process of innovative democracy was brought to an end and a “non-policy” relying on existing market actors within the power sector (FFU companies) and existing market conditions, was implemented. This market conformed energy policy was combined with a policy of purchasing CO_2 allowances in the CO_2 market.

During the same period, most support for green energy technologies ceased and since 2003, almost no new wind power capacity was been built in Denmark, and until 2008, support for renewable energy in Denmark was far below average among the 27 EU countries. In 2008, in a speech to his political party, AFR made a historical political U-turn. He admitted that he had been wrong and declared that a 100 percent renewable energy target would be incorporated into Denmark’s future goals. In an agreement with the opposition, the economic conditions for wind power improved in 2008, although the overall the policy was only change a little and still was mainly based upon a neoclassical economic paradigm.

6. Two Cases of Innovative Democracy and Technological Change

6.1. Wind Power Development

According to government energy plans for 1990 and 1996, wind power was predicted to cover up to 20 percent of electricity production by 2005 and 50 percent by around 2030. The 20 percent goal was almost reached in 2005 and in 2013 30% of power consumption is supplied by wind power. In 2012 the Government, in an agreement with the opposition decided to increase the amount of wind power in energy planning, by setting a goal of 50% wind power of electricity consumption by 2020.

The production cost of wind power at a good coastal site has decreased from around 0.14 EUR per kWh in 1984, to 0.08 EUR per kWh in 1991, to merely 0.05 EUR per kWh in 2004-2013. Until 2002, the Danish wind power regulation regime included a feed-in tariff system, where purchasers of windmills receive a fixed price from electricity companies and a fixed public service payment for CO_2-free electricity production from the government. In this context, this is termed a “political price/amount market” **(**Hvelplund 2005b) system**.** During the 1990s, this system motivated wind turbine producers to lower their production prices, as they realized that more windmills could be sold if the prices of wind turbines decreased.

The wind turbine industry did not develop without an active policy from the Danish Parliament. There was systematic public interference in the market, which broke its “barrier to entry” institutions and created an opening for wind power technology.

The reforms of the 1980s and their political background can be briefly described within the wind power field. In the initial phase from 1980-1992, several policy measures were established to support REC development, despite heavy resistance from representatives of the fossil fuel based companies. Examples of such reforms include the following:

- A 30 percent investment subsidy.
- Utility obligation to purchase wind power at a price equal to 85 percent of the price paid by consumers using 20 000 kWh/year.
- A right to produce up to 7 000 kWh of wind power without income tax payment.
- The establishment of a public wind power test station at Risø Research Centre.
- Spare capacity in the machine industry.
- A motivated population.

During this phase, lasting until around 1992, more than 3 000 cooperative wind turbines were installed. Typically, a cooperative with a 100-300 kW wind turbine had anywhere from 20-60 owners. Consequently, around 1990, there were 100 000-150 000 wind turbine owners in Denmark. Among other elements in the process, this was the result of a debate in the Organization for Renewable Energy (OVE), a green grassroots organization (NGO), which fought for the cooperative model. The model managed to secure very stable public support for wind power and it helped the industry survive at the Danish market during the vulnerable years between 1987-1991, when the export to California stopped, and no new export marked was at hand.

Since 1992, wind power development has been further supported by a steady increase in export markets. Larger wind turbines were developed (600-2 000 kW) and from 1992 to around 2001, there was a 30-40 percent decrease in the cost of wind power electricity.

The political preconditions for the above developments were:

- Efficient grassroots movements: Especially the Organization for Renewable Energy (OVE) and the Anti-Nuclear Movement (OOA).
- A fairly open and active public debate.
- A specific balance in the Danish Parliament, with small parties with green profiles being influential.
- A situation where the energy companies systematically worked against innovative renewable energy technologies.

In this period, the power companies, the Ministry of Finance, the Association of Large Industries and the Danish Economic Council systematically worked and argued against wind power, whereas NGOs, sometimes employees of the Ministry of the Environment and The Danish Federation of Small and Medium-Sized Enterprises argued in support of wind power. These groups were given further political power, became members of public committees and received funds for wind power pilot plants, the publication of periodicals, etc. Despite resistance from large and powerful actors, this "innovative democratic process" succeeded in implementing a policy that supported the development and implementation of wind power in the 1980s and 1990s.

6.2. The Development of Decentralized Cogeneration in Denmark

By 1988, all cities in Denmark with a population exceeding 60 000 inhabitants had combined the production of electricity and heat (CHP). Currently, these CHP systems are largely coal-, and to some extend natural gas based, but future systems are planned to rely upon wind power, heat pumps and geothermal energy. Back in 1975, there had been discussions regarding the establishment of CHP units in small cities. But heeding the advice of the Ministry of Trade, the large power companies, opted for nuclear power and did not consider CHP units.

The grassroots organizations OVE (Organisationen for Vedvarende Energi -The Organization for Renewable Energy) and OOA (Organisationen til Oplysning om Atomkraft. - The Organization for Information on Nuclear Power), argued for decentralized CHP, as it was an alternative to nuclear power. The Utilities, the Ministry of Trade and later the Ministry of Energy, argued that CHP in small cities was not technically achievable and if it were even possible, it would be too expensive. Furthermore, they argued that even if it was technically possible and economically feasible, the potential was too small to spend time discussing it.

As late as 1988, the authorities and utilities considered the potential for decentralized CHP in Denmark to be 450 MW, at most. In 1989, a new Minister of Energy came into office and "suddenly" the new energy plan, "Energy 2000" (Danish Ministry of Energy 1989), claimed a potential of 1 400-2000 MW with regard to decentralized CHP, including industrial CHP.

Public financial support, financed by "Teknologirådets Styregruppe for Vedvarende energi" (The Renewable Energy Governance Group of the Technology Council) was given to independent groups analyzing what price should be paid for electricity sold from the CHP plants to the grid (Mæng 1988).

Concurrently with this, different institutional preconditions were established. These included the utility obligation to purchase electricity from CHP plants according to "avoided cost" pricing for electricity sold to the grid, based upon the principle of long-run marginal costs (LRMC). Furthermore, a "low CO_2 emission" subsidy of 0.013 EUR/kWh plus municipal guarantee was given to natural gas based cogeneration plants.

These concrete institutional reforms had an enormous effect. From 1990 to 2001, power production from decentralized CHP units increased from 1 percent of total electricity consumption to more than 30 percent. Of the decentralized CHP units, 60 percent are organized as cooperatives and are owned by the residents of small towns or villages. The units have between 0.5 and 5 MW of electrical capacity and are mostly fuelled by natural gas. (Lund 1994).

Many years of strong resistance from the power utilities and the Ministries of Energy and Finance has characterized the political process of the above mentioned institutional reforms. The policy was generated by a bottom-up approach and established through considerable public pressure from grassroots movements, local district heating cooperatives and some members of the Danish Parliament. The introduction of small CHPs evolved in what can again be regarded as an innovative democracy process.

7. The second phase, 2002 and onwards: Public Regulation Requirements in a mainly REC based energy system

Since 2002 REC development has entered a process from being just a supplement to a fossil fuel based energy system (first phase) to becoming the primary energy system, with the fossil fuel system becoming supplementary (second phase). At the same time the knowledge regarding renewable energy has spread to municipalities and energy companies, where the planners and engineers to an increasingly degree have studied renewable energy systems and the planning linked to the implementation of these technologies. So both from a market share- and a human resource point of view this second phase represents a profound change.

In the same period fossil fuel technologies have got reduced utility factors (hours of per MW) , as existing windpower capacity has almost zero short term marginal production costs, and therefore in any situation of competition with fossil fuel technologies will have the lowest bidding price at the Nordpool power market. With a large share of wind power the fossil fuel power production systems therefore are suffering economically and to an increasing degree closing down plant capacity.

So we are approaching a situation with increasingly scarce of power capacity in periods without wind and too much electricity production in periods with strong winds. The Danish TSO, Energinet.dk, still believe that this problem can be solved by building new power grids and relying upon export and import of power. But this “solution” is questionable our neighbour countries, Germany and Sweeden are also increasing their Renewable energy capacities, and also mmight reduce their power plant capacities.

Denmark therefore experience as a firstcomer challenges of having an increasingly large proportion of fluctuating energy sources. Hence Denmark is facing an increasing need to establish infrastructure systems that are able to incorporate fluctuations in large amounts of wind power (Lund 2009b), and to establish reserve capacities for periods without wind. Such systems will consist of heat pumps with heat storage in single homes, district heating areas, flexible cogeneration units, plug in electrical cars, etc (See www.ceesa.dk). This is not only a technical challenge, but also a policy design challenge, and Denmark is currently in the midst of developing a policy that makes it possible to establish such infrastructures. The Danish TSO, Energinet.dk, is responsible for analyzing the situation and providing advice regarding the establishment of this infrastructure. But Energinet.dk has not yet found a coherent regulation model that can assure that the necessary technologies are both built and that they perform the mandatory regulation activities. Some electricity trading companies, such as Nordjysk Elhandel, are systematically developing models that can ensure that the needed infrastructure is established.

In the development of this infrastructure, it becomes increasingly important that the common consumer understands the importance of the venture. The CEESA energy research project (www.ceesa.dk) developed models, where heat consumers should receive special subsidies and loan guarantees if they establish home insulation, heat pumps, heat storage and sign a contract obligating them to participate in the regulation of the fluctuating energy supply from wind turbines, and keep their cogeneration unit alive as reserve unit for periods with little or no wind.

It is sometimes said that with this increasingly large share of wind power we have reached a phase, where the solutions have to be developed and designed by large power companies, and that we now have entered a period of a technocratic regulation of the implementation of fluctuating Renewable Energy technologies. Here it is argued that this is not at all the case, and although an innovative democracy approach was important in the initial stages of renewable energy development, it may be even more imperative now, as technical problems linked to the integration of large amounts of wind power may require a high level of consumer understanding and active participation.

This is underlined by the arguments below.

Firstly the design of the Norpool market underlines the need to go from a smart grid solution strategy to a smart energy system strategy.

The cost structure of the Nordpool market is shown in Figure 6. This figure suggests that increased wind power production will push the whole cost structure to the right, which will lower prices in the Nordpool market.

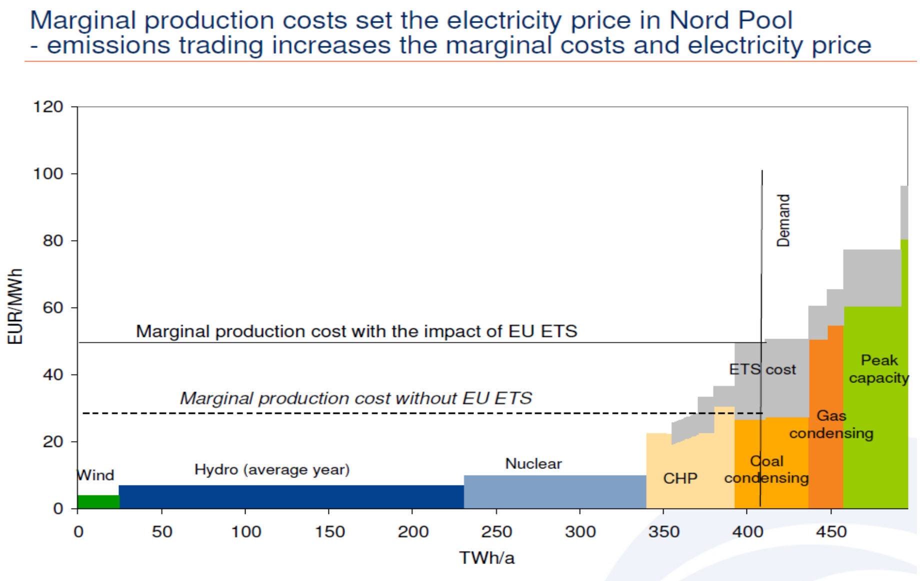

Fig. 6. The Nordpool market cost structure (Munksgaard 2009)

Understandably then, the economy of wind power is relatively unfavourable for any actor already selling electricity to this market, including large producers such as Vattenfall, DONG, E.ON, etc. For these companies, wind power expansion has costs incorporated into three levels: The cost of the wind turbines, lost revenue due to reduced prices in the Nordpool market and the cost of acquiring a lower utility factor at the fossil fuel, hydro and uranium based power plants. Therefore, it often is not economically feasible for these companies to invest in large wind power capacities in the Nordpool market region, unless they can achieve exorbitantly high prices for the wind power they produce. The Danish power company, DONG Energy, won the tender on a 400 MW offshore wind park near the island of Anholt for a price of around 12 Eurocent per kWh, which was alomost the double price of power from an onshore wind turbine. Generally, it is far more economical for the companies to invest in wind turbines outside the Nordpool market.

The above discussion reveals that the lack of incentive among the FFU companies to invest in wind power in the Nordpool market needs to be addressed. Market conditions has to be altered so that wind power investments can become profitable also for FFU companies. Furthermore, investment opportunities for independent investors, such as municipalities, households and private firms outside the energy sector should be improved in order to place competitive pressure upon the FFU companies.

And here it is especially important that the heat market is integrated with the power market. Technically this is done by investing in district heating, cogeneration, heat pumps and heat storage systems. Institutionally by giving the right incentives for using wind power for heat in periods with very much wind power.

Today these incentive does not exist to a sufficient degree in Denmark, where tax on electricity for heat are 3 times higher than tax on oil and gas for heat, and 6 times as high as tax on biomass resources for heat.

If the heat and electricity markets were integrated in the right way, wind power would never have to be sold for a price lower than the cheapest heat alternative, which would be around 3-5 Eurocent per kWh. Without this integration, wind power is often sold for 1-2-3 Eurocent at the Nordpool market, resulting in increasing problems for the economy in wind power projects.

In this perspective it is interesting that the companies that owns the potential integration infrastructure systems consisting of district heating, cogeneration units, heat pumps and heat storages are either small comsumer owned companies in the small cities or large municipality owned companies in the larger cities. If we assume the costs of wind power at the wind turbine level is 4 Eurocent per kWh, the cost of the needed integration infrastructure would be at the same level costs of wind power, including the needed integration infrastructure, around 8 Eurocent per kWh.

This means, from a value added point of view, a cost structure that has 50%- 70% of its costs close to the consumers, whereas a coal-, oil/gas or uranium based energy system would have almost all the costs allocated far from the consumers.

So in this *second phase* of renewable energy development the energy supply costs have changed from distant costs in oil,gas-,coal- and uranium mining to nearby costs in district heating, cogeneration units, heat pumps, and heat storage systems. This change to "closer to the consumer" ownership structures of the renewable energy investments indicates that it is, from a learning and transaction point of view reasonable that wind power and other fluctuating Renewable Energy technologies should be owned by municipalities and consumer owned cogeneration units that already owns the integration infrastructure.

The second phase is also characterized by the introduction of very large wind turbines (2-5 MW), with a height of up to 200 metres. These turbines are approximately four times as high as the first phase wind turbines, which were typically 0.3-1 MW turbines, with a height ranging between 40 and 70 metres. At the same time, these new, large wind turbines also represent more substantial investments. Whereas the first phase wind turbines would typically cost 0.3-1.2 million EUR, the investment cost of the 3 MW turbines are typically predicted to be around 4 million EUR. The final cost of a 20 MW wind turbine park with 6 wind turbines would range from 20-26 million EUR. This represents new challenges for public participation and public ownership of wind turbines. These challenges have been overcome on the island Samsø, where residents only had to pay in cash on average 14 EUR per person in new energy systems and an offshore wind turbine park. The rest was financed by mainly local banks. It does not seem top be difficult to finance locally wind power parks on good locaitions. A project in North West Denmark with 84 MW costing around 133 mill. Euro, was financed by 2000 local shareholdes from Saturday to next Tuesday. So the argument that the new large projects needs big money that only can be supplied by big companies does not seem to survive reality, where big money very fast can be raised by local shareholders. Often there will be mixed ownership models with a combination of a municipality, private companies and households as owners.

Both the change in cost structure towards a higher "close to the consumer" share of the intermittency infrastructure, and the increased size of wind projects requires a new generation of local influence upon renewable energy projects. By intermittency infrastructure is meant an infrastructure that helps handling the intermittency of wind-wave and solar power, and transform it to the needs of the demand curve. For instance the combination of heat and electricity(district heating,cogeneration,heat storage,heat pumps, etc.), where a large wind power production is sold to and stored by the heat system, and or the established cogenerator power capacities for periods with low or no wind, etc. But it can be stated that an increase in wind investment size in combination with the need for a mobilization of the locally owned latent intermittency infrastructure does not get any benefits from a distant ownership model with the large power companies as owners. Rather it needs a new model of mixed local and regional ownership, linked to the latent local intermittency infrastructure and its attached innovation opportunities.

8. Conclusion

Both the first and second phase in REC development represents a difficult technological transformation, where financially and politically reputable FFU companies loses value added, while new and financially unstable renewable energy and energy conservation companies gaines value added and market shares. Thus, a successful transformation will yield a situation where established companies will suffer losses, while vulnerable newcomer companies will benefit. This is the basic stipulation of a transformation from FFU to REC technologies not only in Denmark but in other parts of the world as well. Even in the unlikely scenario where the FFU companies gained 100 percent control of the REC market, they would still lose a considerable amount of value-added and therefore, profit and share value. Therefore, believing in an environmental modernization approach, where FFU companies would undergo a painless transformation to REC technologies, has no actual validity in the real world.

However in Denmark, the political process has been successful in creating REC technologies, especially with regard to the development and introduction of energy conservation, wind power and district heating systems. This success can possibly be credited to the establishment of the innovative democracy process, where a political, financial and informational balance has been established between the FFU and REC lobbyists, such as renewable energy NGOs, the public, in general and industrial interests linked to small companies. An important component of innovative democracy has included the allocation of financial means to a network of NGO based energy offices and independent innovators that have established prototypes of REC technologies at different locations throughout the country. Furthermore, Denmark had approximately 150,000 wind turbine owners, primarily consisting of neighbours to wind turbines who formed cooperative ownerships. Consequently, an ownership competition was imposed upon the FFU companies, forcing them to invest in REC technologies by applying the logic, “if we don’t do it, they will”.

Moreover, the REC development was established despite the opposition and lobbyism of large power companies and the association of large industries and in spite of the resistance and economic paradigms of the Ministry of Finance.

In the second phase, as REC technologies are in the process of replacing FFU ones, they are incurring an increasing amount of market shares, thus creating even greater competition. Furthermore, due to the fluctuating character of solar, wind and wave energy, the increased REC shares necessitate the establishment of a new technical infrastructure, such as flexible heat pumps, flexible cogeneration, heat storage, plug-in electrical cars, etc. Here called an intermittency infrastructure. Therefore, the second phase is characterized by both increased competition between FFU and REC technologies and the need for the development of a new infrastructure at the consumer level that can handle the fluctuations in the REC technologies.

In the second phase of REC development there is an increased influence of the following tendencies that already started in the first phase of the RE development:

A process of green technological innovation will meet *increased resistance* from established market actors due to conditions in the Nordpool market and the inherent basic financial circumstances of these actors. Prices at the Nordpool market will fall if there is a high percentage of wind power in the market, resulting in existing power companies losing money on their present coal, nuclear and hydro capacities. Also, the reduced utility factor at their present power plants, due to an increased percentage of wind power will result in a reduced power plant capacity and thus also back up capacity for periods withj only little wind. negatively.

The second phase of REC implementation therefore requires a very strong innovative democratic process, where the potential of the public, grass roots organizations and new green developers are given communicative, as well as financial power and where new, mixed ownership models with a combination of municipal and private households is established. The second phase will also require a greater public acceptance of REC technologies in order to counterbalance the present resistance against these technologies. An even stronger innovative democratic process will be required in the second phase of development, due to increased economic and shareholder driven conflicts between FFU and REC interests. At present there still is a tendency to trust in a “large company” model as the efficient way of transformation to renewable energy.

A green innovation process can never solely rely upon market tools and existing dominant market actors. This is demonstrated by the problems in the present Nordpool market construction, for instance, as shown in figure 6.

The characteristics of the second phase of development further contribute the following requirements, regarding public regulation:

The infrastructure required to cope with greater amounts of fluctuating REC technologies does not evolve automatically in the market. There must be an established, concrete policy that secures the development and implementation of the necessary infrastructural amendments, here called intermittency infrastructure. In turn, the requirement for new links between the REC supplier level and the consumer level are enhanced.

The 2002-2008 Danish “market experiment” nearly brought REC development and the implementation process to a complete a halt. The experiment has shown that the present market construction alone does not solve the development and implementation requirements in the second phase of REC development.

The policy at present is ambitious with amongst others: 50% wind power in 2020, 40% CO2 reduction from 1990 to 2020, no fossil fuels for heat and electricity in 2035, and 100% renewable energy in 2050. But large parts of the policicies for these goal are still is in a limbo, where there has not been found a new policy model for a mobilization of the latent intermittency infrastructure. This should be done by the right way of combining fluctuating renewable energy sources with heat, biomas and transportation. Neither has a new participatory energy planning process been developed, and an ownership integration of the locally owned latent intermittency infrastructure has not yet been sufficiently developed.

Politically there is a tendency to believe in a continuation of a proces lead by the large power companies, despite the need of a development, where the owners of the latent intermittency infrastructure also gets ownership of the wind turbines.

The conclusion of this chapter is that in both the first and second phases of renewable energy development, “market conditions” must be regarded for what they are - namely manmade political constructions. As the competition between FFU and REC technologies becomes more intense in the second phase, there is an increased need for a strengthened innovative democracy process, so that the advance of REC technologies is not hindered by the strong FFU organizations, now fighting for market survival. In addition, the second phase of development entails a need for a new infrastructure at the consumer level that can manage an increasing amount of fluctuating REC technologies. Therefore, a successful second phase transition from FFU to REC energy technologies requires an innovative democracy process with increased consumer and NGO commitment and financial support from groups that are independent of the FFU organizations.

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Frede Hvelplund - Department of Development and Planning, Aalborg University.

Main research areas: analysis of the relationship between energy policy, public regulation and environmental economics; moreover, he is concerned with the development and implementation of renewable energy as well as energy efficiency technologies.

Address: Fibigerstraede 13,
DK-9220 Aalborg,
Denmark

Tel.: +45 99408380

Fax: +45 98153788

E-mail: *Hvelplund@plan.aau.dk*

Novatoriška demokratija, politinė ekonomika ir atsinaujinančių energijos išteklių naudojimas. Eksperimentas Danijoje – 1976–2013 m.

F. Hvelplund

Alborgo universitetas, Planavimo ir plėtros katedra, Danija

Nuomonės straipsnis
(gauta 2013 m. gruodžio mėn.; atiduota spaudai 2013 m. gruodžio mėn.)

1976–2002 m. laikotarpis Danijoje gali būti laikomas pirmuoju atsinaujinančiosios energetikos ir apsaugos (angl. *renewable energy and conservation* – REC) plėtros etapu, kai REC technologijos buvo kaip priedas naudojamos kartu su iškastinio kuro energertikos technologijomis (angl. *FFU technology*).

Šiame, pirmajame, etape susikūrė ir „Žaliosios energetikos klasteris“, apimantis atsinaujinančių energijos šaltinių technologijas: vėjo, saulės energijos, biomasės ir energijos taupymo sistemas. Šis klasteris buvo sukurtas ir sėkmingai plėtojo savo veiklą, nepaisant sistemingo Finansų ministerijos, pramonės įmonių, grįstų iškastinio kuro naudojimu ir plėtra, pasipriešinimo. „Žaliosios energetikos technologijos“ buvo laikomos konkurentėmis didelėms elektrinėms, naudojančioms tokius energijos šaltinius – anglį ir naftą.

Nepriklausomi lobistai: įvairios energetikos kompanijos, naujos įmonės, priklausančios „Žaliosios energetikos klasteriui“, kai kurie aktyvūs politikai, davė nemažą impulsą žaliosios energetikos plėtrai. Ši organizacijų veikla, kuri egzistavo nepaisant esamų ekonominių interesų, buvo demokratinė įtaka – novatoriškas demokratijos procesas.

2000–2013 m. laikotarpiu Danija įžengė į antrąjį REC technologijų plėtros etapą – labiau pradėta naudoti atsinaujinančius energetikos išteklius šalyje ir šiuo metu šios technologijos gali tapti vienos iš pagrindinių energetikos sektoriuje.

2002–2008 m. dešiniųjų vyriausybė, vadovaujama Anders Fogh Rasmussen (AFR), uždarė novatorišką demokratijos procesą ir remdamasi esamomis rinko sąlygomis ir rinkos dalyviais įgyvendino „ne-politiką“ („non-policy“). Per šį laikotarpį technologijų plėtra iš atsinaujinančių energijos šaltinių buvo beveik nutrūkusi.

Tačiau 2008 m. Anders Fogh Rasmussen (AFR) pakeitė politinę nuomonę, visiškai pritarė ir sutiko paremti, kad ateityje būtų naudojama atsinaujinančioji energetika. 2012 m. Vyriausybė sudarė naują energetikos plėtros planą, kad 2050 m. šalyje bus visiškai naudojami atsinaujinantys energijos ištekliai. Šis tikslas didžiąja balsų dauguma buvo paremtas 2012 m. Parlamento pasirašyta sutartimi.

Šio tyrimo išvada yra ta, kad tiek pirmojo etapo atsinaujinančiosios energetikos technologijų plėtra, tiek antrojo etapo „rinkos sąlygų“ energetikos plėtra yra politinės sudėties. Kadangi antrajame plėtros etape labiau konkuruoja FFU ir REC technologijos, padidėja stiprios novatoriškos demokratijos poreikis, siekiant išvengti, kad REC technologijos nebūtų vėl išstumtos siprių FFU organizacijų, kurios kovoja dėl išlikimo rinkoje. Taip pat antrojo etapo plėtros pobūdis lemia ir naujos infrastruktūros vartotojams kūrimo poreikį tam, kad būtų sėkmingai prižiūrimos kintančios REC technologijos. Sėkmingai FFU tecnhnologijas pakeitus į REC technologijas reikalingas novatoriškas demokratijos procesas ir padidėjęs vartotojų turimų vėjo jėgainių ir savivaldybių valdomų termofikacinių elektrinių, nuosavybės akcijų kiekis.

Taigi vėjo jėgainių integracijos infrastruktūros (centralizuotos šildymo sistemų, katilinių, šiluminių siurblių) savininkams bus suteikta galimybė integruoti vėjo turbinas į centralizuotas elektros ir šilumos tinklų sistemas.

Nepaisant visko, taip pat reikia nepriklausomų nevyriausybinių organizacijų ir finansiškai įgaliotų organizacijų, nepriklausomų nuo FFU dalyvavimo.