Renewable Energy and the need for local energy markets

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ABSTRACT
In Denmark a technological change towards cleaner energy technologies has been developed and implemented since around 1975. The development has had two phases. The *first phase* from 1975 until 1999, where windpower supplied 7% of the electricity production, and were brought close to cost competitiveness. The present *second phase*, where windpower supplies almost 20% of electricity production and combined heat and power plants around 30%. Denmark succeeded to overcome this first phase, and a large green energy technology cluster was established. In the second phase new difficulties and challenges have arisen both with regard to public acceptance and concerning the need of integrating an increasing percentage of fluctuating energy sources into the energy system. A new offensive green energy policy should be established both securing public and political acceptance, and the establishment of local markets securing the technical integration of a large proportion of windpower and other fluctuating renewable energy sources into the energy system.

1. Introduction: The two phases of RE implementation and the Danish "turning point" situation.

The *first Danish energy policy phase* was from around 1975 to around 1999, when the windpower production was around 7% of total electricity production. With this level of windpower production there were no serious problems with surplus electricity coming from combined of heat and power plants (CHP) and windpower units. So in this first phase the main problem was to lower the windpower costs, and to establish favourable conditions for CHP and energy conservation activities. The main political battle was to get the "new" and at this initial stage relatively expensive windpower politically accepted so that a windpower policy was established with subsides in the initial stages of technology development and acceptable, general and transparent rules, when feeding wind power into the public grid. This first Danish energy policy phase was very successful. It resulted in an industrial development, where Denmark took the leading position within energy conservation, CHP and the development of renewable energy technologies, especially windpower technology. The export of green energy technology thus grew from 50 million Euro in 1992 to around 4.5 billion in 2002. One of the main "secrets" behind this development was the co-operative neighbour ownership of windturbines. Around 1990 there were around 150.000 owners of wind turbines in Denmark, which had a very positive effect upon the local acceptance of windpower projects, and consequently upon the political acceptance of windpower at that time.
We are now in the *second Danish energy policy phase, which* has become manifest especially since 1999, as the amount of windpower has doubled since then. In 2002 around 19% of the electricity in Denmark came from windpower, and around 30% of the electricity production was linked to CHP heat production. Consequently, when the relatively large windpower production is fed into this type of electricity system, there is surplus electricity production in

an increasing number of hours. And this electricity has to be sold at the Scandinavian Nordpool electricity market at often very low prices. This problem is especially serious during windy winter periods, where, a large proportion of CHP based electricity production is co-produced with heat.
Furthermore the nineties were characterised by an abolishment of the co-operative ownership model for new windpower capacity, and the owners of new capacity were private owners, typically farmers. Consequently the local political base and neighbour support was slowly eroding. The Danish energy system therefore has, due to erosion of the co-operative ownership model, and a large CHP production in combination with around 19% windpower of electricity production reached a technological and institutional "turning point", with the following characteristics:

- Increasing problems with surplus electricity being at too low prices at the Scandinavian Nordpool market.
- Increasing density of windturbines at inland sites concurrently with a change in ownership structure away from the co-operative neighbour ownership model has resulted in rising local opposition to windpower projects. [1]

The association of large Danish industries, "Danish Industry", and the association of large energy companies historically have always been against the development of green energy technologies such as windpower. But these organisations have lacked sufficient parliamentary support to this opposition. This was changed when the right wing Government came into power November 2001, where the green energy policy was brought to a halt.
The situation in the present energy policy phase 2 therefore is, that the Danish green energy innovation process has been stopped, and that consequently there is a need for a new policy, which can solve both the political acceptance problem, and the technical problem of integrating an increasing percentage of fluctuating renewable energy sources into the energy system.

2. Renewable energy characteristics and Governance Systems.

The Renewable Energy Governance models should be discussed both in relations to the specific characteristics of renewable energy technologies, and in relation to the phase of implementation of renewable energy in a given country.

2.1. The specific characteristics of Renewable Energy

When examining the various arguments in the debate, it is striking that there does not seem to be any thorough discussion regarding (a) the basic differences between "the nature" of fossil fuel- and renewable energy technologies, and (b) the different Governance needs in different phases of RE implementation. In the following we will look at the specific characteristics of renewable energy in the two phases of RE development.

Phase 1: The phase with no surplus energy problems.
The fundamental characteristics of renewable energy technologies are amongst others [1]

[1] It though should be mentioned, that a waste majority (80%) of all Danes, according to opinion pools want increased use of renewable energy technologies.

1. Many renewable energy techniques are *energy automations***,** having a cost structure with a very *high percentage of investment costs* and very low running costs. This both implicates high sunk costs and therefore investor risks, and an increasing importance in keeping the competition at the equipment market alive, as this market contains the largest cost fraction.
2. RE technologies mostly have *a site dependent* resource base. The *different natural resource* bases from location to location, makes it necessary to establish a governance system that furthers an EU-wide "site efficiency"[2] generating process rather than a " mono price" (one price on a European market) based price competition.
3. RE technologies often are *dispersed technologies*, being distributed around the country. Often close to residential areas, which makes it particularly important to involve neighbours and people from the region in the design, development and ownership of RE projects.
4. RE technologies have a *value-added profile*, which when applied by fossil fuel based energy companies would decrease their value added, and decrease their profit. This enhances the initial phase 1 resistance from these companies, although renewable energy due to its small phase 1 market share does not yet constitute any market threat to the fossil fuel based technologies/companies.
5. When this resistance is combined with the relatively weak *newcomer position of RE* it is important to develop and maintain a general political and public support for RE technologies. In the initial phases of RE development the costs are high, and a public support for the payment of these initial development costs is a must.

Additional *second phase* characteristics.

6. Wave-, wind- and photovoltaic energy are fluctuating sources of energy, requiring an infrastructure, which should be able to cope with these fluctuations in a cost efficient way. There is a need for establishing an infrastructure, which can cope with these fluctuations in this second phase, where wind-power amounts to almost 20% of the total electricity production. An active political process therefore is needed in order to establish an energy infrastructure, which also develops and support the integration of fluctuating and often decentralised RE sources.
7. *Increasing RE market share results in growing visibility***,** enhancing the need for local participation. In a mature phase of implementation[3], especially wind-power becomes increasingly visible, making local resistance against wind-power projects increasingly frequent. In this phase renewable energy also has become a serious competitor to the old energy companies, raising a though resistance from these interests.
8. Implementation of RE technologies removes value added and profit from the fossil fuel based energy companies. In phase 2 the increased RE market share becomes a serious economic threat to fossil fuel based technologies, and consequently also causes increased opposition from these companies.

The renewable energy (RE) Governance systems should take the above 8 characteristics into consideration. In the next section we will discuss two important RE governance models in relation to these 8 characteristics.

[2]. By "site efficiency" is meant efficiency with regard to the exploitation of a specific regional renewable energy resource.
[3] Like windpower in Denmark, supplying around 20% of total electricity consumption in 2003.

2.2. Renewable Energy Governance systems

The two most common renewable energy governance systems are:

(a) The "Political price-/amount market" model, often called the "feed in system", which has politically set prices for RE (Renewable energy) electricity, and where the produced quantity of RE electricity is determined on the market; and

(b) The "Political quota-/certificate price market" model, where the RE electricity quantity is politically fixed as a quota and the RE electricity prices determined on the market.

The "Political price-/amount market" model has been successful in Germany, Spain, and Denmark, countries that boasted around 80% of the European wind power production in 2000.

In 1999, the Danish Parliament approved a law introducing a "Political quota-/certificate price market" model for RE. Wind turbines contracted from 2000 and onwards should be subdued to payment according to these not yet totally settled rules. Almost no contracts have been entered into under these rules, which since 2001 has brought the Danish wind power development to a very critical situation[4]. In June 2002 the introduction of the certificate market was postponed, and the new right wing government is introducing rules which are, in general relatively unfavourable towards a continuation of the wind-power development in Denmark. These rules are neither clear nor totally settled in 2003.

In 2000, the German Parliament approved a new advanced "Political price-/amount market" governance model, and in 2001, the French Parliament accepted a similar model. We call these models advanced, as they include as well a price differentiation between good and poorer wind sites, as an innovation pressure, decreasing the kWh price by 1.5% annually in relation to year of plant construction[5].

In the UK a "political quota-/certificate price" market was introduced in 2002, but there are not yet usable results from this model. In Texas version of this model has been introduced resulting in some experiences, which may be can be used to tell something about the "political quota-/certificate price" model when used for wind turbines located in the Texan desert far away from resident buildings.

Recently, the EU commission accepted the use of the "Political price-/amount market" model in the latest Directive proposal[3], which has been accepted by the Council of Ministers. This keeps the question of the future regulation framework open. The "Political amount-/certificate price market" model, therefore, is no longer 'the only possible future regulation model'. This development has lately been supported by a European Court adjudication[6], which says that the German "Political price-/amount market" model is not to be regarded as illegal state aid, and is therefore acceptable as a way of regulating RE development.

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[4] It should be emphasised, that the Danish wind power boom (660 MW) of the year 2000 was contracted before 31/12 1999 and based on the old "Political price-/amount market rules", which were in effect until this date.

[5] . By this is meant, that a wind turbine build in 2003-during its lifetime-will get a kWh price, which is 1.5% lower in running prices, than the kWh price of a wind turbine build in 2002. A wind turbine build in 2004 will-during its lifetime- get a price, which is 1.5% lower, than the price of a wind-turbine build in 2003, etc.

[6].13 March 2000: Judgement of the Court, Case C-379/98.

3. Institutional context and the analysis of RE Governance models.

When analysing renewable energy governance system it is necessary to establish a context, which is adequate seen in relation to the energy policy goals, and the special characteristics of renewable energy technologies context. In Denmark this was not done up to the change of policy in 1999. This analysis of the institutional context is focussing upon the institutions in which the RE technology market/development is embedded. In Figure 1 below, a number of such institutions are described, exemplified by a "Political quota-/certificate price market" governance system.

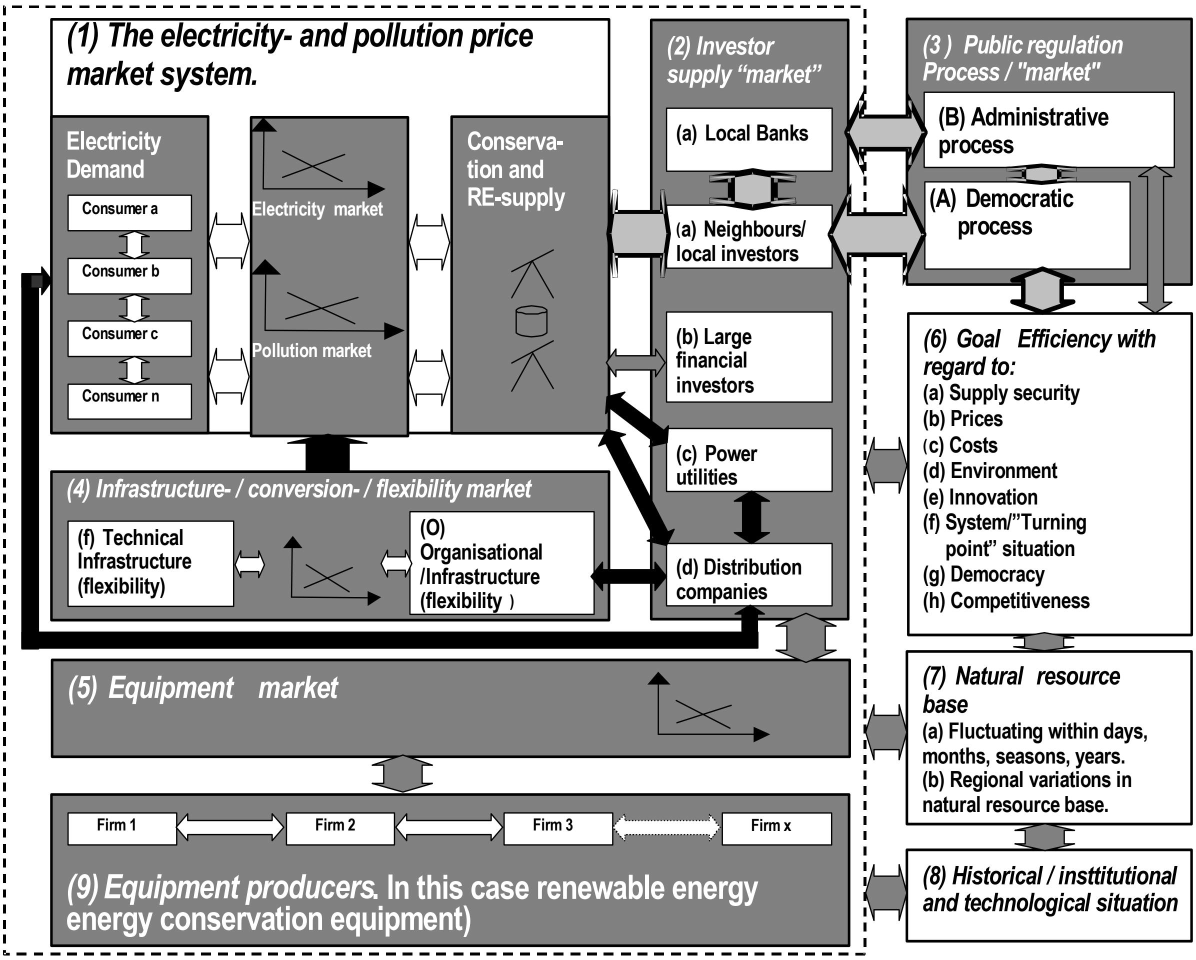

Figure 1. A relevant[7] institutional context around RE governance systems and the case of the "Political quota-/certificate price market" model.

Source: [1]

***Figure explanation**: The Figure focuses upon the interrelations between the policy goals (box 6), the electricity-and pollution price market (box 1), the investor supply market (Box 2), the public regulation and policy "market"(box 3), the conversion and flexibility market (Box 4),*

[7] In relation to energy policy goals, and the RE characteristics described above.

the equipment market (Box 5), the natural resource base (box 7) and the historical institutional situation (box 8).

The specific interest of this paper thus resides in an analysis of the links between (a) the above five "market" areas and (b) the specific RE characteristics mentioned above. Furthermore the analysis should include both the first initial phase of RE implementation and the present second "turning point" phase of RE implementation which Denmark is entering in these years.

The most important messages in Figure 1 are the following:

(a) The RE equipment market should be included in the context (box 5).
It is necessary to establish a systematic analysis of the contents and interrelationships between the electricity-and pollution price market (Box 1), and the market for energy equipment (Box 5). Renewable energy technologies and especially wind-, wave- and solar-based electricity production can be considered as energy automatons. This means, that it is more important to look at the market for production of these automatons, than upon the market for electricity produced at these automatons, the cost structure is characterised by about 85-90% investment costs, and only 10-15% running costs. Thus, once a wind turbine has been built, one is dealing with a technology with a "stranded cost" percentage that is far higher than in a fossil fuel power plant. This results in very high investor risks on the market. What effects then will this cost aspect have on the development of competition on the market?

***Consequence (a)*:** A "political quota-/certificate price market" model would weaken the competition at the equipment market, as the producers would not be able to expand their profit by lowing production prices and expanding the market size. Hence the "Political price-/amount market" model is best with regard to establishing competition at the equipment market.

(b) "RE-investor supply" and its composition do matter (Box 2).
(The boxes 3A and 2a are connected to each other displaying the importance of the link).

The areas thus linked provide a description that makes it possible to discuss a series of interrelated questions such as:

The importance of discussing the connections between the people who reap the economic benefits from investing in RE (e.g. wind power), and the people who carry the potential burdens linked to noise and visual inconveniences. In phase 2 renewable energy will be seen more and more the larger share of electricity consumption it supplies. Consequently the neighbour and political reaction will become increasingly important. RE, and especially wind power, is characterised by being difficult to conceal, and often has to be distributed in a given area within the vicinity of a number of communities. This means that a lot of people will feel the visual and, in some cases also, noise inconveniences linked to, for instance, having a biomass- or wind power plant in their neighbourhood[8].
The market therefore cannot be seen in insulation from the political regulation process, box 3, and its relationship with the local involvement, box 2, and the investor supply market. One way of "solving" this problem is to fuse these two groups by supporting a policy centred on neighbour- and local ownership. Furthermore, this discussion is linked to the political process

[8] One can naturally install offshore wind power systems away from residential areas, but their total output would not be sufficient to supply whole continents with electricity and energy. Furthermore, such concentrated production of wind power would make it necessary to build huge high-tension power lines.

in Box 3A, indicating that people's political acceptance of RE plants will depend on the extent to which *some of the economic benefits are given to the people who carry the burden.* Including neighbours and local banks in the context is a must, and is also linked to the discussion of governance systems and the *need for "price stability*" over a longer period of time. Long-term price stability is necessary for the strategically and politically important investor group; neighbours and local communities. Without long-term price stability the neighbours and local communities are not able to participate as viable investors at the investor market.

Consequence (b): **The** "Political price-/amount market" model generates price stability, and therefore also supports the establishment of local neighbour investor groups.

(c) The regional variation of the natural resource base makes a difference, when designing a RE Governance system (box 7).

Any context describing the RE Governance systems should consider, that the RE resource base is varying from location to location. And the use of RE is characterised by "harvesting" and transforming to electricity by means of the same plant, where the fossil fuel and uranium technologies are characterised by "harvesting" the oil, coal, and uranium in one phase and in another phase processing it to electricity at power plants.

This means, that the market for RE technologies should both take care of the "harvest" procedure, and the transformation to electricity in one market process. Therefore it is not possible just to use the market mechanisms from the fossil fuel technologies upon the development of RE technologies. This should be considered thoroughly, as we will do later in this paper.

Consequence c: The "Political price-/amount market" model makes it possible to establish different prices from site to site, and in that way is making it possible to "harvest" the not so good inland sites without having to give windfall profits to the best coastal sites.

(d) The study of market power does matter.

Due to the different value-added profiles of RE- and fossil fuel/uranium technologies, one cannot expect that fossil fuel/uranium companies will in general to support RE technologies, as a transformation from fossil fuel to renewable energy technologies will reduce the value-added share remaining within these companies. So even if they should want RE technologies, they often would not have the financial freedom to further their implementation.

It also is crucial to be able to take a closer look at the concrete characteristics of development on the market, especially with regard to monopolistic and/or oligopolistic tendencies. Figure 1 illustrates, by means of the black arrows between the demand and supply sides that, at present, the demand side (distribution companies) in Denmark are the owners of the supply side, i.e. the power utilities and transmission system, which can also build and own RE plants. There are similar ownership links in all the Northern European electricity service supply systems. The above ownership links naturally cause huge problems with market control carried out by large fossil fuel and uranium based actors, enabling these to squeeze out investors[9] who do not have a strong capital background and ownership connections to the demand side distribution companies. This 'factor' should be seriously taken into consideration when defining the selection criteria presiding over the choice of an appropriate RE institutional framework.

[9] Due to the cost structure of RE production (e.g. wind power), characterised by both high capital costs (85-90% of costs) and low running costs (10%), low price periods will drive investors with a weak capital background to bankruptcy. This state of affairs may then potentially result in small investors being bought up by big investors with a strong capital background, such as the large utilities.

Consequence (d): The "Political price-/amount market" model supports the entrance of neighbour investors at the investor market, and in that way also supports a process, where independent investor groups can play an important role on the market.

(e) The infrastructure for electricity conversion and production flexibility should be analysed, as it is essential for the economy of RE technologies

The economy of RE sources and especially wind power is a function of the technical infrastructure in which in particular RE is embedded. Wind power-, photovoltaic- and wave energy production varies according to the amount of wind-, sun- and wave energy.
The Danish energy system has reached a boundary with several periods of "excess" wind- and heat bound electricity production. This "problem" will increase in parallel with a further increase in the Danish windpower production.
The present official strategy to solve this "challenge" is huge electricity exports during windy periods, which entails the risk of very low sales prices for wind power. Scenarios built on an increasing proportion of forced export at low prices will probably result political resistance against wind power and make a CO2 reduction policy increasingly difficult to champion.
Another strategy is to use wind power in regional systems, consisting in heat pumps linked to cogeneration, flexible regulation of cogeneration units and the establishment of cogeneration- and wind turbine systems, which, on their own, can already stabilise the grid. This strategy will make it possible for Danish system operators to decide when to import and when to export electricity. At present, this type of system is being discussed in Denmark and seems to be much more promising economically than the current official export strategy [2]
In parallel with this development a market for electricity is institutionalised called the Nordpool market (Scandinavia) and the Leipzig market (Germany) with rules, which are designed for the old fossil fuel based electricity system with large centralised often coal based power plants. This marketplace can be characterised as centralised, and it is not possible for local renewable energy actors, cogeneration units or consumers to trade mutually at a local market place.
The technological development towards distributed fluctuating RE based electricity production is in general incompatibility with the present market rules at the Nordpool and Leipzig market place.
A "local market" system, where local cogeneration plants, wind-power plants and consumers are giving incitements to trade internally in order to cope locally with the wind- power fluctuations is needed.

4. A coming innovative and democratic "Political price-/amount market" system.

In this paper we have analysed two RE governance systems in relation to a set of main characteristics of renewable energy systems, which should be taken into consideration when establishing a RE institutional framework. In the above description of an institutional context, we have emphasis upon a context, which will be able to "catch" some useable analytical results within these RE characteristics. An analytical context, which should be adequate seen in relation to these RE characteristics.

The first conclusion upon our analyses was that the "Political price-/amount market" model was most efficient when considering equipment market, the investor market, the variation of the natural resource base and market power questions.

Our second conclusion was, that the need for local and regional acceptance was even more necessary in this second phase development, where the density of RE technologies was increased. And we could conclude that the question of acceptance locally and politically was best pursued by means of the “political price-/amount market” model.

Our third conclusion was linked to the question of creating an infrastructure, which could cope with the fluctuation evolving, when large amounts of RE were produced. In this conclusion we emphasised, that it would be necessary to rearrange the market in such a way, that local markets for such infrastructure was constructed.

The here proposed RE reforms could be summarised as a need for the development of:
A "political price-/amount market" system of a similar design as the new German system.
A governance system giving investment priority to neighbour-/local investors securing that these groups always have the right to achieve ownership shares.
A flexibility and conversion market, ensuring that local and regional technologies are included in the infrastructural regulation tasks.
A system of openness at early phases of the public regulation decision process.

The result of including these components might probably be, as analysed in this publication, that the many "different markets" will be vitalised:
The amount market because of a mechanism of produced amounts decided by a market.
The equipment market while turnover can be increased by lowering prices.
The investor market because of the continuance and strengthening of local and neighbour investor groups at the market.
The political market because of a system of openness, which makes it possible for many people to participate in the democratic process.

As a result of this vitalisation of the economical- as well as the "political market" the RE innovation process will probably accelerate, and the achievement of an array of energy policy goals will be within reach.

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