Green Electricity Certificates - A Supplement to the Flexible Mechanisms of the Kyoto Protocol

By

Lene Nielsen
Department of Economics
University of Southern Denmark , Odense
Campusvej 55
DK-5230 Odense M
Denmark
lni@sam.sdu.dk

and

Tim Jeppesen
Department of Economics
University of Southern Denmark, Odense
Campusvej 55
DK-5230 Odense M
Denmark
tij@sam.sdu.dk

ABSTRACT

The liberalisation of the European electricity market creates a need for new instruments to coordinate climate change initiatives with competition. This paper describes and analyses a system of Green Electricity Certificates to regulate the introduction of renewable energy sources in the European Union. We argue that a European system of Green Certificates is a cost-efficient method to induce renewable energy production and thus to reduce CO_2 emissions. A system of Green Certificates combines the advantages of command-and-control (CAC) regulation with market-based incentive regulation. Like CAC regulation, Green Certificates are based on a centrally determined target, while the market ensures cost-efficient behaviour by the agents. The system of Green Certificates implicitly implies the harmonization of different national subsidy schemes supporting renewable energy generation. Therefore, the system may contradict the principle of subsidiarity and thus be opposed by some Member States. Based on Dutch experiences from a similar system of green labels, potential problems and possible solutions will be presented in this paper. In particular, the issues of ensuring compliance, managing the risks of renewable energy generation, market structure and disincentives are analysed along with relations to the principle of subsidiarity. Furthermore, the system of Green Certificates is compared with the flexible mechanisms of the Kyoto Protocol in order to discuss their common features and assess the compatibility of the instruments.

Key Words: Renewable Energy, Regulation, Green Certificates, Liberalisation, Subsidiarity, The Kyoto Protocol.
JEL: L51, Q42, Q48

1 Introduction

There are at least two good reasons why common policies should be implemented to ensure the introduction and development of renewable energy sources in the European Union.

First, in 1997, the EU made a commitment to reduce greenhouse gas emissions by 8% in the period 2008-2012 compared to the 1990-emissions. This commitment was made under the auspices of United Nation's Framework Convention on Climate Change in Kyoto. The European Commission envisages that one possible means to achieve this end is to increase the share of renewable energy sources in the generation of electricity. The Commission has given its suggestion as to how this may actually be achieved in its White Paper on renewable energy[1]. In this White Paper, the Commission suggests to set an indicative objective of 12% for the contribution by renewable sources of energy to the European Union's gross inland energy consumption by 2010. Electricity generated from renewable sources is currently more expensive than electricity from competing fuels. Therefore, initiatives to promote renewable energy production are necessary.

The second main reason for implementing harmonised European policies on renewable energy generation is to avoid potential distortions to trade within the Internal European Electricity Market. Distortions may arise due to different national schemes to promote renewable energy sources already introduced by several Member States. In a non-liberalised electricity market consumers have no alternative suppliers. Therefore, the absence of common European rules does not create any distortions to electricity trade because trade is limited and strictly regulated. With the internal electricity market, starting-off in 1999, some coordination of the regulatory schemes is required[2]. Coordination must restrict distortions of trade in renewable electricity, distortions of competition and distortions of trade in general.

The purpose of this paper is to examine the possibilities for implementing harmonised measures in the EU. These measures must promote the use and development of renewable electricity and in addition effectively coordinate national initiatives. Thus, the questions, which we will try to answer, include: Which instruments are available and appropriate to use in order to introduce and develop renewable energy sources in the context of the internal electricity

[1] COM(97) 599, 26.11.97, 'Energy for the Future: Renewable Sources of Energy - White Paper for a Community Strategy and Action Plan'.

[2] Directive 96/92/EC *Official Journal* L 027, 30/01/1997.

market? How do these instruments perform compared to the flexible mechanisms identified in the Kyoto protocol? Moreover, the harmonization of national measures touches upon aspects of sovereignty, distribution of powers, and subsidiarity. Therefore, it will also be discussed how the principle of subsidiarity influences the development of harmonised measures.

In this paper we introduce Green Certificates as a new regulatory tool. We argue that a European system of Green Certificates is a cost-efficient method to induce renewable energy production and thus to reduce CO_2 emissions. A system of Green Certificates combines the advantages of command-and-control (CAC) regulation with market-based incentive regulation. Like CAC regulation, Green Certificates are based on a centrally determined target, while the market ensures cost-efficient behaviour by the agents. The system of Green Certificates implicitly implies the harmonization of different national subsidy schemes supporting renewable energy generation. Therefore, the system may contradict the principle of subsidiarity and thus be opposed by some Member States. Green Certificates have a number of similarities with the flexible mechanisms of the Kyoto protocol. Green Certificates are, however, solely directed towards the electricity sector while the flexible mechanisms in principle cover all energy producing- and consuming sectors. Therefore, Green Certificates may intervene more with national electricity planning policies than the flexible mechanisms do.

The structure of the paper is as follows: In section 2 we introduce Green Certificates as a regulatory instrument to assure the implementation of renewable energy sources in a liberalised electricity market. In 1998, a somewhat similar system was voluntarily implemented by the Dutch electricity distributors. In section 2 we therefore also examine experiences acquired with the Dutch system. In section 3 we identify and analyse some of the obstacles that remain to be settled in order to implement a system of Green Certificates in the EU. This analysis focuses in particular on the functioning of the markets for electricity and Green Certificates. In section 4 we compare Green Certificates with the flexible mechanisms of the Kyoto protocol and discuss the issue of subsidiarity. Conclusions are given in section 5.

2 Implementing renewable energy sources in a liberalized electricity market

Costs of renewable energy generation exceed costs of conventional energy generation. This is the situation today, and this will probably also be the case at least in the near future. The Internal Electricity Market Directive allows producers to collect additional costs of renewable energy generation via the

electricity prices[3]. Although this gets renewable and conventional electricity on equal footing, producers are unlikely to make the necessary investments without additional incentives to do so.

Member States have taken different approaches to increase the share of renewable energy sources[4]. Whereas some countries have implemented support schemes to initiate investments, others have done very little to increase the share of renewables. The different levels of effort may result in an inexpedient situation with some Member States facing high average electricity prices due to a high share of renewable energy production. Other Member States, not pursuing to increase renewable energy generation, may face relatively low average electricity prices and therefore be better equipped to compete on the liberalised electricity market. Thus, the internal market for electricity may bring disincentives to invest in renewables. Therefore, in order to realise the goal formulated in the White Paper on renewable energy, it is of utmost importance that electricity producers and consumers on the European market face similar incentives.

The EU has several instruments at its disposal to make each Member State contribute to the goals of the White Paper. The EU may for instance impose on each Member State to supply renewable energy sources corresponding to 12% of its electricity consumption. This solution would, however, cause very different costs of implementation across the Member States and thus lead to political opposition. In addition, production quotas may be viewed as inconsistent with the principle of subsidiarity because the EU directly influences domestic electricity production.

A more acceptable solution for the Member States would be to initiate increased renewable energy generation by granting subsidies, tax exemptions and/or price guarantees. These types of regulation have been, and still are, used by several Member States such as Sweden, Denmark, Germany, the Netherlands, Austria and the UK.

Subsidies and price guarantees may be inconsistent with Art. 92 of the EU Treaty regarding state aid. Until presently, the Commission has taken a

[3] Due to public and environmental service obligations, as stated in Art. 3(2) of the directive.

[4] Haas, Reinhard, Nobert Wohlgemuth and Claus Huber (1999): 'Promotion Strategies for Renewable Energy Systems in Liberalised Electricity Markets'. Paper presented at the Forty-Seventh International Atlantic Economic Conference. Vienna, March 16-23.

favourable position as regards aid to renewable energy production[5]. This situation may, however, change with the liberalisation of the electricity market as the discriminatory impact of state aid will become decisive under the new circumstances of competition. Community law does not forbid Member States to maintain subsidy schemes provided these do not discriminate between foreign and domestic electricity producers. This implies, for instance, that German investors, setting up wind turbines in Greece, must receive the same subsidies as the domestic investors. In order to avoid the situation of subsidising foreign electricity producers, Member States may decide to abolish subsidy schemes and implement different regulatory schemes in order to fulfil the commitments of the Kyoto agreement as well as the Community strategy on renewable energy sources.

A system of Green Certificates represents another potential policy instrument available to the Member States as well as to the Commission. The system ensures that the use of renewable energy sources account for 12% in 2010 and harmonises different national policies. Thus, provided the system is implemented efficiently, it contributes to the fulfilment of the EU commitments made in Kyoto, and improves the functioning of the internal electricity market by removing different national subsidy schemes.

2.1 A system of Green Certificates

Regulation by Green Certificates requires all consumers to purchase a fixed share of electricity based on renewable energy sources. As such, each electricity consumer is obligated to purchase for example 12% of their total electricity consumption from renewable sources.

The system differs from typical quota arrangements as it prescribes a minimum consumption quota to be implemented on the demand side. Usually, quotas are implemented as maximum quotas on either production input, production output or by-products like emissions or effluents. The fact that regulation is moved away from the production side towards the demand side may prove to be a particular strength of the certificate system because the politically sensitive supply sector is not subject to direct regulation. Regulation does not directly affect the profit function of the utilities but the utility function of the households.

A green certificate is a document certifying that a given producer has generated

[5] See Community guidelines on state aid for environmental purposes (*Official Journal* C72, 10.3.1994, page 3).

a specified amount of renewable electricity. If a producer generates for example 100 MWh of renewable electricity per year, four certificates could be issued per year, each representing the value of 25 MWh. The certificate is either issued by an authority controlling the producer, or by the producer under the control of an appropriate authority.

Each consumer must prove that he complies with his minimum consumption quota. This is proved by the ownership of Green Certificates, representing the specified amount of consumption. Consumers may purchase certificates directly from the producers. This may, however, make overall transaction costs very high due to the large number of small scale consumers. In order to reduce transaction costs, distributers may instead purchase certificates on behalf of consumers, consuming less than for example 100 GWh per year. This solution would reduce the number of actors on the market. It should be noted though, that it also would increase the potential for market dominance and the formation of price cartels.

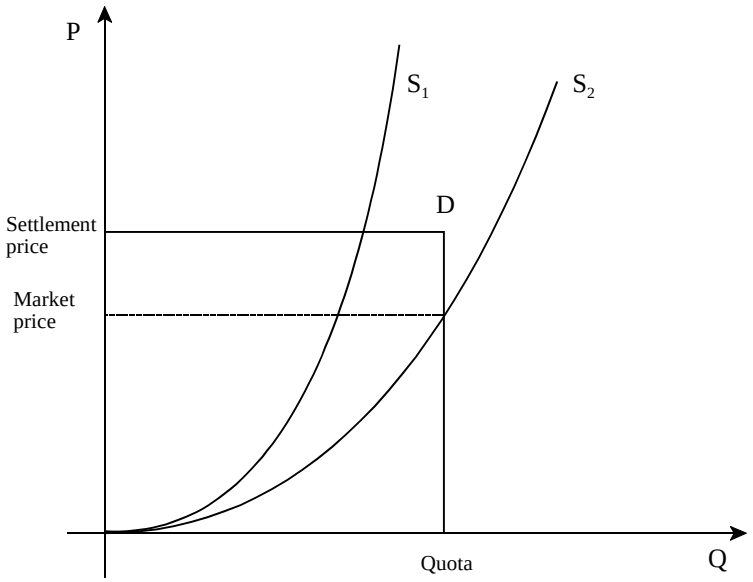
Electrons produced by renewable energy sources cannot be separated from electrons produced by conventional sources. Thus, separate markets for renewable and conventional electricity will be unduly complicated and expensive. Instead, two other markets emerge: A new financial market for Green Certificates with certificates representing a certain amount of renewable electricity, and a physical market for electricity, with green and conventional electricity traded at similar market prices. The additional cost of producing renewable electricity will be covered by the price paid for Green Certificates.

Power producers are attracted to the market for Green Certificates due to the government/EU induced demand for renewable electricity. In a perfect market, producers will choose to supply renewable electricity and satisfy demand as long as it is profitable to do so. Consequently, consumption quotas initiate a new type of demand making renewable energy sources more valuable and inducing market prices on renewable energy sources to increase. This again, initiates capacity expansions into renewable energy sources and increases the development of renewable technologies. Ideally, expansions will continue until demand equals supply. However, renewable energy sources are unpredictable compared to conventional energy because of, for example, fluctuating climatic conditions. The equilibrium amount of renewable energy capacity may thus be hard to identify as it differs between years. Consequently, certificate prices are likely to fluctuate widely making investments more risky. We will return to the issue of risk management in section three.

Like in any other well-functioning market, the price in the certificate market is determined by supply and demand. However, in this market demand is induced

by the obligation to purchase the specified amount of certificates, and not *per se* by a willingness to pay the additional costs of renewable energy. Therefore, the demand curve will be vertical up to a maximum price determined by the settlement rate that consumers must pay if they are not in compliance with their quota. The politically determined settlement rate represents the maximum price consumers are willing to pay for Green Certificates and thus the upper boundary of the demand function, cf. figure 2.1.

Figure 2.1 Supply and demand at a market for Green Certificates



Source: Skytte (1999)

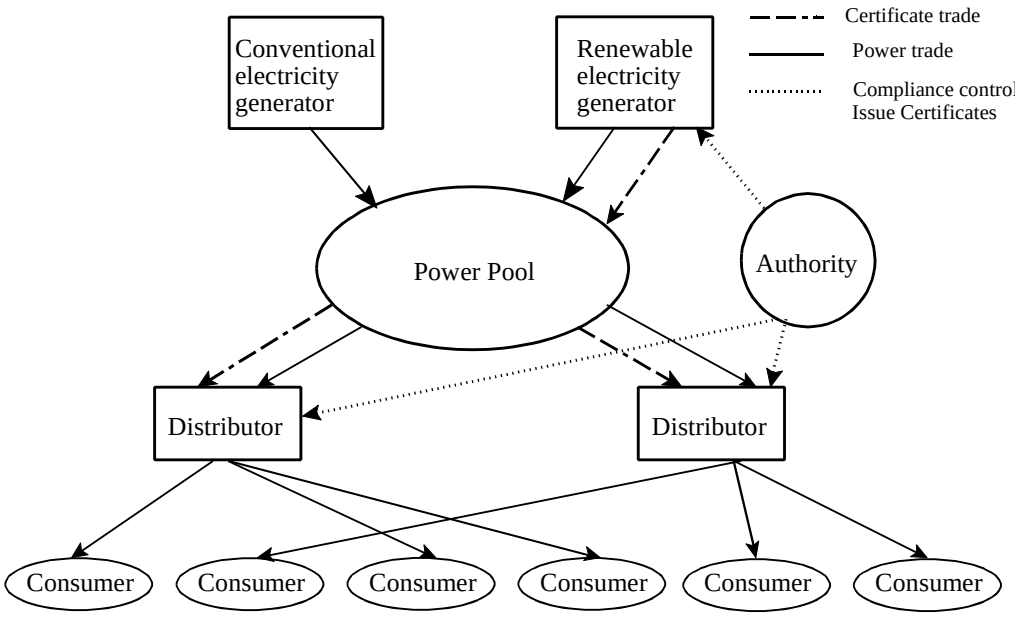
Supply, is determined by a number of factors such as costs, technology mix and expectations. The supply curve is relatively inelastic as costs of production are low once the technology is established[6]. Consequently, the supply curve is steep but upward sloping and thus intersects the demand curve as illustrated in figure 2.1. If the supply of Green Certificates is to low (S_1 in figure 2.1), the market price is determined at the horizontal part of the demand curve and equals the settlement price. If on the other hand the settlement price is high, new investments in renewable electricity are initiated resulting in higher supply. Consequently, a market price will be established below the settlement rate (S_2 in figure 2.1).

[6] Skytte, Klaus (1999): "Modelling markets for green certificates and interaction with other electricity markets. Paper presented at the workshop: Co-ordination in deregulated electricity markets, March 22-24, Ivalo, Finland.

As mentioned, Green Certificates could be traded either bilaterally between distributors and producers, or centrally at a pool. In order to gain transparency, a centralised certificate pool would have to be established. A centrally organised pool will lower search costs as well as informational rents. Certificate trades could either be organised through the existing stock exchanges or through the electricity pool that will mature with the liberalisation of the electricity market.

Figure 2.2 illustrates the market structure for 'green' as well as 'conventional' electricity and the market for Green Certificates. It is assumed that certificate trades are carried out via the power pool and that distributors fulfil the minimum quota on behalf of the consumers. National or EU authorities carry out the functions of controlling that distributers are in compliance with minimum quotas and issue the Green Certificates.

Figure 2.2 Market structure of a centrally organised market for Green Certificates



Control may be very simple in this system as the amount of watt hours delivered to the net from different sources is easily monitored. A green certificate documents that green electricity has been delivered to the net, and that the holder of the certificate is in compliance with the obligation to consume the specified amount of green electricity. Consumers/distributors must possess the required number of certificates on the day when inspection is carried out. Inspection should be carried out regularly, for instance once a year, by the appropriate Member State authority. Each certificate should be provided with a serial number containing information regarding the name of the producer and

issuer, the technology used in production, and the date of issue and of expiry. This information should be registered centrally in order to avoid any cheating or double counting. At the date of expiry, the certificate is registered as used, and thus loses its value. In the following period, the consumer must purchase new certificates.

Consumers or distributors not holding sufficient certificates by inspection may be sanctioned in several ways. One way would be to let those not in compliance make a compensation payment into a renewable fund. This fund may be used for grants supporting R&D in renewable technologies or for investment support for renewable plants. Alternatively, sanctions could be carried out by making distributors failing to meet their quota buy Green Certificates at a high settlement rate from distributors in compliance.

The European Commission has several instruments at its disposal to achieve the goals of the Kyoto protocol and its own White Paper on renewable energy. Compared to simple production quotas or uncoordinated national tax and subsidy schemes, a European system of Green Certificates would have several advantages. Green Certificates combine the advantages of Command-and-control regulation with the advantages of market based incentive regulation as the overall goal is defined by the authorities and responses are determined by the actors on the market. This induces cost-minimizing behaviour. The system of Green Certificates implies that renewable energy is produced by the most cost efficient technologies. In Europe this has the obvious implication that, for instance, electricity from wind turbines is primarily generated in Member States with a comparative advantage in this production (e.g. Denmark). These Member States consequently may produce more than the specified target while other countries will produce less wind-based electricity but perhaps more biomass-based electricity (e.g. Sweden and Finland). Thus, a system of Green Certificates equalizes the marginal costs of producing renewable energy across Member States. This is analogous to market-based environmental regulation where marginal abatement costs are equalized across Member States or across sources.

In 1998, a system of Green Labels was introduced to regulate the introduction of renewable energy production in the Netherlands. This system has several similarities to the simple system of Green Certificates described above. Therefore, the Dutch system of Green Labels will be briefly introduced below.

2.2 Experiences gained from the Dutch market of Green Labels

In the second half of the1990s, the production of renewable energy was subject to wide-ranging reforms in the Netherlands. The aim of the reforms was to increase the Dutch consumption of renewable energy to 10% of the total energy

consumption by 2020. For this reason, the Dutch energy distribution companies voluntarily committed themselves to invest in renewable energy generation. Distributors believed that a system of Green Labels could be an intriguing method to induce those investments and have therefore agreed to implement a system of Green Labels in the period 1998-2000 in order to test the system. The system is coordinated by the Association of Energy Distribution Companies in the Netherlands (EnergieNed)[7].

Dutch distributers have agreed to ensure that 3.2% of the total electricity consumption is based on renewable energy sources before the year 2000[8]. In the first phase of the programme, 1998-2000, the sale of Green Labels is based on voluntary purchase of 'green power' at a higher price by end-users. From 2001, demand will be driven by binding minimum consumption quotas.

Renewable energy producers receive a green label for each 10,000 kWh of renewable electricity they produce. Green labels are valid for one year only. This implies that excess labels issued in one year cannot be used to fulfil the quota in subsequent years. All electricity is sold at the same market which implies that electricity from renewable sources is not priced higher than electricity from conventional sources. The higher production costs of electricity from renewable sources are covered by selling Green Labels to the distributors. Thus, two markets have evolved: One in which electricity is sold, and one in which Green Labels are sold.

The market for Green Labels is expected to be divided in a market for Green Labels already issued (the spot market) and a market for Green Labels to be issued (the futures market). The futures market enables producers and distributors to close contracts on renewable energy that will be produced in the future. Trade is bilateral, i.e. directly between distributors and producers. In order to improve trading conditions, EnergiNed has opened a web site on the Internet which serves as a marketplace where supply and demand for Green Labels can meet online. The primary purpose of the web site is to facilitate the search for available labels and to identify potential buyers. In addition, the web site will contain information regarding the distribution of available certificates on the different renewable technologies, and information about the difference between the quota and the number of sold labels.

If a distributor has failed to fulfil the requirement by the end of the year he is

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[7] EnergieNed: "The Green Label". For more information see www.groenlabelned.nl

[8] Energistyrelsen (1998): "Notat om de hollandske erfaringer med et grønt marked". For more information see www.ens.dk

sanctioned by compulsory purchase of Green Labels, at a previously fixed settlement rate. These labels must be purchased from a company in compliance with its minimum quota. The fixed settlement rate is based on the principle that it should be much more profitable to purchase the labels on the free market or to generate renewable electricity than risking compulsory settlement. The Dutch Green Labels are supplemented by a number of financial compensation and bonus arrangements further inducing renewable energy generation.[9] Therefore, compliance is monitored by the tax department.

The Dutch market for Green Labels was launched on the1st of January 1998. Due to the recent start there is little information about how the system has performed. EnergieNed has, however, gathered information about 55% of the trades performed by August 1998. In this sample, 34,000 labels were traded, corresponding to 20% of the goal for 1998. 70% of the labels traded were based on renewable energy from wind turbines, 14% from water and gas[10], and 2% from biomass. All Green Labels were traded as long term contracts. 67% of these was long term contracts for 10 years or more. The average price for a label was 4 Dutch cents per kWh, or approximately 2 US cents per kWh.[11]

If the system of Green Labels proves to be a cost-effective method to induce investments in renewable energy generation, distributers plan to suggest the passing of a mandatory system in the Netherlands (the second phase). In a mandatory system, the Green Labels will be replaced by Green Certificates and annual quotas for renewable electricity will be announced for a period of the following five years.

The system of Green Labels is quite similar to the system of Green Certificates, but there are a number of differences as well. First, the bilateral trade with Green Labels will be substituted by certificate trades at the national electricity pool. This is an advantage especially for small producers because it is cumbersome to approach and negotiate with a number of different distributors. A national pool should only be approached once. Second, several of the schemes supporting and inducing renewable energy will be phased out or changed. When prices are determined on the spot markets, a guaranteed price cannot be

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[9] Several schemes supporting the Green Labels are in place: Renewable electricity is ensured a guaranteed price above conventional electricity, certain 'green funds' are exempted from paying taxes, companies can write-off 'green investments' faster than other investments, tax-deductions for large renewable energy installations, energy taxes are reimbursed.

[10] Methane from dung and waste.

[11] Drillisch, J. (1998) Quotenregelung für erneuerbare Energien und Zertifikatshandel auf dem niederländischen Elektrizitätsmarkt. *Zeitschrift für Energiewirtschaft* No. 4: 247-263.

maintained. A price-subsidy will, however, be established from 2002 and phased-out in a five-year-period. Furthermore, it is envisaged in the Netherlands that tax-deductions and speedy write-off provisions are to be replaced by schemes subsidising the installation of new plants. Energy taxes are planned to double, but this will not affect the absolute price of renewable electricity because energy taxes will continue to be reimbursed for renewable electricity[12].

3 Obstacles to a market in Green Certificates

Currently, a system of Green Certificates is being considered by the European Commission[13]. The work is, however, in a very early phase and it is still uncertain how such a system may be designed. So far, the Commission has only outlined the basic principles of the system[14], leaving several questions to be answered before a European system of Green Certificates emerges. It is, for instance, not settled how certificates should be traded and how the market should be organized. Neither is it decided how long certificates should be valid, or how the credibility of the system is secured and the risks reduced in order to initiate investments. Nor is the level of detail, that should be applied in a policy covering all EU Member States, settled. Hence, a system of Green Certificates may be very specific in the regulation of national energy policies. This may not be in accordance with the EU principle on subsidiarity.

The Dutch system of Green Labels is likely to clarify some, but not all, of these questions. The system of Green Labels has just been put into operation on a relatively small and voluntary scale. It is therefore not clear whether the experiences acquired in the Netherlands are applicable to a European system of Green Certificates.

The success of a market for Green Certificates is dependent on the creation of a transparent market based on a high degree of trust that non-compliers will be punished and that punishment will be high enough to avoid disobedience. Thus the first precondition for a well-functioning market is a credible system to ensure compliance. The second condition is that the environment for investments is safe enough to initiate investments.

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[12] Nevertheless, renewable electricity production will be affected through a change in the relative prices.

[13] Report to the Council and the European Parliament on Harmonization Requirements. Directive 96/92/EC Concerning Common Rules for the Internal Market in Electricity. COM/98/167/final.

[14] Ibid. page 5-6.

3.1 Ensuring compliance

Potential investors naturally hesitate to enter the market if they find the system of Green Certificates unreliable. If producers assume that no demand will be initiated by the quotas, no market will be created. Consumers may decide not to fulfil their quotas for two reasons. Either because sanctions are too weak or because the probability of being caught cheating is too low. Effective and credible monitoring procedures, control, and sanctions are therefore decisive for an efficient system of Green Certificates.

In a system of Green Certificates, control and monitoring must be directed towards the "green" power producers and distribution companies. The control of the producer must ensure that the electricity delivered is actually based on renewable energy sources. The control of distribution companies must ensure they comply with their consumption quotas.

Monitoring producers is straightforward in a market of Green Certificates. Every watt hour delivered from the different sources to the net is registered. Therefore, it is easy to control whether the amount of renewable electricity supplied equals the number of certificates issued. Each certificate may be provided with a serial number making identification of origin possible. By registering certificates and trades centrally, double counting is avoided and control is made easier. Registering and control may be carried out by national authorities and through the establishment of certificate pools.

It is up to Member States to sanction consumers not fulfilling their quotas. This may be done like in the Dutch system, by making non-compliers buy certificates from over-compliers at a higher settlement rate. This system may, however, be hard to carry out in a European context if domestic non-compliers would have to buy certificates from selected foreign producers. How should certificates, which are to be sold at a higher rate, be picked out if the number of excess certificates throughout Europe is high? And what if there are no excess certificates? How should sanctions then be carried out? Due to these problems, it may be better to carry out another type of sanctions as envisaged in Denmark.

In Denmark, a majority in the Parliament agreed on the principles of a new electricity reform in March, 1999[15]. This reform includes provisions regarding the establishment of a market for Green Certificates. In the Danish model it is envisaged that sanctions should consist of penalty payments earmarked to be

[15] Energistyrelsen (1999): "Aftale om ny elreform"

used for the development of renewable energy[16]. However, using penalty payments raises the question of whether the EU or the Member States should collect the penalty payments and redistribute the resulting revenue.

In the liberalised electricity market envisaged in Denmark, transmission and distribution will remain state regulated natural monopolies in order to assure third party access to the net and in order to safeguard that 'public service obligations' are observed. The regulated transmission and distribution companies have a long tradition for monitoring electricity producers while Member State authorities have a long tradition for controlling production as well as transmission. Sanctions may therefore be more effectively implemented at Member State level than at the EU level. The argument for decentralised control is further strengthened if bilateral trade in certificates is allowed. Then certificates trade is carried out directly between large scale consumers and producers which increases the need to have detailed information about the local agents in the market.

3.2 Managing the risks

The second precondition for an effective system of Green Certificates is that the environment, in which investments are carried out, is stable and provides potential investors with clear expectations about price developments. If prices fluctuate widely, the risk of investing is too high which prevents at least some investors from entering the market. Then the question is how to minimise the risks of a market in Green certificates.

One reason why renewable energy investments are uncertain is the changing conditions of production. Most renewable energy sources are difficult to predict due to climatic variations. If the rain is not falling, the sun is not shining, and the wind is not blowing, very little renewable energy is produced. Despite these changing conditions, fluctuations in the price of renewable electricity have been remarkably small in a number of Member States. This is, however, mainly due to the fact that the price of renewable electricity has been supported by subsidies and price guarantees ensuring the producer a minimum price. When a system of Green Certificates is implemented, minimum prices will be replaced by Green Certificates. The price of the certificates is, of course, highly uncertain. Therefore, it has been claimed, by for instance Danish shareholders of wind turbines, that Green Certificates will make investments in renewable energy more uncertain compared to the existing price guarantees. There are, however, also arguments for the opposite to be true and ways to minimise the risk.

[16] Energistyrelsen (1998): 'Notat om det grønne elmarked, herunder overgangsordning'.

In a spot market, the price rises when supply is short. Therefore, in years when climatic conditions are unfavourable, the supply of Green Certificates will be low relative to demand, putting an upward pressure on certificate prices. In a system of subsidised prices, prices are guaranteed no matter the level of kWhs produced, but the volume of kWh is still unpredictable. Therefore, a system of Green Certificates may create a more stable investment environment than subsidy schemes as higher prices on certificates counterbalance reduced earnings due to lower production. Therefore, it is possible that over time earnings are more stable with a system based on Green Certificates than with a system based on price guarantees.

The argument presented above assumes that certificate trade can only take place in a climatically and technologically homogenous market. A market like that of the EU is, however, not homogeneous. The EU covers a wide area and even if the wind is weak in Southern Europe it may be strong in Northern Europe. This has the consequence that the certificate price in low-wind areas will not rise because certificates can be purchased from high-wind areas. Consequently, higher certificate prices may not counterbalance decreased supply of certificates due to climatic variations for the local producers, specialising in one technology. One way to counterbalance the fluctuating prices on certificates would be to spread the risk by diversifying production on different technology types and different locations. This is, however, not a possible solution for small-scale producers and insurance may be needed in order to deal with this type of risk.

In the Netherlands, Green Labels initially were valid for one year only. The unfavourable consequence of short-lived credits was that trade was not possible in the beginning of the year when no credits were yet produced. However, consumers may expect price elasticity on the supply side to rise infinitely at the end of the year because the credit is worthless in the following year. This may cause the certificate price to drop to zero if the market is characterised as a "buyer's market". If this is recognized by the consumers there will be no trade during the year but at the end of the year. Thus, the market for certificates with finite validity is likely to be inefficient. If consumption quotas are mandatory and the market is characterised as a "seller's market", certificate prices may also be very close to the fixed settlement price. In a seller's market, producers may hold back certificates in order to put an upward pressure on certificate prices. If purchasers regard penalty prices as a real threat and if they fear under-supply, then they will be willing to pay a price very close to the fixed settlement price. Clearly, certificates should be valid for more than one year. That means banking should be allowed in order to transfer unused certificates to be used in the following years. Banking reduces the risk for both consumers and producers as price fluctuations are reduced and the planning horizon becomes wider.

A further risk aspect, which may hinder an efficient certificate market, is that investors are unfamiliar with such a market. Under these circumstances, risks and uncertainties are perceived to be very high which may make potential investors reluctant to invest or to enter the market. If this is the case, the supply curve will be vertical and, in the short term, placed to the left of the demand curve.

An important way in which to reduce the risk of investing in renewable technologies, is to set up a futures market for the Green Certificates along with the spot market. By selling futures producers of renewable energy commit themselves to provide the buyer with Green Certificates at a fixed price in the future. This is of benefit for the producer as he is guaranteed the sale of his production and his investment becomes safer. A futures market also benefits the purchaser of credits as purchasers may be uncertain whether enough certificates will be supplied in the future for them to fulfil their quotas and to avoid penalty. In order to make the market even more flexible, a market of future options could be created. Overall, a futures market would bring continuity into the system and reduce the risk on behalf of both the supply and the demand side.

3.3 Incentives and disincentives in a market for Green Certificates

In section two, it was claimed that consumption quotas may ease implementation as the production sector is not directly regulated by these quotas. However, it may be a problem that quotas are tied to consumption and that 'green' and 'conventional' electricity are complementary goods.

Assume that minimum consumption quotas of renewable electricity are fixed at 50% of total electricity consumption. Then electricity prices will be determined as:

$$P = \frac{MC_{conventional} + MC_{renewable}}{2}$$

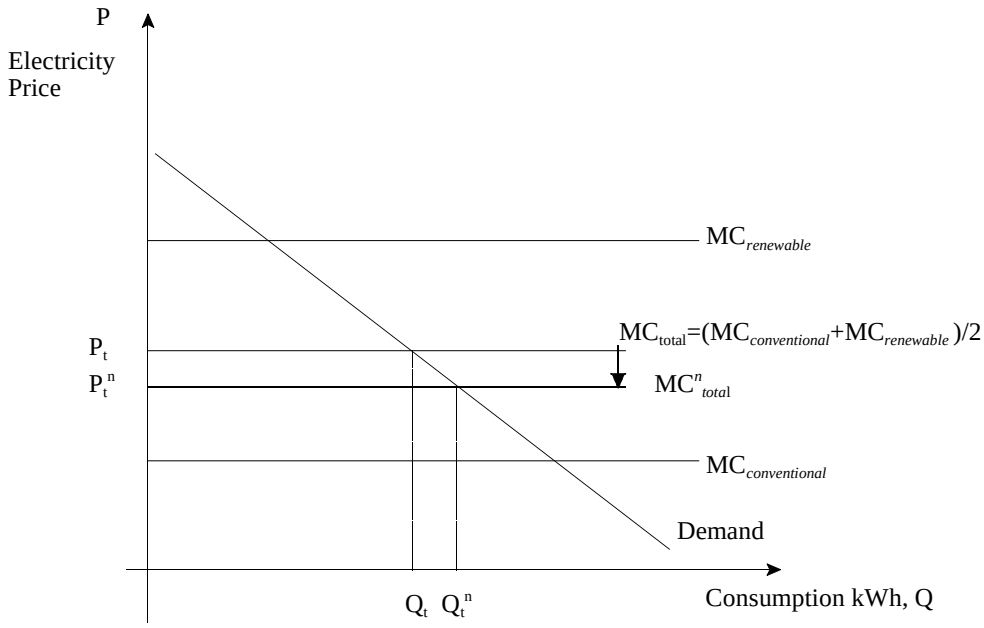
Assuming a stable demand as shown in figure 3.1, this results in the consumption of Q_t kWh.

Assume now that electricity based on renewable sources becomes cheaper due to the introduction of a new efficient technology. The new technology changes the total marginal costs from MC_{total} to MC^n_{total}, increasing demand of electricity to Q_t^n.

However, due to complementarity of demand, demand after conventional electricity increases along with demand after renewable electricity.

Consequently, the introduction of new efficient renewable technology types may increase conventional electricity demand in a system of Green Certificates because quotas are implemented on the demand-side and electricity is sold in the same market irrespective of the fact that renewable and conventional electricity may be regarded as two different commodities. Hence, a system of Green Certificates may have contradictory properties: If the system is successful, investments and innovation of renewable energy sources will rise, the costs of renewable energy generation will fall and demand after conventionally produced electricity will rise resulting in adverse environmental effects.

Figure 3.1 Complementarity in the electricity market when renewable and conventional electricity is regarded as one commodity



The adverse environmental effects are, however, not unavoidable. A natural response to falling prices of renewable electricity would be to increase the consumption quota of renewable electricity. Naturally, this reduces the adverse environmental effect of Green Certificates.

3.4 Relations to the principle of subsidiarity

The principle of subsidiarity means that the EU should take action only if the action can be attained more sufficiently at the EU level than at the Member State level. According to the fifth action plan, subsidiarity should be implemented in a way that ensures the mixing of actors and instruments at the

appropriate levels.[17] The Commission has implemented subsidiarity as a new law-making procedure with the EU determining the goal and leaving it for the Member States to determine the means to achieve the goal[18]. In a European system of Green Certificates, the EU is determining the goal (e.g. 12% of electricity consumption must be renewable), but it does not necessarily leave it to the Member States to decide how to achieve it.

Traditionally, each Member State has decided the share and types of renewable technologies to be implemented. However, as quotas in a green certificate system are implemented on the demand-side, it is left for the suppliers to decide which types of renewable technologies to implement. Evidently, the most competitive technologies being the ones with the lowest certificate prices, will be implemented first.

Seen from an innovative perspective, this may not be optimal as it may delay the innovation of technologies which are not competitive in the short run, but potentially competitive in the long run (e.g. wave and solar energy). Therefore, in order to secure the development of uncompetitive renewable technologies some Member States may regard it as appropriate to prescribe different levels of different technologies to be consumed. The Danish government may determine, for example, that 25% of renewable energy should be produced by biomass technologies in order to induce domestic producers to innovate those technologies. The fixing of quotas on certain technologies may also be implemented by defining a different value on certificates generated by the technology in question. Certificates generated via solar energy may, for example, be worth 50% more than certificates generated via wind turbines due to political priorities.

However, in the Internal Electricity Market with an EU system of Green Certificates this option is no longer appropriate. In this situation, the national government cannot force electricity producers to use specific technologies because it would induce unfair competition to the producers.

As mentioned, due to natural monopoly characteristics of transmission and distribution companies, these remain subject to state regulation in the Internal

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[17] Environmental Action Programme 19993-200, 'Towards sustainability', *Official Journal* C138, 17 May 1993.

[18] See for instance the proposals for new water policy directives: Proposal for a new bathing water directive, COM(94) 36 final, proposal for a directive on the ecological quality of water, COM(93) 680 final, Proposal for a new drinking water directive, COM(94) 612 final, and proposal for a directive establishing a framework for Community action in the field of water policy, COM(97) 49 final.

Electricity Market. Therefore, the Member States have the possibility of forcing distributors to buy electricity produced by specific technologies in order to induce innovation. Such a policy would, however, not necessarily result in more innovation by domestic producers, because certificates may also be purchased from other Member States. Distributors are free to choose between producers, and would, of course, choose the producer with the lowest price. In this situation, foreign producers may oust domestic producers. Thus, if the Danish distributors are to buy renewable electricity produced by biomass technologies, Danish biomass producers may be forced out of the market by for instance, Finnish producers. Such detailed regulation of technology choice would of course not be cost-efficient but it might, nevertheless be desired by some Member States. These Member States may obstruct a system of Green Certificates due to subsidiarity reasons because their possibility to determine the mix of renewable technologies is threatened.

4 Green Certificates and the flexible mechanisms of the Kyoto Protocol

In 1997 the third Convention of the Parties to United Nation's Framework Convention on Climate Change (UNFCCC) was held in Kyoto, Japan. At this summit perceptible progress was made towards a global warming agreement containing legal rights and obligations for the Parties signing and ratifying the Protocol. The Kyoto Protocol contains three flexible mechanisms for cost-efficient greenhouse gas (ghg) abatement. Below, these mechanisms will be briefly introduced in order to discuss and compare their differences and similarities as well as their compatibility with a European market of Green Certificates.

4.1 The flexible mechanisms of the Kyoto protocol

Though the flexible mechanisms are all incorporated in the Kyoto Protocol, it is not specified how they are to be designed and implemented. For all three instruments the Protocol refers to the Convention of the Parties (CoP) or to the CoP serving as the Meeting of the Parties (CoP/MoP) to elaborate technical, institutional and procedural details[19]. Since the flexible mechanisms have not been thoroughly defined, the comparisons made with Green Certificates will be based on several assumptions regarding the specific implementation of the mechanisms.

The flexible mechanisms introduced with the Kyoto Protocol are Joint Implementation (JI), Emission Trading (ET) and the Clean Development

[19] UN FCCC, *the Kyoto Protocol*, 1997

Mechanism (CDM).

Joint Implementation may be defined as: 'An Annex B[20] state Party or an enterprise in that state, carrying out a part of its commitment to reduce ghg concentrations in another Annex B Party'. A JI transaction involves an agreement between an 'investor' and a 'host' in which the host provides for ghg abatement services and transfers a quantity of this ghg abatement to the investor. The transferred ghg abatement is referred to as 'credits'. Credits gained by JI investments may be reported to the relevant institution of the FCCC and thereby included in the national ghg account. In return for credits, investors provide host Parties either with financial resources, energy technologies, human capital or any transfer the Parties may agree on.

Emission Trading enables Annex B Parties to trade a portion of their assigned ghg amount (their emission quota). Parties reducing emissions below the assigned amount are allowed to transfer these surplus emission permits to another Annex B Party. The main difference between JI and ET is that JI is based on bilateral trading while ET is based on a fully integrated multilateral trading system. Under a JI system, investors will finance specific projects and, depending on the organisational structure, negotiations and transactions will be carried out directly between project partners. Project partners accordingly will agree on a price per ton of ghg reduction and the amount of ghg abatement to transfer. Under an ET system, participants will purchase fungible disaggregated permits at a pool, whereas the market price will be determined by demand and supply of ghg units.

A second significant difference between JI and ET is that the JI policy seeks to pursue other goals than ghg abatement, although abatement is the primary objective. Other objectives in this respect could be closing the efficiency gap or increasing the living standard of the host countries. These considerations are usually based upon distributional aspects and once the large economic differences of the Annex B countries have been smoothed out, JI may lose its relevance. However, the fact that JI takes multiple aspects into consideration might make the mechanism more politically acceptable than ET.

As the **Clean Development Mechanism** is based on bilateral project level trading, this instrument also has certain similarities to JI. The main difference between JI and CDM would be that host countries are developing countries not committed to fulfil a reduction target under the Protocol. In contrast to JI and ET, the Kyoto Protocol furthermore identifies three institutional aspects to be

[20]Annex B countries include the OECD member countries, a number of former Soviet republics and the Central and Eastern European countries.

implemented under the CDM. Such an aspect is related to the establishment of operational entities certifying emission reductions resulting from each project. In addition, the CDM is to be supervised by an executive board. Finally the CDM is to assist in arranging funding of other CDM projects.

4.2 Green Certificates and the Kyoto mechanisms

Green Certificates and the Kyoto mechanisms possess several common features and complement each other in a number of respects.

Green Certificates equalize the marginal costs of producing renewable electricity while the Kyoto mechanisms equalize the marginal abatement costs. For that reason, all four instruments therefore present cost-efficient means to reduce ghg abatement. The Kyoto mechanisms and the certificates, however, differ with respect to environmental certainty. As such, the Kyoto mechanisms are applied under a specific target for ghg emissions and the environmental impact is known in advance. Green certificates, on the other hand, define a minimum target for renewable electricity consumption. Therefore, the environmental impact of certificates is dependent on which type of conventionally produced electricity the renewable sources substitute.

In the Kyoto Protocol it is stated that the flexible mechanisms must be supplemental to domestic abatement. During CoP4, the EU strongly defended a strict definition of the criteria of supplementarity. As such, the EU suggested that at least 50% of each Party's commitment must be fulfilled by domestic ghg abatement. A system of Green Certificates contributes to fulfilling the criteria of supplemental action as the share of renewable energy sources is increased throughout the territory of the EU.

The Kyoto mechanisms may be implemented either by a common UN policy or by each Party defining its own criteria on which basis the instruments will be implemented. The EU Member States have signed the Kyoto Protocol both as individual Member States and as one Party under the auspices of the EU. Therefore the EU may decide to implement the Kyoto mechanisms within a common EU framework. In terms of EU and the Kyoto mechanisms, ET is the most relevant mechanism to implement as a common EU policy including Member States only. CDM and probably also JI include countries outside the EU, and policies regarding these instruments must be based on negotiations between all relevant Parties. ET may be carried out between Member States in an EU market and assigned amounts have already been defined by the internal

EU burden-sharing agreement[21].

Both Green Certificates and ET are most appropriately organised through a centralised market - a pool. In order to provide transparency and to reduce transaction costs, a futures market should be organised along with the spot market. Another similarity regards the fact that price elasticities may be infinite if it is not allowed to transfer units produced or bought in one year to the subsequent years. Therefore, the trade of assigned amounts and Green Certificates should be organised similarly through a pool with banking opportunities and a futures market. However, it is clear that Green Certificates and assigned amounts are not directly tradable with each other, as the units contained in a Green Certificate consist of renewable watt hours while the units traded via assigned amounts are CO_2 emission rights.

It is, however, very likely that the two markets have a mutual impact. For instance, if a system of Green Certificates imposes on each consumer to purchase an increased share of renewable electricity, higher demand increases the certificate price, attracting more investments to the production of renewable electricity. When the consumption of renewable electricity increases, the consumption of conventionally produced fossil fuel electricity presumably decreases correspondingly. Consequently, CO_2 emissions decrease and parts of the assigned amounts are released from the national ghg accounts. These parts of assigned amounts (or emission permits) are tradeable on the ET market and may be traded either in the EU or on the world market. Producers of renewable electricity may thus gain a double bonus via the ET system because Green Certificates trigger trade on the ET market.

Of course an efficiently implemented ET system would be sufficient in order to achieve the desired level of emissions. In this respect it need not be supplemented by a system of Green Certificates. A system of Green Certificates is, however, designed to regulate the electricity sector specifically. Therefore, a system of Green Certificates may supplement an ET system if it is an explicit political objective to increase the share of renewables in the production of electricity. An ET system alone cannot regulate a specific sector in detail.

The fact that a system of Green Certificates can be used as a detailed energy sector regulation may cause some Member States to oppose to the system. In some Member States a system of Green Certificates may be viewed as a system

[21]With the Kyoto Protocol 'bubbles' were introduced as a fourth flexible instrument. Bubbles are not based on trade and so far the EU is the only Party to the Protocol officially forming a bubble. A bubble-policy implies that countries within the bubble may redistribute ghg commitments internally.

which assign powers to the EU level which Member States should have. In an efficiently implemented system of Green Certificates it is no longer possible for Member States to maintain the different support schemes that promote renewable energy. Therefore, a system of Green Certificates implicitly harmonises national renewable energy policies. An ET system does not require such harmonization. On the contrary, in an ET system the EU only determines the environmental target and leaves it for the Member States to choose the means to achieve it. Consequently, Member States can maintain different support schemes promoting renewable energy.

Another factor which seems to show the benefit of an ET system over Green Certificates is market potential. It is well known that the success of a market depends on market potential. The market potential of an ET market is obviously larger than the market potential for Green Certificates, as the certificate market only constitutes one part of the total ET market. The ET market involves large CO_2 emitting sectors outside the electricity sector such as transport, industry, forestry and agriculture.

A potential barrier of an ET system compared to Green Certificates relates to the initial distribution of rights and obligations. In a system of ET, rights must be distributed initially with regards to emissions. The EU recently agreed to a burden-sharing agreement. This agreement allows the southern Member States (and Ireland) to increase ghg emissions in the period 2008-2012 compared to 1990-emissions while most northern Member States (except Sweden) are to carry out substantial emission reductions. Although, Member States have agreed to the burden-sharing agreement, it is rather questionable if they will actually respect this initial allocation if a European ET system is implemented. Will Member countries with energy-efficient production sectors agree to the fact that they must bear the ghg abatement costs of the countries that have done very little to increase energy-efficiency? This question may imply widespread political controversies inside the EU. A system of Green Certificates partly solves this issue as regulation is implemented on the demand side. No Member State is given an obligation to reduce ghg emissions by a certain amount. Obligations are rather placed with the individual EU citizen and changes in production will take place due to changes in demand. As such, production changes will take place where these are implemented at the least costs, and marginal costs of compliance are equalised throughout the EU.

5 Concluding remarks

With the liberalisation of the European electricity market, new instruments are searched for in order to coordinate climate change initiatives with competition. In this paper we have argued that a European system of Green Certificates is a

cost-efficient method to induce renewable energy production and to reduce CO_2 emissions. A system of Green Certificates combines the advantages of command-and-control regulation with market-based incentive regulation as the goal is determined centrally by for instance the EU, and the market ensures cost-efficient behaviour by producers and consumers.

In a system of Green Certificates, producers receive certificates corresponding to the amount of renewable electricity produced. Consumers are obliged to purchase certificates representing a share of for instance 12% of their consumption. Thus, producers sell certificates to consumers, and the certificate price covers the cost-difference between conventionally produced electricity, and electricity produced by renewable technologies.

A system of Green Certificates implicitly harmonise different national subsidy schemes supporting renewable energy. Because price guarantees contradict a liberalised market, these must be abolished. However, Member States may maintain subsidy schemes provided these are non-discriminatory. This implies that governments may have to subsidise foreign companies. Green Certificates imply that consumers pay the additional costs of renewable production directly through the certificate price instead of the exchequer and that governments therefore avoid the situation of subsidising foreign producers. However, Green Certificates also imply that governments lose the power of controlling the market through issuing subsidies. Therefore, the system may contradict the principle of subsidiarity and thus be opposed by some Member States.

Although Green Certificates may be a promising alternative to price guarantees, subsidies and production quotas, some obstacles do exist impeding the introduction of a European Certificate market. One of these obstacles includes the risk that consumers may find the threat of sanctions too weak and may therefore not fulfil their quotas. This implies that producers have no incentive to increase production of renewable electricity and that no market for Green Certificates is developed. In order to safeguard the credibility of the certificate market, efficient procedures for monitoring, control and sanctions must be established at Member State level.

A second factor which implies that a European market for Green Certificates may not develop is the risk characterising the generation of electricity based on renewable sources. The price of Green Certificates is difficult to predict due to the fact that many production technologies are dependent upon climatic circumstances. In a market with production based on homogeneous technology types, low production of renewable electricity in years with poor climatic conditions are counterbalanced by higher certificate prices. However, in a market where electricity generation is based on several competing renewable

technologies, producers may experience great losses due to bad climatic conditions and due to low certificate prices as other technology types may perform well in these years. This type of risk may be dealt with through geographic and technological diversification of investments or through appropriate insurance arrangements.

A third potential obstacle is the life-time of the certificates. Experiences from the Dutch market illustrate that finite validity of certificates is inefficient and may bring the price-elasticity to rise to infinity. In order to provide for an efficient market without drastic price fluctuations at the end of the year, banking should be allowed in order to save up certificates for years of low supply. As such, banking implies that renewable energy may be "stored" as financial assets.

In addition to banking, a futures market for Green Certificates may reduce the risk of the market. By fixing the price of future certificates, producers become familiar with the yield of their investment, provided production is carried out as predicted. A futures market brings continuity into the system and reduces the potential risk on behalf of both consumers and suppliers.

A forth obstacle is related to the fact that renewable and conventional electricity are supplied as complementary goods at the same market price. This relationship implies that reduced prices on renewable electricity increase demand for fossil fuel based electricity, and thus have an adverse environmental effect. This adverse effect could be counterbalanced by increasing the consumption quota of renewable electricity. Hence in order to gain the intended environmental effect from Green Certificates, marginal costs of generation must be observed and the quota adjusted in accordance with these.

The principle of subsidiarity presents a final potential obstacle to a European market for Green Certificates. Member States have traditionally had the power to select a specific technology mix after their own choice. A good reason to preserve this system is that the innovation of certain technology types is given priority and thereby speeded up. In a European Certificate market such detailed regulation is still possible but no longer appropriate. Member States may specify the quotas of the consumers as regards technology shares. However, this does not necessarily influence domestic R&D as certificates from specific technology types may be cheaper abroad and no incentives will be given to domestic producers. Due to the fact that governments can no longer define the domestic technology mix in production, Green Certificates may be objected under the argument of subsidiarity.

A system of Green Certificates has a number of similarities with the flexible mechanisms of the Kyoto protocol. First of all, the instruments are cost-efficient

within their given framework. Green Certificates equalise the marginal costs of generating renewable electricity, while the flexible mechanisms equalise marginal costs of greenhouse gas abatement. Second, Green Certificates are compatible with the criteria of supplementarity as defined in the Framework Convention on Climate Change. Green Certificates, when restricted within the EU, cause ghg emissions to decrease in Europe and therefore supplement the Kyoto mechanisms. In fact, the implementation of the Kyoto mechanisms increase the value of renewable energy sources as these sources both face a value due to the kWh they produce, and due to the ghg emission reductions they generate. Regulation by Green Certificates is directed towards the electricity sector alone. The Kyoto mechanisms have a broader focus and cover all ghg emitting sectors. Due to the narrow focus, some states may view Green Certificates as too much intervention with national policies, and due to that prefer Emission Trading as a regulatory instrument. Thus, Green Certificates supplement the flexible mechanisms of the Kyoto protocol, but do not qualify as a substitute.