Chapter

9

Support schemes for renewable energy in the Nordic countries

– an introduction

In order to promote the use of renewable energy sources, different types of support schemes are used. The use of different support schemes varies a lot between the different North-European countries. The resulting economic support levels are also very different.

In this chapter the use of different support schemes is presented for the Nordic countries, both for electricity and heat production. The presentation refers to the situation in 2005. There is also a presentation of the EU directive on the promotion of electricity from renewable energy sources.

Examples of support schemes used in the Nordic electricity market are feed in tariffs, green certificates, investment support and operation support. The Nordic countries all use at least one of these schemes.

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Background

There are different reasons for promoting renewable energy in different countries.

- Mitigation of CO_2 and other emissions
- Security of supply (self-sufficiency, diversification)
- Development of new energy technology
- Employment and local economic development
- Sustainable development

Support schemes are needed because in general, renewable energy sources (RES) are not competitive in the market.

The support levels for renewable energy are very different in the different North-European countries. For example Germany has a substantially higher level of support for renewables in power generation, while other countries, such as Iceland and Norway, have very low support levels. This of course affects the investment climate for new renewable power in different countries, but it should be noted that there are several other factors that are important when taking investment decisions, e.g. local physical conditions for renewables, other production taxes or environmentally related taxes such as carbon, or fossil fuel taxes. (In Iceland and Norway in principle all electricity production is based on renewable energy sources, in spite of the fact that support levels are low.)

Issues regarding support schemes for renewable electricity are important because they fundamentally influence the liberalised Nordic electricity market, and because both the support schemes and their consequences are complex.

Support schemes and support levels in the Nordic Energy systems

There exists a variety of support scheme constructions on the Nordic/North European energy market, both for electricity and heat:

- Feed-in-tariffs (fixed price or premium)
- Quotas + tradable green certificates
- Investment support
- Tax incentives (tax rebates, direct production support, environmental bonus…)
- Taxation of fossil fuels in heat production
- R&D support

The electricity market

In the following table the main elements of current electricity production sector support schemes in the Nordic counties are indicated (valid for 2005, comparisons made for Germany and Poland). For further description on individual countries, we refer to the country specific sections in the sub-chapters below.

Table 9.1: Electricity market – support schemes

Type of support scheme	Denmark	Finland	Norway	Sweden	Iceland	Germany	Poland
Feed in tariff						●	
Green certificates				●			●
Investment support		●	●*				
Operation support	●	●**		●***			

*) Only wind power receives support, indirectly biomass electricity production will receive support through Enova's "varmeprogram"

**) Constructed as a tax rebate

***) Operation support only for wind power, will be phased out after 2009 for land based wind power.

The Nordenergi working group has translated the different support schemes into support per produced MWh as shown in the Figure below. The calculation shows that there are large differences in support per MWh in different countries. The figures are valid for the situation in 2005.

Figure 9.1: Level of typical resulting electricity price for different types of renewable electricity production

The figure shows the high fixed electricity price for renewable electricity production in Germany, typically twice the price level that Nordic renewable electricity production experience. (In the figure constant market price on electricity in the Nordic countries have been assumed. The electricity certificate price i Sweden may vary. Here the typical 2005 level is assumed.)

Other important factors influencing the investment climate

These differences in support levels of course influence the investment climate for new renewable power in respective countries, but it should be noted that also other factors are important for the investment climate. Examples of such factors are:

- The level of carbon or fossil fuel taxes changes the competitive situation for CHP plants.
- Other taxation issues

- Perceived stability of the support scheme – is it politically stable or not? For how long will this support scheme exist?
- Predictability of which monetary level the support will be at, during the economical life time of the investment
- Other administrative hinders and processes, such as the time to receive the necessary environmental permits
- Acceptance by the general public for different technologies
- The local physical conditions for renewable energy sources

Hence, it is not straightforward to present a complete picture of the relative investment climate for renewable electricity production in each country.

The heating market

In the following table the main elements of current support schemes in the heating market for Finland, Sweden, Denmark and Norway are indicated (valid for 2005). For further description on individual countries, we refer to the country specific sections in the sub-chapters below.

Table 9.2: Heating market – support schemes

Type of support scheme	Finland	Sweden	Denmark	Norway
CO_2 tax on fossil fuel	•	•	•	
Green certificates		•*		
Investment support	•	•**		•
Operation support		•***	•****	

*) For biomass CHP
**) Investment support for individual heating for biomass, solar heating…
***) Constructed as a tax reduction for biomass
****) PSO and state-support for gasfired decentralised plants and waste fired plants. Support for future biogas fired production

The European RES support schemes picture and the EU RES directive

Different dimensions for support schemes are shown in Figure 9.2. The first dimension is where the financing of the support scheme comes from: from the government or from the customers. The second dimension is who defines the support/price level and who defines the amount of RES. (It could be the authorities or the market). Different combinations of set-up for these dimension defines different types of support schemes.

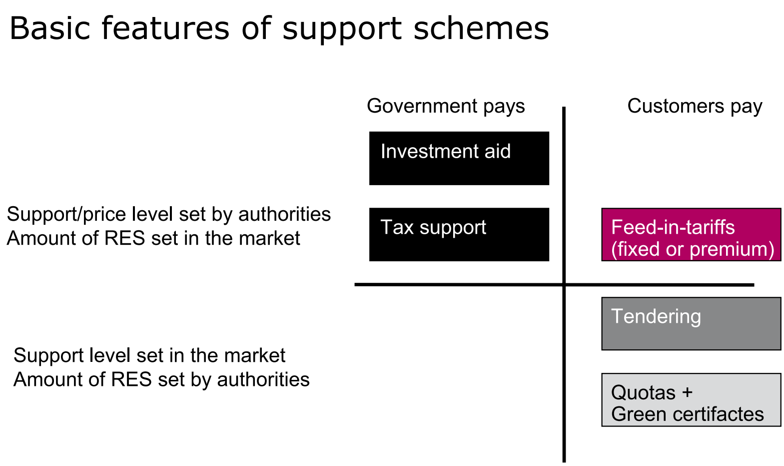

Figure 9.2: Basic features of support schemes

The use of different support schemes in EU countries and in Norway is presented in Figure 9.3. The figure shows that feed-in tariffs is the most widely used support scheme.

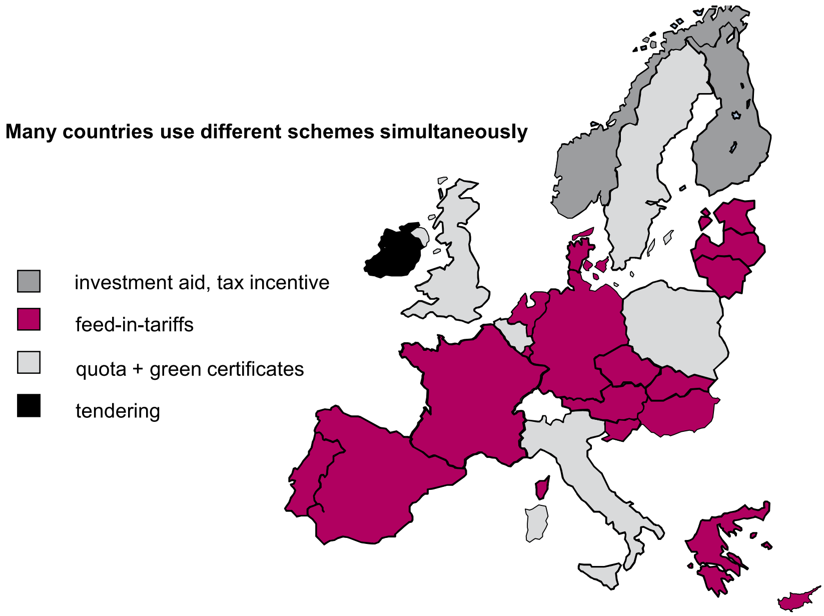

Figure 9.3: Main RES support schemes in EU countries and in Norway

The EU directive

The promotion of electricity from renewable sources of energy is a high. The promotion of electricity from renewable sources of energy is a high Community priority for several reasons, including security and diversification of energy supply, environmental protection and social and economic cohesion.

The Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market [Official Journal L 283 of 27.10.2001] follows up the White Paper on renewable sources of energy (RES) which confirmed a target of 12% of gross inland energy consumption from renewables for the Community as a whole by 2010. Electricity produced with renewable sources should represent 22.1% of the electricity consumption in 2010. It also constitutes an essential part of the package of measures needed to comply with the commitments made by the EU under the 1997 Kyoto Protocol on the reduction of greenhouse gas emissions.

Every five years, starting from October 2002, the Member States must adopt and publish, a report setting the indicative Member State targets for future consumption of renewable electricity (RES –E) for the following ten years and showing what measures have or are to be taken to meet those targets. The Member State targets must take account of the reference values set out in the Annex to the Directive for Member States' indicative targets concerning the share of electricity produced from renewable energy sources in gross electricity consumption in 2010. The targets and measures must also be compatible with all the national commitments entered into as part of the commitments accepted by the Community at Kyoto.

For the Nordic counties the reference values in Annex 1 to the RES-E directive are as presented in Table 9.3.

Table 9.3: Reference values for electricity from renewable energy sources

Country	RES-E 1997 (TWh)	RES-E 1997 (% of electricity production)	RES-E target 2010 (% of consumption)	RES-E raise to 2010 compared to 1997 (TWh)
Denmark	3.21	8.7	29	
Finland	19.03	24.7	31.5	
Norway	115	99.5	90**	10
Sweden	72.03	49.1	60.0*	17*
Iceland	5.57	99.9	99.5	0.5

*) Sweden have objected to this figure on the grounds that it is difficult to single out one year as a representative one. The annual production of RES-E varies a lot due to climatic factors. The figure Sweden has accepted is 54 %, which corresponds to 10 TWh in the last column.
**) This target is not yet decided, but is the Norwegian position in the ongoing dialogue with the EU commission.

In 2007 the Commission plans to set new indicative targets on the EU level for 2020.

EU Evaluation of support schemes

The Commission published a communication on "The support of electricity from renewable energy sources" on December 12, 2005. According to the communication the current level of support for renewable electricity differs significantly among the different EU member states. Effectiveness of different support schemes are analysed in the communication. The Commission does not propose European harmonisation but proposes a process of optimising of national systems. This means, for example, increase of stability, reduction of administrative barriers, and ensuring compatibility with the internal electricity market.

Political renewable support in the Nordic countries

Below is a short description of the political situation on renewable support in the each of the Nordic countries.

Denmark

Current and future politics

It is unlikely that the current policy regarding land based wind power will be changed in the short run. At the moment the building of two new wind farms (2x200 MW) at sea are going through tender processes. The result of the first tender was made public at the end of June 2005, and the guaranteed price was fixed at 518 DKK/MWh (market price plus subsidy) for the generation of 50,000 hours of full load (which is equivalent to approximately 12 years of production). A part of the political reasoning behind the decision to build the two wind farms is to stimulate and support the Danish Wind Power Industry.

Establishing new wind power is not seen as a measure to reach the Danish climate target although recent signals from the government indicate that this could be changed in the near future.

Current support schemes

The significant increase in wind power production has been reached primarily due to large subsidies for wind power in the late nineties. This was however changed by 1. January 2003. Since then the subsidy has been 100 DKK/MWh on top of the market price for electricity.

There is also a "Skrotningsordning for landvindmøller"; a system which gives a mark-up on the electricity price (12 øre/kWh) for reconstruction of windmills (from old and small windmills to new and more efficient windmills). From 2004 to February 2006, this scheme has only contributed to 12 MW new capacity.

These support schemes have not been considered good enough to lead to investments. The build out of new land based wind power has therefore come to almost a complete stop.

Regarding biogas, the subsidy is considerably higher as the price is set at 600 DKK/MWh including market price on electricity. It is however at the current stage still not sufficient to stimulate the build out of new plants.

Planned changes to supporting scheme structure

The call for tender indicates that there is no immediate plan to join the Swedish certificate system although the possibility of a Swedish/Norwegian/Danish system has been discussed informally

Finland

Current and future politics

Corner stones of Finnish energy policy are energy, economy and the environment. This means that the aim of the energy policy is to secure energy supply, a competitive price of energy and fulfilment of environmental commitments, e.g. reduction of greenhouse gas emissions.

According to the current National Energy and Climate Strategy, the main measures to reduce Finland's CO_2 emissions are promotion of renewable energy and efficient use of energy, and reduction of carbon intensity in energy production. The emission trading scheme is a new strong steering instrument, which covers nearly all thermal electricity generation and most of the district heat and process heat production in Finland. The strategy has therefore been revised. This is discussed further in a section below.

In addition to reduction of CO_2 emissions, reduction of other environmental emissions, improvement of self-sufficiency in energy, employment, regional development and development of new energy technology have also been reasons to promote renewable energy in Finland.

Current support schemes

Renewable energy sources in Finland are supported by investment aid and by taxation. Funds are also granted for technology development and commercialisation of renewable energy technologies.

Power plants that use renewable energy can get aid to their investments. The share of aid varies depending on the technology used and the size of the power plant. At maximum the support can be 30-40 % of investments for wind power plants. For larger power plants which combust wood fuels, the support has typically been limited to 5-10 % of investments. New large hydro power plants over 10 MW of size are excluded from the support scheme. Aid can also be granted to investments related to production of renewable fuels. The total investment aid to RES was Euro 24.5 million in 2004.

Electricity produced from renewable energy sources can get direct support (tax refund). The total amount of direct support to RES (tax refund) was about Euro 32 million in 2004 (preliminary data).

Tax must be paid for fossil fuels used for heat production, which improves the price competitiveness of bio energy. As electricity from bio energy is mainly produced in CHP power plants, fossil fuel taxation also indirectly enhances electricity production from renewable energy sources. For example, for hard coal the tax in heat production is about 6 Euro/MWh.

In 2004 about Euro 16 million was provided in funding for R&D projects relating to RES and energy use of waste.

In total, investment aid, direct support (tax refund) and funding of R&D projects was about Euro 73 million in 2004 (preliminary).

Planned changes to supporting scheme structure

The National Climate and Energy Strategy, which was introduced by the Government in November 2005, proposes some remarkable changes to RES support policy in Finland. The strategy does not propose any new support instruments but changes to existing ones. As emission trading has increased the market price of electricity and that way increased the competitiveness of CO_2-free power generation (e.g. from renewable sources) there is not anymore such a strong reason to support renewable power generation within the emission-trading sector. That is why the strategy proposes that the investment aid should be directed to new technology and to sectors outside the emission-trading scheme. The strategy also proposes the abolishment of tax refund for electricity from industrial wood waste and residues. However, there still remain other reasons for RES support, such as security of energy supply and employment.

Iceland

Current support schemes

State subsidies or other support schemes for electricity generation do not exist in Iceland. According to information from the Ministry for Industry and Commerce it is anticipated that the RES-E Directive, 2001/77/EC, will be adopted on the European Economic Area (EAA) and Iceland will fulfill its indicative RES-E targets for 2010 of 99,5%.

Norway

Current and future politics - renewables

Even if most of the power production today is based on renewable energy, there is an established goal of introducing minimum 3 TWh wind power by 2010. This is the only formal political goal directly related to increased renewable production, and it is a sub-goal to the governmental goal for an environmentally friendly energy policy – energy savings and new environmentally friendly production should correspond to minimum 12 TWh within 2010. The other concrete goal is minimum 4 TWh increased access to biofired central heating, heat pumps and industrial waste heat used for district heating.

The wind power target was originally supplemented by a support scheme based on a combination of production support of 4.75 øre/kWh (€0.0057/kWh) and investment support. The investment support was supposed to be adjusted by a governmental agency based on an evaluation of each individual project. There is no support for other kinds of renewable power production in Norway.

The wind power support scheme was used only for a few wind projects, as the new large wind parks (notably Smøla 1.55 MW, and Havøygavlen, 40 MW) were based on export of RECS to Holland. In 2004 the production support was terminated, as only 8 GWh of wind production claimed eligible to support. From the power industry's point of view, the political risk associated with the production support system as well as the level of the investment support and the evaluation procedure, was considered a problem.

Therefore, the industry has lobbied for a mandatory green certificate system, preferably in cooperation with Sweden and other countries. This system should cover all new capacity based on renewable energy. The government presented a white paper about this in august 2004, and a proposal for a new law introducing the certificate system was presented in November 2004, with an intention of starting a common Norwegian-Swedish certificate system in 2006. However, as close cooperation with Swedish authorities are required and the Swedish process was delayed, the Norwegian certificate system was postponed until 2007. In February 2006 the negotiations broke down. Currently therefore, there is no prospect for a common certificate market and the Government has promised to publish other support schemes shortly (see Chapter 10).

When the green certificate process gained momentum in 2003, the governmental agency handling the wind power support scheme system saw a need to establish a support system that can be converted into the certificate system at a later stage. The last two years, wind projects have received investment support of up to 25 percent through a tender system, with an option to enter the certificate system at a later stage if the investment support is paid back. This investment support is generally considered to be too low compared to current costs for wind power in Norway, and only a few projects are currently under construction.

The technical potential for further increase in renewable power production in Norway, both in wind and small-scale hydro, is huge. However, new hydro faces strict environmental constraints and support to new hydro capacity is controversial. Environmental concerns are part of the discussion also when it comes to other sources of renewable electricity production, but the realistic potential for wind is still significant.

There is also a support scheme for renewable technology development, currently for tidal, wave and solar power.

Sweden

Current and future politics - renewables

The short term target is to increase the electricity production/consumption from renewable sources by 10 TWh until 2010, compared to 2002. This goal is based on the indicative target given to Sweden in the RES-E directive. With current support schemes the Energy Agency in November 2004 concluded that this target will be hard to reach without adjustments to the support structure.

New targets for renewable electricity production for 2016 have been proposed in Proposition 2005/06:154 "Förnybar el med gröna certifikat". The proposed goal for new renewable electricity production is 17 TWh within 2016 (compared with the 2002-level for renewable electricity production). The Government recently proclaimed that the long-term goal is to have a 100 % renewable energy system.

Other measures in energy politics are energy taxation on the consumer side that is being subject to a "green tax shift", witch means that taxes on e.g. labour is lowered as so called environmental taxes are raised, e.g. electricity taxation for consumers. Sweden has also a carbon tax for heat production, which affects the non-renewable fired CHP plants.

Current support schemes

Since May 1, 2003 Sweden has a system of tradable green certificates promoting renewable energy trough a governmentally decided quota obligation. The quota obligation is on the end consumers, but is handled by the electricity sales companies. The quota obligation is successively rising every year, from 7.4 % in 2003 to 16.9 % in 2010. The energy intense industry has the quota obligation 0 %. At the moment there are no quotas decided after 2010, but a change is expected, se below.

Covered renewable electricity production is:

- All windpower
- All biomass based electricity production
- Hydropower < 1.5 MW
- Production increase in all hydropower, made after the start of the system.
- Solar electricity
- Electricity production based on peat (not renewable)

The price of the electricity certificates was in average the last year (June-04 to June-05) 230 SEK/ MWh or 24 Euro/MWh, with a slight decline in the price in 2005.

When this system was introduced it replaced all other support schemes, except one “environmental bonus” to wind power.

Planned changes to supporting scheme structure

The government has proposed changes in the current green certificate system (Proposition 2005/06:154 “Förnybar el med gröna certifikat”, dated 2006-03-16). The main changes that are suggested are:

- Raised level of ambition to plus 17 TWh in 2016 compared to 2002
- Prolongation of the system to 2030, with fixed quotas until 2016
- New definition of power intensive industries (which has 0 quotas)
- 15 years time limit for how long one plant will be eligible to green certificates. The exception is for small hydro plants, witch will be phased out of the system by 2010
- A control station 2012 when the development after 2016 should be decided
- Moving the quota obligation from the end consumer to the electricity sales company

- Inclusion of the certificate price in the electricity price
- Connection between Guaranties of Origin and the green certificates, to assure that the ”quality” is accounted for in the country where the certificate is delivered

The planned changes are due to start on Jan 1, 2007.

Chapter

10

Tradable green certificates in the Nordic countries

In this chapter, a Swedish-Norwegian and an all-Nordic scheme for tradable green certificates (TGCs) are analyzed using energy-systems modelling. Some examples of how TGC schemes interact with the markets for electricity and CO_2-emission allowances (EUAs) are also given.

The analyses show, among other things, that a common Nordic market for TGCs may save around 0.5 billion EUR compared to if all four Nordic countries having separate markets with renewable-electricity targets as stated in the EU directive on renewable electricity from 2001. It is also shown that the outcome from a common Swedish-Norwegian market, which has been under discussion for the past few years, is highly dependent on the total Swedish-Norwegian ambition level (or quota). Since the Swedish target for renewable electricity is already set, the outcome, in terms of TGC prices, TGC generation and cross-border TGC trade, from a common Swedish-Norwegian market primarily depends on the Norwegian ambition.

However, while a TGC scheme has been in operation in Sweden since May 2003, the interest in TGC schemes in the other Nordic countries is currently low. The relatively advanced plans for a common Swedish-Norwegian market have, just recently, been postponed indefinitely. It currently seems likely that Norway will choose other support schemes for new renewable electricity production.

The interaction between the markets for TGCs, EUAs and electricity is complicated. Depending on the causes of price changes on the TGC market, wholesale electricity prices may be both unaffected and reduced. The impact on retail electricity prices is even more complex since these prices may, in theory, increase as well as decrease depending on the

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causes of TGC-price changes. Price increases on the EUA market, however, tend to reduce TGC prices in a very direct manner, at least in theory. On the other hand, this has not been the case on the Swedish TGC market. Despite dramatic increases in EUA prices and, thus, wholesale electricity prices, the Swedish TGC price has remained fairly stable.

Introduction

Background

The White Paper on renewable energy within the European Union (EU) sets as a target to increase the share of renewable energy from the present 6 to 12 percent (22 percent for electricity supply) by 2010 (European Commission 1997). As a consequence, directives for national targets among member states for electricity supply based on renewables were proposed (European Commission 2001).

To stimulate renewable electricity, some European countries have chosen to initiate market-based schemes through tradable green certificates (TGCs), e.g. the Netherlands, the UK and Sweden - while other countries, for example Germany and Spain, have hitherto chosen regulated systems through *e.g.* feed-in tariffs. The other three Nordic countries, Norway, Finland and Denmark, have to different degrees shown interest in choosing TGCs as a future means to stimulate renewable and/or small-scale electricity supply, but have, hitherto chosen other means to stimulate new electricity production based on renewables.

The principle of TGC markets

The principle of TGC schemes is that generators of renewable electricity that are included in the TGC scheme (*e. g.* existing small-scale hydro power, biofuel-based power, wind power, power supply from photovoltaics, new hydro-power schemes as in Sweden) have the right to sell TGCs in proportion to produced electricity (*e.g.* one certificate for each MWh produced). The demand for these TGCs is ensured through an obligation put on *e.g.* electricity end consumers to purchase a certain amount of renewable certificates in a specific proportion to their electricity use (*e.g.* ten percent of total electricity demand has to come from power production that is allowed to issue TGCs). In Sweden, the purchase of TGCs is managed by the electricity retailers. Since there is a demand for and a supply of TGCs, a market price will emerge on the TGC market. This market price is the additional income for a TGC generator in excess of the market price for electricity.

After this introduction, the present chapter proceeds by giving a short overview of the current status of TGCs in the Nordic countries. Subsequently, a number of model results from previous studies relating to international TGC markets are presented and discussed. The international markets that are being dealt with here are both a common Swedish-Norwegian TGC market and an all-Nordic TGC market including also Denmark and Finland. Finally in this chapter, the interrelationships between the markets for TGCs, electricity and EUAs are analyzed and briefly discussed.

Current status in the Nordic countries

We begin this chapter with a brief overview of the current status (March 2006) related to TGCs in the Nordic countries.

Sweden

The Swedish TGC scheme has been in operation since May 2003. The goal is to induce investments in renewable electricity that will generate 10 TWh in 2010. This comes in addition to the approximately 6 TWh that were generated in 2003. Electricity generators that may issue TGCs are new hydro-power schemes, existing small-scale hydro-power schemes, biofuel CHP (including peat but excluding waste incineration), wind, geothermal, solar and wave. In 2004, 11 TWh of electricity were produced by facilities under the TGC scheme. Out of these 11 TWh, 75 % was produced in biofuel-based power plants, 18 % in hydro plants and the remaining 7 % in wind power plants (Swedish Energy Agency 2005a). The quota obligation in 2004 corresponded to 7.9 TWh which implies that supply exceeded demand and that surplus quotas are being banked.

TGC prices in Sweden have been stable around 20-25 EUR/MWh TGC ever since the system was launched. This implies that the TGC prices have been practically unaffected by the changes in wholesale electricity prices that have been experienced during the past few years. The wholesale electricity price level has been affected, in particular, by the European trading system for CO_2-emission allowances (EU ETS) that came into force on Jan 1st 2005. As we will see later on in this chapter, the model theory, however, indicates a very direct connection between the wholesale electricity price and the TGC price. A further discussion on the Swedish TGC price development is carried out in Chapter 11.

The TGC market prices have led to a mark-up on retail electricity prices of typically 1.5-3.5 EUR/MWh electricity (depending on the retailer) for eligible consumers during the first half of 2005 (excl. VAT; Swedish Energy Agency 2005b). Thus, differences in mark-ups between retailers have been relatively high.

During the spring of 2006, a governmental bill is being prepared concerning a somewhat refined TGC scheme. Issues to be resolved are, among others, the quota obligations after 2010 (an additional target of 7 TWh between 2010 and 2016 has been proposed) and the possibility of introducing restrictions on the amount of years that a power plant may participate in the TGC scheme. Furthermore, the TGC system is proposed to be extended until 2030. Finally, it is also proposed that existing small-scale hydro-power plants may issue TGCs only until 2010. It is the intention that the quota size will be adjusted in accordance with such phasing-out of TGC generators.

Norway

During the previous governmental period, there was a broad majority in favour of launching a common TGC market with Sweden by January 1, 2007. Following the parliamentary election in September 2005, a red-green coalition overtook the governmental office in Norway. In the coalition document of this government (Soria Moria-erklæringen), it became obvious that a large share of the Norwegian hydro-power potential was to be excluded from a TGC scheme. Hydro-power stations larger than 1 MW were not entitled to issue TGCs.

After a meeting between the Norwegian and Swedish Ministers responsible for energy on January 16, it was decided to postpone the launch of the common market indefinitely. The reason was believed to be the Norwegian wish to further investigate the TGC market. According to Europower, the main reason for the postponement was the Norwegian viewpoint not to include hydro-power schemes larger than 1 MW.

The Norwegian political parties now in opposition became upset about the postponement and claimed that the common market with Sweden had been subject to sufficient investigation and analysis to follow the original time schedule. The parties in opposition had support in their view from both market investors and environmental organizations. However, in March 2006, after a break-down in the negotiations, it was finally decided that there will be no common TGC market between Sweden and Norway.

Investors and political opposition await a new strategy for inducing investments in renewable electricity in Norway. The Minister of Petroleum and Energy, Odd Roger Enoksen, does not exclude the option of a separate Norwegian TGC market that precedes a common market with, for instance, Sweden. Discussions of including the heat market in a TGC scheme have also been carried out. Earlier, a separate Norwegian market had been ruled out because of the arguments that such a market will be too small in terms of market players, turnover and liquidity.

Denmark

In Denmark, the introduction of a TGC scheme has been subject to discussions during several years. Already in 1999, there was a political majority in favour of introducing TGCs as a policy measure for increasing investments in renewable electricity. In the follow-up plan from 2000, a time schedule for the implementation of the TGC market (VE-bevismarked) was included. Up until 2002, the general view was that the Danish market would be sufficiently large to ensure a proper functioning, and the launch was due in 2003.

In a new follow-up from 2002, however, signs of change started to show. The reason was doubt concerning a well-functioning Danish TGC market that ensured sufficiently high support for producers. This, in turn, was because of the need for provisional regulation and exclusion of existing capacity that was established under the old, more generous, support scheme. The implementation was, therefore, postponed awaiting a common market including other EU Member States.

Lately, signals pointing in a more positive direction concerning a Danish TGC market have started to show again. Several parties in opposition have expressed a wish to increase investments in renewables, and it has been argued that a TGC scheme could be just the right means to reach that ambition. Also the Government has lately shown an increased interest in renewable energy.

Finland

In Finland, there has been very little activity relating to the implementation of a TGC market. The focus in Finland is set on CO_2-reducing measures (for example through increasing nuclear-power capacity) rather than increased investments in renewables. Therefore, it is unlikely that Finland will introduce a TGC market unless the EU decides to implement such a market on a European level.

Common Nordic markets for TGCs

A Swedish-Norwegian market

As mentioned before, a common Swedish-Norwegian market was very close to implementation before the final postponement in March 2006. Politicians in both countries were, generally, in favour of such a common market. Important arguments for introducing international markets are the prospects of better functioning due to larger market volume (turnover and liquidity) and due to natural differences in potential for producing renewable electricity.

Studies related to the outcomes of a common Swedish-Norwegian market for TGCs have been carried out by, for example, Profu (2005), Profu (2006) and ECON (2004a). All three studies rely on the use of energy systems modelling in order to assess the impact on *e.g.* electricity prices, TGC prices, TGC generation and cross-border TGC trade.

In Figure 10.1, the assumptions for costs and potentials for new renewable electricity used by ECON (2004a), are shown. Even though the cost curves are relatively similar, the potential for new renewable electricity is assumed to be larger (and somewhat less expensive) in Norway in the short-term perspective.

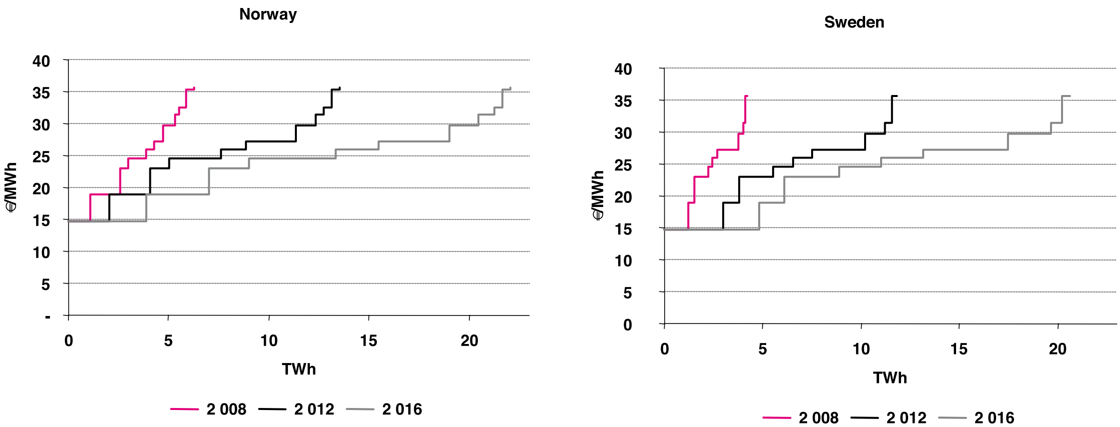

Figure 10.1: Potential and costs for new TGC eligible electricity production in Norway (left) and Sweden (right) for three different model years (Source: ECON, 2004a)

The impact on TGC prices if Norway joins the market is shown in Figure 10.2. These results are also taken from the ECON study. The results for a separate Swedish market are compared to the situation in a common market with a Norwegian quota obligation (*i.e.* the domestic demand for TGCs) corresponding to 8 and 12 TWh (electricity) in 2016. The corresponding quota in Sweden is set to 16 TWh in 2010 and 21 TWh in 2016, including existing TGC generation. The TGC prices in the common market are in both cases significantly lower than in the separate Swedish market. As expected, the higher the Norwegian quota gets, the higher the TGC price on the common market becomes.

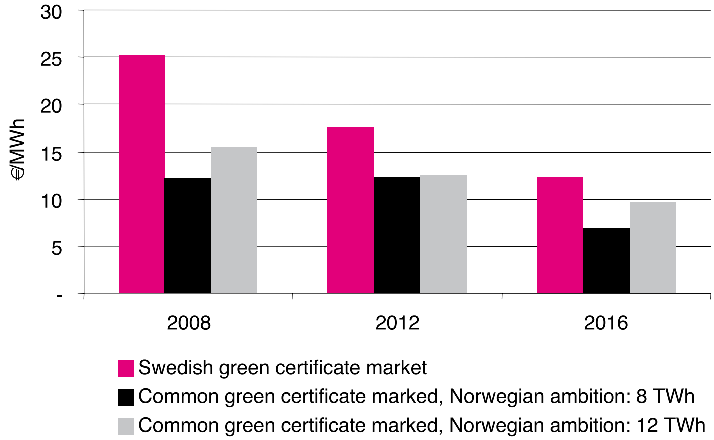

Figure 10.2: TGC prices in 2008 on a separate Swedish market and on a common Swedish-Norwegian market (8 TWh and 12 TWh in Norway respectively). (Source: ECON, 2004a)

The modelling results generated by Profu (2006) basically come to the same conclusions. TGC prices and cross-border TGC trade between Sweden and Norway highly depend on the Norwegian quota. The Swedish quota is assumed to be given according to the current legislation (16 TWh until 2010) and the governmental bill (21 TWh until 2016). If the domestic Norwegian quota is lower than 16 TWh in 2016, model results indicate that Norway will be a net exporter of TGCs (see Figure 10.3). If, on the other hand, the Norwegian quota is assumed to be larger than 16 TWh in 2016, Sweden becomes a net exporter of TGC. At this total quota level, TGC prices become high enough to induce investments in Swedish wind power, which starts to make a significant contribution to the market.

In Figure 10.3 it is also apparent that Sweden and Norway complement each other in terms of means to produce renewable electricity. Swedish TGC generation is dominated by biofuel-based electricity, due to the abundance of district heating, while Norwegian supply is dominated by wind power and hydro power. The potential for wind power and new hydro-power schemes is assumed to be relatively favourable in Norway.

However, public acceptance issues may become a bigger obstacle to the expansion of both wind and hydro power than assumed in this study. Furthermore, limitations in the transmission grid in Norway may also increase the costs of integrating certain parts of new wind-power schemes in comparison to what has been assumed here. This will, of course, reduce the Norwegian potential for generating TGCs, and, thus, also the trading balance towards Sweden in a common market.

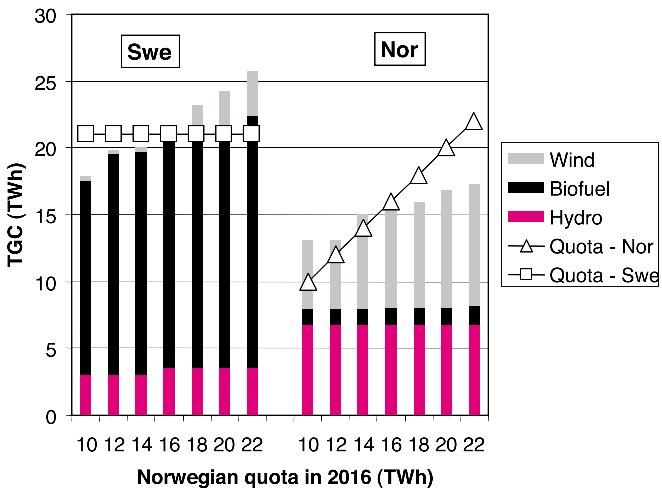

Figure 10.3: TGC generation in Sweden and Norway as a function of the Norwegian quota in 2016. If TGC generation (bars) exceeds domestic demand for TGCs (lines) than there will be a net export of TGCs. (Source: Profu, 2006).

Figure 10.4 shows the calculated TGC price in the common Swedish-Norwegian market as a function of the total Swedish-Norwegian demand for TGCs. It is indicated that the “practical” quota limit is around 45 TWh in 2016. For a common quota larger than that, TGC prices become very high. For a total TGC demand less than 25 TWh, model calculations indicate that TGC prices would approach zero. This means that new investments in renewable electricity production until 2016 would amount to 14 TWh (25 TWh minus the 11 TWh that already exist in the Swedish TGC scheme) even without the income from the TGC market. The reason for this is that several new investments in both countries become profitable under the baseline assumption of a CO_2-emission permit price of around 20 EUR/t.

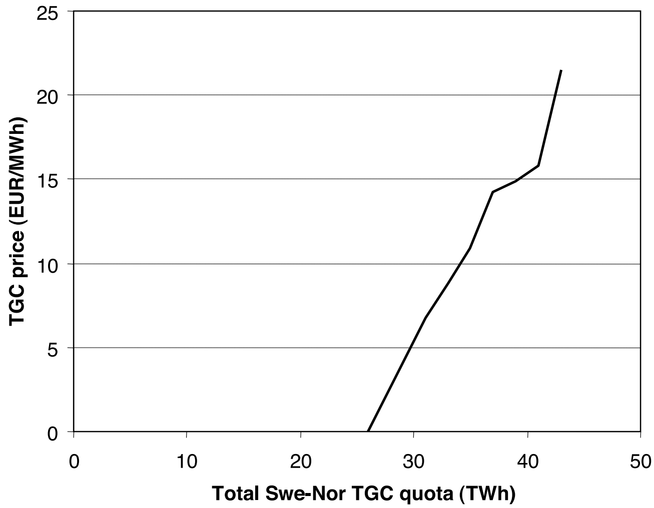

Figure 10.4: TGC price on the common Swedish-Norwegian market versus the total Swedish-Norwegian demand for TGCs in 2016 (Source: Profu, 2006)

An all-Nordic market

Research has been conducted on a common Nordic TGC market including also Denmark and Finland (see *e.g.* Unger and Ahlgren, 2005; The Nordleden 2 project, 2003; ECON, 2004b; and Hindsberger *et. al*., 2003)

Assuming targets for renewable electricity production in accordance with the EU Directive 2001/77 on the promotion of renewable electricity production (see Table 10.1), model analyses using MARKAL-NORDIC indicate that around 0.5 billion EUR in present-day value (discounted over 20 years) could be saved if these Nordic targets were met on a common Nordic market for TGCs instead of four separate TGC markets (Nordleden 2, 2003).

Table 10.1: Assumptions based on EU Directive 2001/77 (assumptions for Norway are based on own estimates)

	Swe	Nor	Fin	Den	Total
Quota (% of total domestic demand)	16	10	18	29	16
Quota (TWh)	24	13	16	11	64
Base-year (2002) TGC generation (TWh)	10	5	11	7	33

In Figure 10.5 the TGC generation by country and technology (in model year 2011) is shown for a case with a common Nordic TGC market and a case with four separate national markets. Both cases assume targets according to Table 10.1. When moving from separate markets to a common Nordic TGC market, all countries besides Norway become net importers of TGCs, although with a fairly modest negative balance. It is mainly cost-efficient Norwegian wind power that increases its share when comparing a common market to separate markets.

According to Figure 10.5, a common Nordic market for TGCs in 2011 would be dominated by biofuel-based electricity production, accounting for roughly 55 % of total generation. Approximately 25 % would be hydro-based and 20 % would originate from wind power.

The results in Figure 10.5 illustrate *one* particular example of the outcome from merging four separate TGC markets into one common. Depending on the domestic targets (or quotas) it is obvious that the cross-border trade may take other directions than shown here. For example, the Swedish target is in the current system considerably lower than was anticipated in the study behind Figure 10.5 (*i.e.* the target according to EU Directive 2001/77). Thus, based on the findings in Figure 10.5, Sweden may actually have the potential of exporting TGCs on a common Nordic market for a lower domestic target.

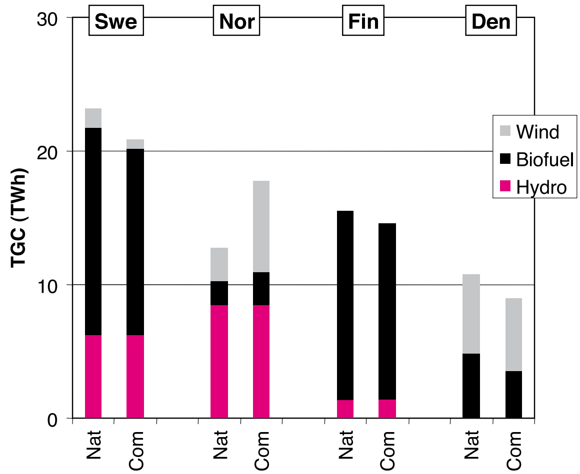

Figure 10.5: TGC generation in the model year 2011 when the Nordic markets for TGCs are separated ("Nat") and when the markets are integrated into one common Nordic market ("Com"). (Source: Nordleden 2, 2003)

The resulting TGC prices from the TGC schemes discussed here are shown in Figure 10.6. Since Norway becomes a significant net exporter of TGCs in a common market according to the model runs (see Figure 10.5), it follows that TGC prices are lowest in Norway if the markets are separated. Thus, Norway increases its TGC generation when moving from a separate market to a common market and TGC prices, consequently, will rise in Norway. Interestingly, there are only minor price differences between Denmark, Finland and Sweden. According to the model results a common market would have prices around 12 EUR/MWh, which is significantly lower than the current prices on the Swedish market. It is, however, not always straightforward to compare model prices with real-world prices. The "model price" is more specifically the marginal cost of generating renewable electricity minus the wholesale electricity price. Real-world TGC-market prices depend also on other factors, such as strategic behaviour, expectations and the possibility of banking, that are not included in the model description. Furthermore, discount rates are probably higher in real-life investments than the five percent used here, which implies that TGC prices may be underestimated in this study. As mentioned before, some of these issues are discussed more closely in Chapter 11.

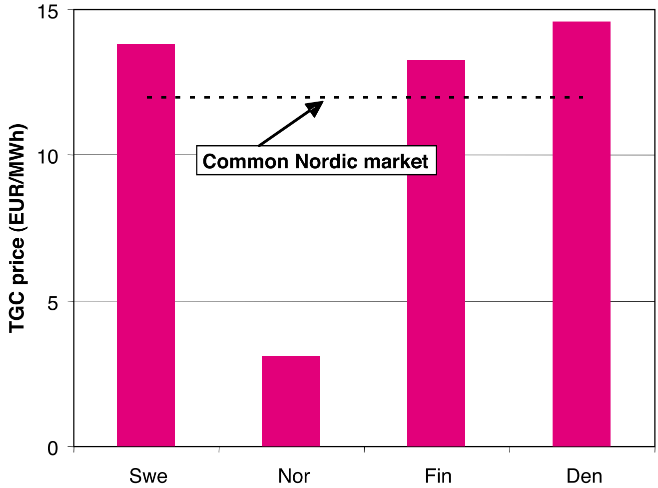

Figure 10.6: TGC prices on separate markets and the common Nordic market. (Source: Nordleden 2, 2003)

As mentioned before, analyses of a common Nordic TGC market have also been carried out by ECON (2004b). The quotas that were used in this study are shown in Table 10.2. It is assumed that energy-intensive industry is excluded from the quota obligation as is also the current situation in Sweden.

Table 10.2: Assumed quotas in the Nordic countries in the ECON (2004b) analyses (applies to model year 2012)

	Swe	Nor	Fin	Den
Quota (% of domestic use excl electricity-intensive industry)	18	10	28	36

The resulting new TGC-generating capacity (in MW in 2012) is shown in Figure 10.7. In terms of capacity, wind power and hydro power are the dominating TGC technologies in the common Nordic market.

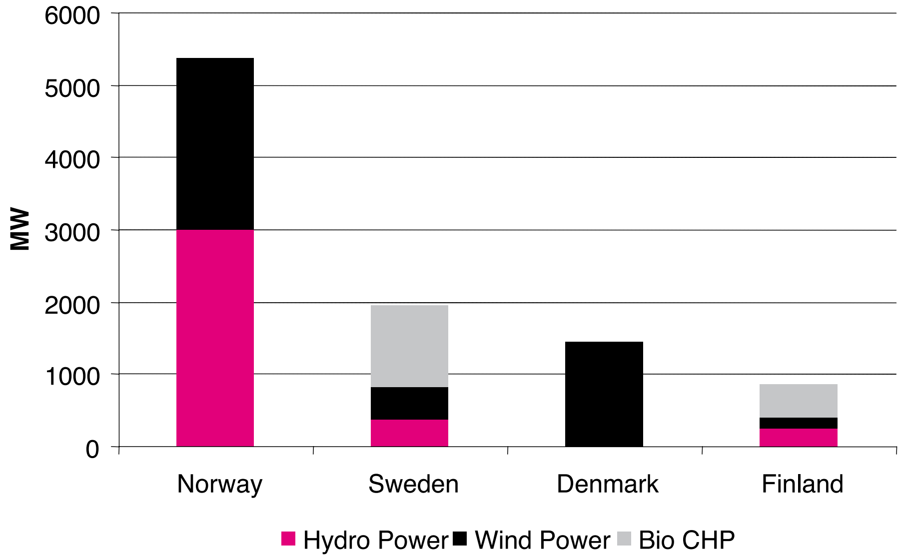

Figure 10.7: New TGC-generating capacity in 2012 (*in addition* to existing capacity in 2004) on a common Nordic TGC market. (Source: ECON, 2004b)

Drawn from the same study (ECON 2004b), Figure 10.8 shows the country-wise demand for TGCs, TGC generation and net TGC trade balance for the model year 2012. Similar to the previous study by Nordleden 2 (2003), Norway is the only net exporter. Sweden and Finland are net importers while Denmark is in balance.

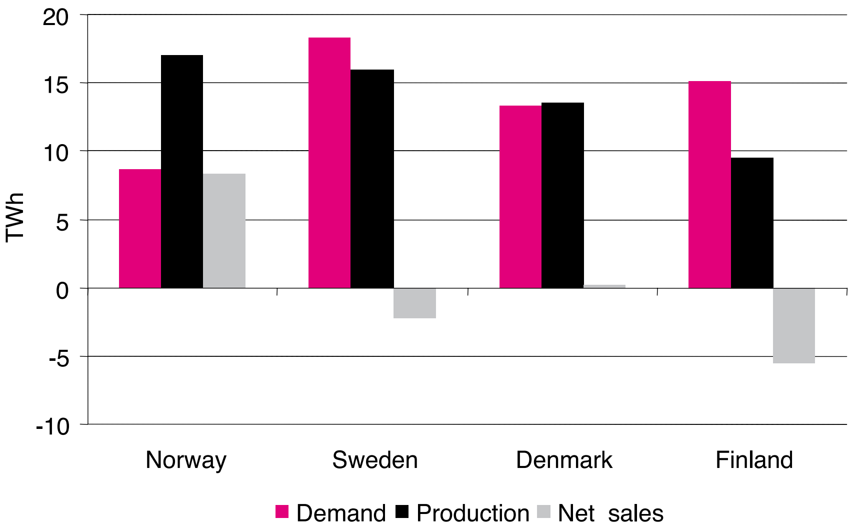

Figure 10.8: Nordic TGC market; Supply, demand and trade. (Source: ECON, 2004b)

Interactions between the TGC market and the electricity market

In this section, it is described how changes on the TGC market, in this case a common Swedish-Norwegian TGC market, may affect the common Nordic electricity market. First, we have to define what we refer to as a "change". In real life, changes always occur over time. Thus, it may be difficult to directly relate such changes to a particular cause, *i.e.* the causality is not apparent due to "noise" from other factors that also occur during that same time period. In a model, however, we can isolate a change in the system studied and directly observe the effects of that change for a given moment in time. Nevertheless, we have to define the "changes" that we are interested in. In this case, we choose to look at two different changes on the TGC market, and the consequences of these changes for the electricity market: an increase or decrease in the quota obligation (or, alternatively expressed, TGC demand) and an increase or decrease in costs for investing in TGC-generating technologies. The first change implies quantity adjustments on the TGC market, while the second change is assumed not to have any quantity impacts on the TGC market.

If the TGC quota is increased, all else being equal and for a given model year, the TGC price on the market also increases as ever more expensive investment options have to be exploited. Thus, we get a quantity-induced increase (or decrease if we reduce the quota obligation) in the TGC price (see Figure 10.9; MARKAL-NORDIC model runs). Similarly, if we increase the costs for new investments in TGC-generating technologies we also get increased TGC prices, everything else held equal. If, for instance, we increase the discount rates for new wind-power schemes in Sweden and Norway, investment costs for wind power are increased and so are TGC prices. This corresponds to a cost-induced increase (or decrease if we reduce costs instead) in TGC prices (see Figure 10.9). Both these changes on the TGC market, the quantity- and the cost-induced market changes, imply a change in TGC prices. The impact on the electricity market is, however, fundamentally different.

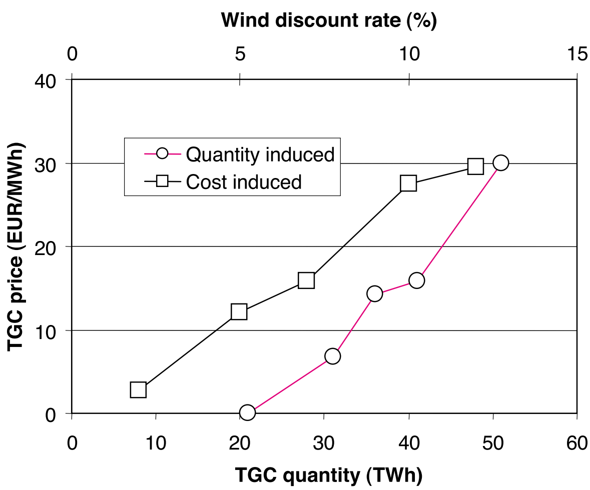

Figure 10.9: TGC prices as a function of different TGC quotas (or demand) and a function of different discount rates for investments in wind power.

A quantity-induced increase in TGC price is always accompanied by an increase in the supply of TGC-generating electricity production. Increased supply of electricity means, everything else held constant, reduced wholesale electricity prices in the short term. This is especially pronounced if demand is relatively inelastic, which is a fair approximation of electricity demand. Reduced wholesale electricity prices as a function of quantity induced TGC-price increases are shown in Figure 10.10 for a case where TGC prices vary between zero and 30 EUR/MWh. Within that span, wholesale electricity prices fall about 5 EUR/MWh. In the long run, however, electricity generators outside the TGC scheme are likely to adapt and wholesale electricity prices should approach long-run marginal costs for new electricity production, regardless of the TGC quota, provided that TGC-generating production is not alone sufficient to meet increases in electricity demand and phase-outs of existing capacity.

Reduced wholesale electricity prices as a function of increased supply of TGC-generating electricity was also obtained in the study by Unger and Ahlgren (2005) and by ECON (2004b). In the former study, the reduction in wholesale electricity price on the Nordic market was almost 7 EUR/MWh when an all-Nordic TGC scheme was introduced with a quota of 20 percent of total electricity demand by 2011 compared to a scenario where no TGC scheme at all existed in any Nordic country. The latter study by ECON found that the reduction in wholesale electricity price was around 8 EUR/MWh when an all-Nordic TGC scheme was introduced based on the assumptions in Table 10.2 compared to a scenario where Sweden is the only country among the Nordic countries to host a TGC scheme

But what about changes in TGC price as a consequence of changes in investment costs, *i.e.* cost-induced changes of the TGC price for a given model year? The cost induced increase or decrease in TGC price is not accompanied by a change in supply of TGC-generating electricity. Thus, electricity supply is not affected. The model calculations indicate that wholesale electricity prices are almost entirely unaffected by the cost-induced changes in TGC prices (see Figure 10.10). This indicates that demand for electricity and supply from conventional generation (outside the TGC scheme) also is relatively unaffected.

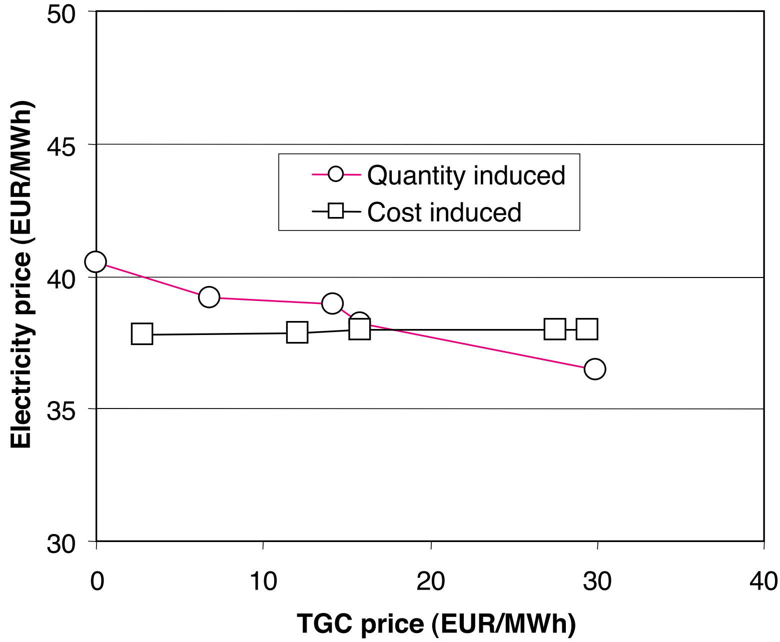

Figure 10.10: Wholesale electricity price as a function of TGC price if the change in TGC price is induced by a change in TGC demand and by a change in TGC-generation costs.

In the case of a cost-induced increase in TGC price, it is needless to say that the mark-up on retail electricity prices increases since wholesale electricity prices are unaffected and TGC prices are increasing. In the case of quantity-induced increases in TGC price, however, it is not as straightforward. In this case we have two components of the retail electricity price, the wholesale electricity price and the TGC price, that work in opposite directions when the TGC-generating electricity supply is increased, everything else constant (at least in the short run as mentioned before). Depending on the share of the domestic electricity use that is included in the TGC scheme, *i.e.* how many of the electricity consumers have to purchase TGCs in proportion to their electricity use, the retail electricity price may take somewhat different directions following a quantity-induced increase in TGC price. In Figure 10.11, we may observe both an increased *and* a relatively unaffected retail electricity price as a consequence of an increase in the quantity-induced TGC-price increase. Related research has shown that retail electricity prices even may decrease as the TGC quota is increased, everything else held constant (see *e.g*. Unger and Ahlgren, 2005; ECON, 2004a, Hindsberger *et al*., 2003). In theory, the impact on retail electricity prices from increasing TGC demand is a matter of how the accompanying reduction in wholesale electricity price relates to the accompanying increase in TGC price and the share of the electricity consumers that are obliged to purchase TGCs.

If the energy-intensive industry is excluded from the obligation to purchase TGCs, the given amount of produced TGCs has to be purchased by fewer customers than if all electricity users were included in the TGC scheme. Thus, mark-ups on retail electricity prices for the TGC-purchasing customers are also higher (also seen in Figure 10.11).

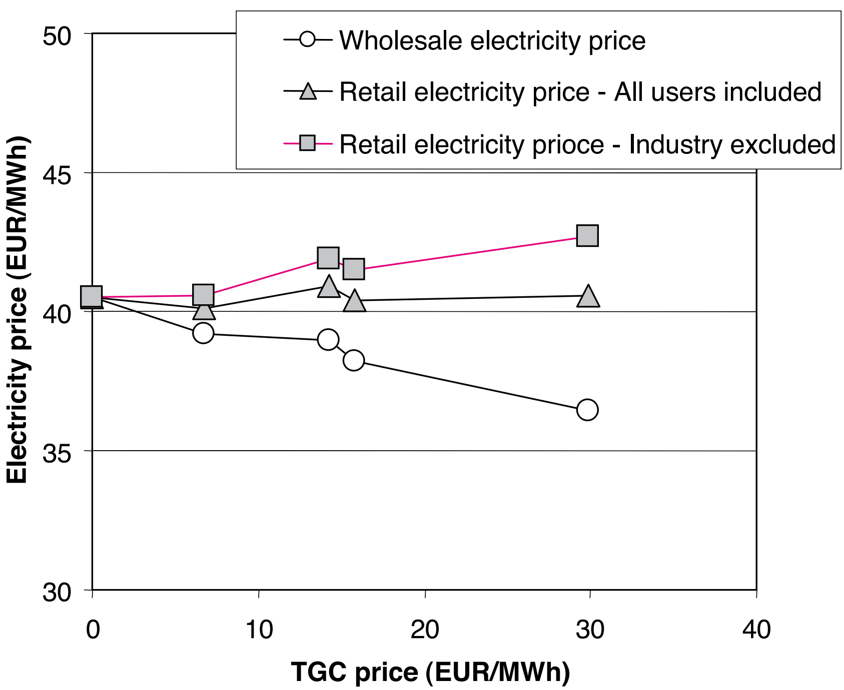

Figure 10.11: Wholesale and retail electricity prices for a quantity-induced change in TGC price.

In Figure 10.12, the impact on the future electricity-supply system in the Nordic countries is shown, when changing the demand for TGCs on the common Swedish-Norwegian market for a given year (in this case 2016). When the TGC quota is increased, it affects both utilization of existing plants and investments in new conventional capacity. For a total Swedish-Norwegian quota that increases up to 41 TWh in 2016, the main supply option that is being replaced by the increase in renewable electricity is gas-fired power. The assumed high gas prices make coal a relatively viable option, even though EUA prices are assumed to be 20 EUR/t. This is why new investments in gas are rejected prior to new investments (or reduced utilization of existing supply) in coal power as a consequence of the increasing supply of renewable electricity.

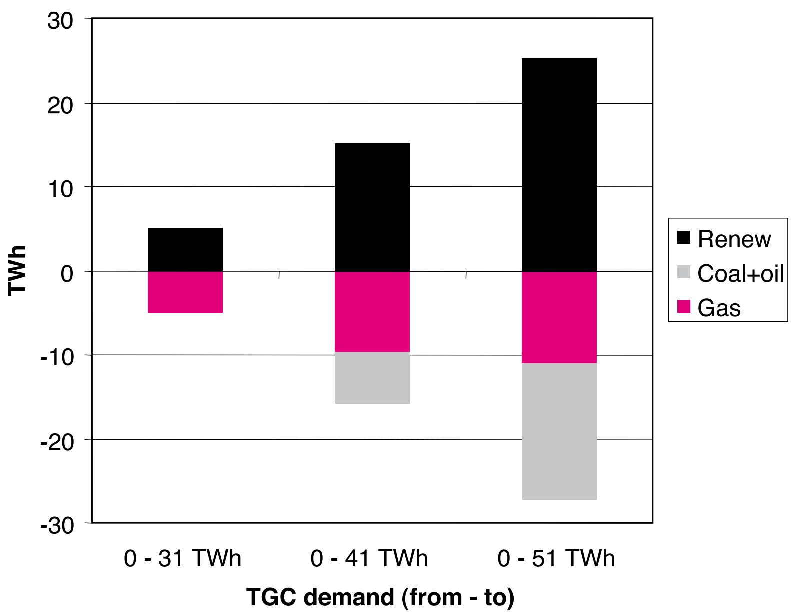

Figure 10.12: Change in Nordic electricity supply as a function of constantly increased demand for TGCs on the common Swedish-Norwegian market in the model year 2016. The reason why the increase in renewables is less than the demand increase on the x-axis is that a significant share of new investments in renewable electricity is carried out also in the base case, *i.e.* the case without any TGC demand

Interactions between the TGC market and the EU ETS market

The theoretical and model-related interaction between the EU ETS market and the Nordic TGC market is somewhat more straightforward than the interaction between the Nordic electricity market and the Nordic TGC market shown in the previous section. It is reasonable to assume that changes in the Nordic TGC market will have virtually no impact on the EU ETS market since the latter is a far larger market. However, costs for reducing CO_2 in the Nordic countries may be affected by the Nordic TGC scheme. For instance, an increase in TGC supply, all else equal, will reduce CO_2 emissions in the Nordic countries, thus reducing marginal costs of reducing CO_2 emissions in that region. This implies that the Nordic countries may change their trading balance for EUAs versus continental Europe. EUA prices, however, are likely to be unaffected.

If, on the other hand, EUA prices are changed, it may have a significant impact on Nordic TGC prices, at least in theory. Increasing EUA prices will increase wholesale electricity prices. Increased wholesale electricity prices, in turn, mean that investments in renewable electricity need less extra support in excess of the electricity price in order to become profitable. TGC prices should thus fall as EUA prices increase, all else equal. This can be seen in Figure 10.13 where TGC prices (in a common Swedish-Norwegian market) and wholesale electricity prices in the Nordic market are shown as a function of EUA prices.

In Figure 10.13 it can also be seen that it is not obvious that increasing EUA prices mean more money in the pocket for TGC generators. In fact, in this example the total reimbursement (the sum of the wholesale electricity price and the TGC price) for TGC generators seems unaffected by changes in the EUA price due to the reduction in TGC price.

However, as mentioned before, contrary to the model results the current Swedish TGC market has, hitherto, been virtually unaffected by the price changes on the EUA market.

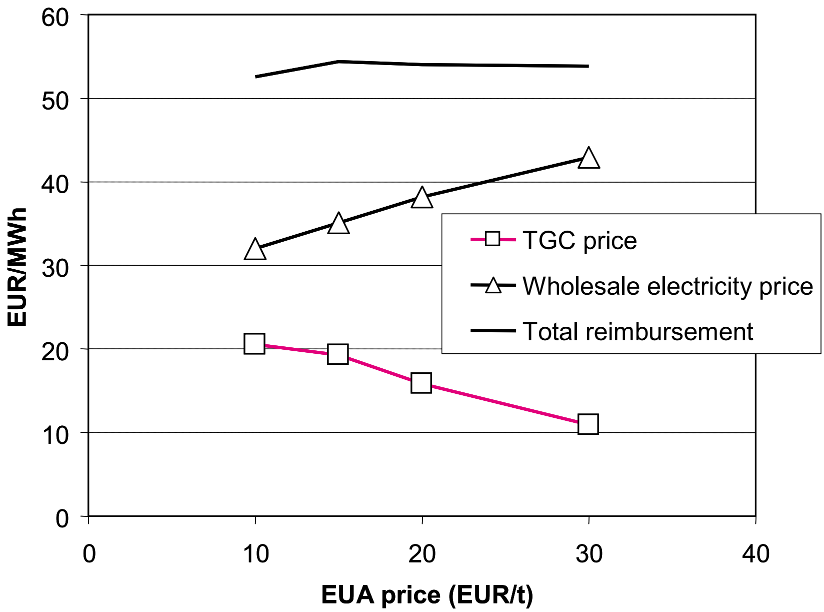

Figure 10.13: TGC price, wholesale electricity price and total reimbursement (the sum of TGC price and wholesale electricity price) for TGC generators.

Chapter

11

Price formation of green certificates

Supporting systems that are solely dependent on a sensitive and hard-to-grasp balance between supply and demand – is that what politicians really want?

The biggest problem regarding the design of the Swedish green certificate system is that the possibilities for short term adjustments are limited. If a shortage occurs in the system, prices might soar. Electricity retailers are more or less forced to buy certificates no matter the price and producers already produce as much as they can given current capacities. We anticipate a shortage situation already in 2008. A clear conclusion from this analysis is that there should be more safety valves built into the system. A more defined cap, a possibility to borrow certificates in times of shortage are examples of possible improvements.

If the quantitative results from our simulation (Figure 11.1) proves to be right there will be a permanent surplus after a few years of deficit. The plants that are built or are under construction during years with high certificate prices will continue producing for many years even if certificate prices remain low. Even in a surplus situation, there are only a few short term possibilities for adjustments. Low prices are in themselves no disadvantage for customers, but they can be regarded as a political letdown towards those that invest in renewable production.

The most important point with this chapter is not to predict future certificate prices, but to show that the connection between certificate prices and the producers' need for financial support might prove to be rather thin. Fundamentally, this is due to the fact that politicians have, in advance, decided precise levels for how much renewable production that must enter the system while short term possibilities for adjustments

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are close to non-existing. We can rest assured about one thing though, it is that the bill that just past the Parliament will not be the last to discuss this system.

Before extensive support systems like the green certificate system are introduced, politicians should demand that it is possible to survey the consequences reasonably well, both for the people that are supposed to pay the bill, i.e. customers, and for investors. Support systems that are solely driven by a sensitive and thin balance between supply and demand – is not what politicians really want.

Introduction and analytic approach

Over the last few years, politicians have shown a great interest for trade based support systems like Sweden's green certificate system and the EU's system for emissions rights trading (EU ETS). But do the politicians really know what they are doing when they introduce systems like these? A lot of things indicate that the foundational mechanisms involved are not fully understood.

The picture that was given when the green certificate system was introduced is that the price would be derived from the costs for expansion of renewable production less the income that actors get from the power market. Initially, the price would be low, since the cheapest production would enter the market first. After that, the price would rise. Assessments indicated that the price for certificates would be approximately 100 SEK/MWh (1€ = 9.2 SEK).

That proved not to be the case. For the first two years 2003 and 2004, the price landed at the level of the price cap in the system (200 SEK/MWh for 2003 and 240 SEK/MWh for 2004. Since the end of 2004, the price cap is practically speaking not in use anymore. In 2005, the price of certificates was about 200 SEK/MWh. Today (spring of 2006), prices are below 200 SEK/MWh.

Two factors can explain why prices have not skyrocketed since the cap was taken out of use. The first is that the system today generates a surplus, i.e. more certificates are produced than what is consumed right now. The other is that power prices have increased by roughly 50% following the EU ETS, which has made power production much more profitable. The interesting question is why certificate prices have not decreased more.

One explanation for why the price is not falling is that certificates can be saved and sold at a later point in time. A situation with a momentary surplus thus does not automatically lead to falling prices (the costs for storing are low). On the contrary, a situation signified by deficit will lead to a sharp increase in prices. Since there is a penalty for not declaring enough certificates of 150% of the average certificate price, there is in reality no cap on prices in a situation of deficit. (It is highly risky to predict how buyers and sellers will act in a situation of deficit. One thing that comes into play is that buyers and sellers are often parts of the same group of companies. The design of penalties in the system makes "tactical choices" and manipulation of prices possible. The question is also if everyone involved are conscious of supply and demand for certificates. It is desirable that this be studied more closely.) Thus, it is enough for actors to anticipate a deficit some time in the future for prices to rise. The price of green certificates is therefore decided by two parameters surrounded with great uncertainty, the risk of deficit and the consequences of that deficit.

Price of green certificates= Risk of deficit* Consequenses of deficit

Despite the fact that the system is fully dependent on the balance between supply and demand, prices could remain pretty stable over the next few years. This would be the case if we have a solid surplus production of certificates at the same time as actors see a risk for a deficit in the future. While new production projects are being introduced (or are not being introduced), it will become more clear for actors whether the surplus production of certificates will remain or whether it will turn into a shortage. Prices will then either soar (because actors anticipate a future shortage) or drop towards zero (because they believe that the surplus will continue).

Prices for green certificates are, according to this way of looking at it, decided by the market participants' beliefs regarding the balance between demand and supply. Will enough new production be introduced in the system to meet the requirements? This, in turn, will be decided by many different factors that are hard to survey, among other things the possibilities to get permissions for new investments and investors' trust in the system.

The balance between supply and demand - a quantitative assessment

In this project, we have tried to make a quantitative assessment of how the balance between demand and supply can be expected to evolve over time. There is always a risk associated with publishing quantitative results (especially when you will be reviewed in just a year), but we think that these results clearly show the insecurities in this type of support system, both for the customers who will pay the bill and for investors. Our quantitative results can be summarized in the picture below.

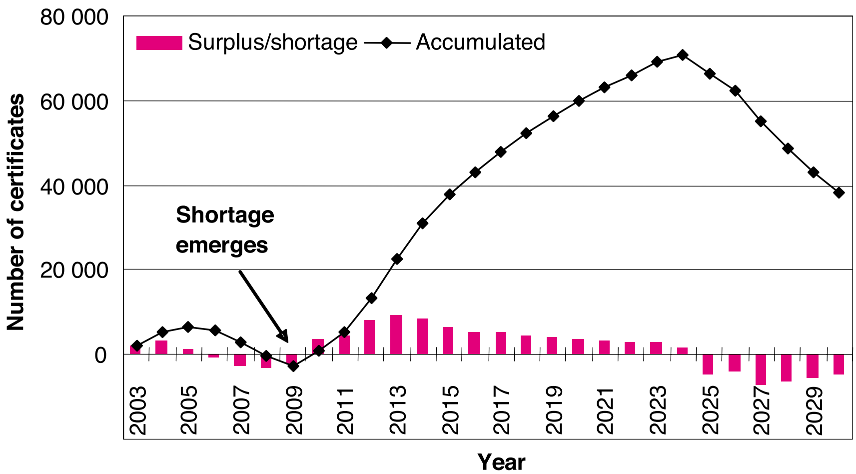


Figure 11.1 : Price formation of green certificates. Source: NEP.

The dotted line in Figure 11.1 shows the accumulated surplus or deficit in green certificates. The picture that is painted shows what is essentially the worst scenario imaginable. Within just a few years, an absolute shortage of certificates will emerge and prices will skyrocket (how much is impossible to say). After a few tough years for consumers (and good years for people who have already invested in renewable production), a new balance in the system will be found. Some time around 2010, many of the projects that are now decided on will be in operation. At that point, there is a possibility that there can be as much renewable production in place that the risk of a future shortage approaches zero. Prices should then drop significantly. We do want to emphasize that several of the projects that we have included in our calculations here can be delayed or may not even be realized at all. The point is, first of all, to show that this type of support system in itself generates a huge insecurity about the prices for certificates. It is an insecurity that probably is a disadvantage for everyone involved.

Figure 11.1 illustrates an interesting feature in the certificate system. A period of shortage and high prices will stimulate a substantial expansion. This can lead to a surplus situation and prices close to zero. Built into the system is thus a tendency toward jerky and fluctuating prices of certificates.

A comparison can be made with the EU ETS system. Could it be that it is the risk for shortage that drives the price on that market too? In that case, what will happen to prices in 2007 when the supply and demand conditions become obvious? Will the price turn to zero or increase dramatically? In comparison with the green certificate system there are a number of features in the EU ETS system that may stabilize the prices, so called "safety valves", of which the CDM and JI projects are the most important. The fundamental problem that demand and supply must balance at one time or another still remains.

Experiences from Swedish system for green certificates

In May 2003, a new system for support to renewable electricity production was introduced in Sweden, the Green Certificate System.

This system implies that consumers are obliged to buy certificates correspondingly to their electricity consumption. This obligation is called the quota duty. Green certificates are given to electricity producers using renewable energy sources. The producers can sell the certificates in order to get compensation for the extra costs associated with producing electricity from renewable sources compared to traditional electricity production. Alongside wind power, electricity production from biofuels, small scale hydro etc. is also entitled to certificate allowances. This support, in its current form, stretches until the year 2010. The target is to stimulate an additional 10 TWh renewable electricity production in 2010 compared to 2002.

Price level

For both 2003 and 2004, the price for green certificates equalled the price cap set for penalties for those consumers who were not able to declare enough certificates to cover their duty. The price for 2003 was set at approximately 200 SEK/MWh (the penalty was set at 175 SEK/MWh, and since the penalty is not tax-deductible for companies, it is profitable to pay a higher price for the certificates than to face the penalty) and for 2004 at approximately 230 SEK/MWh (the penalty was fixed to 240 SEK/MWh). For 2005, the price was 220 SEK and thus far in 2006 it has been just below 200 SEK/MWh.

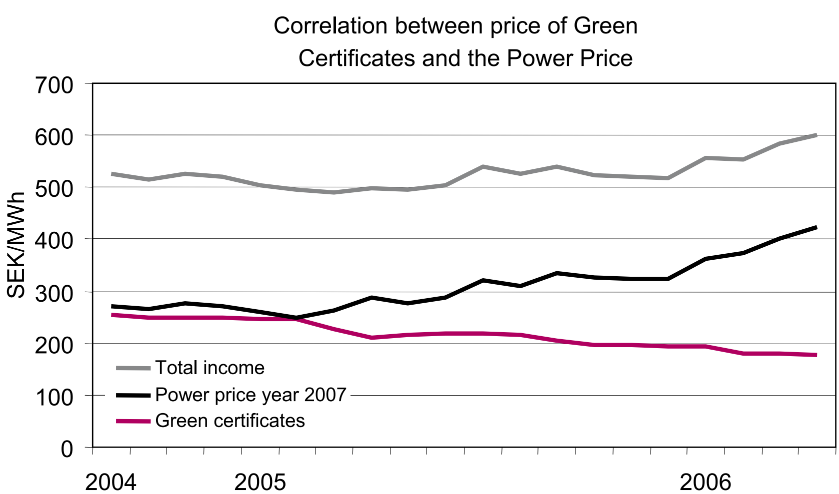


Figure 11.2: The price of green certificates 2005. Sources: NordPool and Montel (1€ = 9.2 SEK)

Theoretically, there is a strong connection between the price of electric power and the price of certificates, since it is the sum of those that constitutes the compensation for renewable production. This connection is illustrated in Figure 11.2. The picture shows that there might have been such a connection previously, but it has been broken during the last year. Given the price of power that we have today, the price of certificates should be below 100 SEK/MWh.

Effects on investments

One experience thus far from the certificate system is that it has not led to any major investments. On the contrary, electricity production from already existing plants, primarily biofuel plants, has increased more than what was expected. The Energy Agency estimates that there is a risk that the target of reaching 10 TWh renewables will not be met until 2010.

Extension of the system

The Swedish Parliament has recently decided that the certificate system should be extended until 2030. At the same time, the level of ambition should also be raised. The new target is 17 TWh of renewable production before the year 2016. The time during which a plant will be eligible for support will be reduced to a maximum of 15 years.

The political ambition is that the Swedish certificate system shall develop into an international system. Among the Nordic countries, only Norway has, thus far, expressed an interest in joining, but even Norway is hesitant to introducing a certificate system.

Another future change is that electricity retailers shall carry the quota duty, not consumers. That would imply that retailers must include the cost of certificates in their offers to customers, which in turn could increase the interest for trading in green certificate forwards.

Price formation for certificates

When the system was introduced, most analysts estimated the price to land below 100 SEK/MWh, since that was roughly the cost to increase production in plants using biofuels. Following the need for using new and more expensive production facilities to meet quota targets, the price was expected to rise.

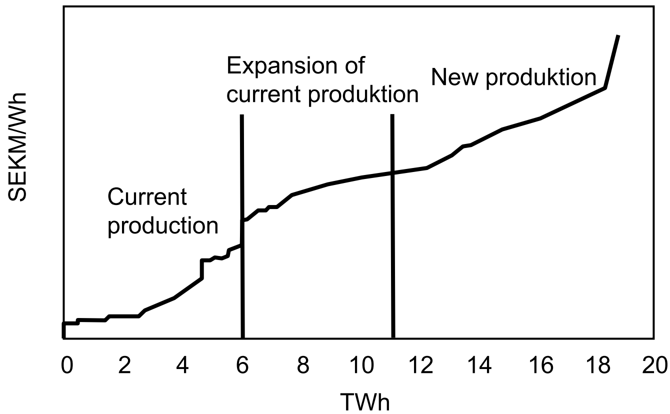


Figure 11.3: Price formation of green certificates. Source: "Trade with green certificates", SOU 2001:77 (1€ = 9.2 SEK)

As was mentioned earlier, the price turned out to be twice as high and the only reason that it did not go even further up was that buyers, at that price level, might as well pay the penalty fee as buy certificates. As a matter of fact, roughly 25% of customers chose to pay the penalty during 2003. For 2005 and beyond, there is no longer a fixed penalty fee in the system. The fee is instead set to 150% of the average certificate price for the last 12 months.

High certificate prices combined with buyers choosing to pay the penalty have led to a surplus of certificates, i.e. more certificates are produced than are cancelled. The way that the balance between supply and demand is expected to develop in the future is presented in Figure 11.4.

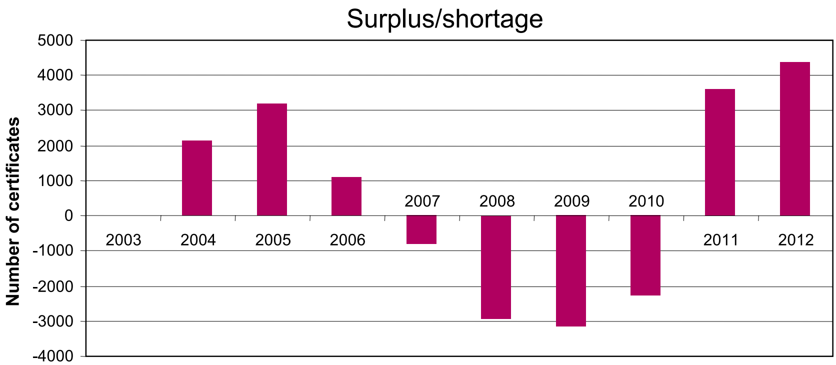


Figure 11.4: Surplus/shortage in the certificate system. Source: NEP

If the high certificate production continues, a surplus of certificates will be generated until this year. This situation explains why prices of certificates have fallen during the last year even though that there is no longer a price cap. An important aspect of the certificate market is that certificates do not have to be cancelled immediately, but they can be stored. A temporary period of surplus does not have to lead to falling prices as long as there are enough people who anticipate a future shortage. The cost for a producer to store certificates (build storage capacity) equals the cost of interest. Certificate prices are thus not decided by the current balance between supply and demand on the market, but by market participants' expectations of future price levels. That is why we can have a price around 200 SEK/MWh today although there is a short-term surplus of certificates.

The contrary does not apply if a short-term shortage on certificates appears. Customers have to buy and cancel enough certificates whatever the price may be. The low costs for storing certificates also implies that the price of certificates delivered and paid for immediately (spot contracts) will not differ significantly from the price of certificates delivered and paid for at a certain point in time in the future (forward contracts).

What does the market think about future prices of certificates?

First of all, the markets' collective estimate is a price of just below 200 SEK/MWh. As was mentioned earlier, the price on the spot market and on the forwards market should be the same. Today's price level reflects the markets' estimates of future prices.

Is the markets' expectation of a price at 200 SEK/MWh reasonable?

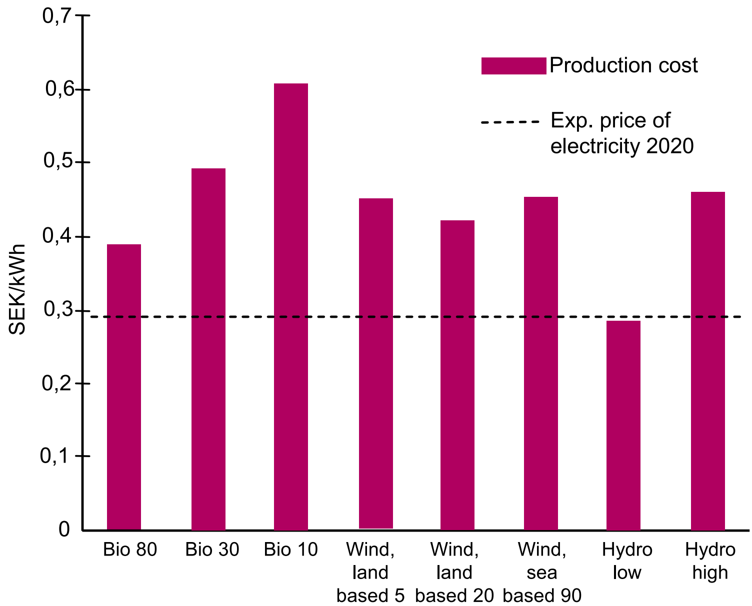
The way that the system is designed, there is really no limit to how high the price of certificates can become. What hinders the price from skyrocketing is that a high price can be expected to lead to a powerful expansion of new generation, which in the longer term would lead to surplus supply and a fall in prices. In the short term, the possibilities for adjustments are small, though.

What prevents the price from falling is that quite extensive investments are necessary in order to meet the future quotas. To reach the target of 10 TWh of new power production capacity before 2010, Sweden's Energy Agency has outlined the following pace of expansion. This is to be regarded as an example.

Wind power, land based	Five parks with 40 plants each
Wind power, sea based	Six parks with an average of 50 plants each
Industrial CHP	10 plants investing in, among other things, new turbines
Thermal power	15-20 new or rebuilt plants in different sizes
Hydro power	Reinvestments in 100 plants and 15 new

The costs for renewable electricity production are still pretty high, as is illustrated in Figure 11.5.

If market participants have the same expectations that Sweden's Energy Agency gives voice to, i.e. approximately 300 SEK/MWh, those investments will not be realized unless investors see certificate prices of at least 100-200 SEK/MWh.



Bio 80 = Bio fueled thermal power 80 MW's of electricity
Bio 30 = Bio fuelled thermal power 30 MW's of electricity
Bio 10 = Bio fuelled thermal power 10 MW's of electricity
Wind land based 5 = wind power 5 * 1 MW of electricity, land based
Wind land based 20 = wind power 10 * 2 MW's of electricity land based
Wind sea based 90 = wind power 30 * 3 MW's of electricity sea based
Hydro low = hydro power low level
Hydro high = hydro power high level

Figure 11.5: Costs for electricity production including risk premium for today's technology, information dated 2003. Source: "Survey of green certificate system", ER 2005:09 (1€ = 9.2 SEK)

A lowest level of certificate prices is also connected with the way that the price for carbon emissions rights develops. Assume that carbon prices remain at a level of 20 EUR/tonne and the price of electricity remains at 400 SEK/MWh. If a wind power plant can be built at a cost of 400 SEK/MWh, that plant would be built even if there were no income generated from green certificates. The central issue is, of course, whether an investor dares to believe that prices will remain at these levels.

Conclusions on the green certificates system

Currently, the market estimates the future price of green certificates to remain at just below 200 SEK/MWh. The most important factors affecting the price is the probability that enough new electricity production will enter the system to meet the quotas and what the consequences will be if they are not met. This, in turn, will be decided by for instance the possibilities to get permissions for new investments and whether investors dare to trust the price levels that today's market shows.

The biggest problem regarding the design of the green certificate system is that the possibilities for short term adjustments are limited. If a shortage occurs in the system, prices might soar. Electricity retailers are more or less forced to buy certificates no matter what the price and producers already produce as much as they can given current capacities. We anticipate a shortage situation already in 2008. A clear conclusion from this analysis is that there should be more safety valves built into the system. A more defined cap, and a possibility to borrow certificates in times of shortage are examples of possible improvements.

If the quantitative results from Figure 11.1 prove to be right there will be a permanent surplus after a few years of deficit. The plants that are built or are under construction during years with high certificate prices will continue producing for many years even if certificate prices remain low. Even in a surplus situation, there are few short-term possibilities for adjustments. Low prices are in themselves no disadvantage for customers, but they can be regarded as a political letdown towards those that invest in renewable production.

The most important point with this section is not to predict future certificate prices, but to show that the connection between certificate prices and the producers' need for financial support might prove to be rather thin. Fundamentally, this is due to the fact that politicians have, in advance, decided precise levels for how much renewable production must enter the system while short-term possibilities for adjustments are close to non-existing.

A comparative analysis of policy instruments promoting green electricity under uncertainty

- Extract from a scientific paper written by Björn Carlén, Department of Economics, Stockholm University for the NEP project

Introduction

This paper studies, in a more systematic way than previous literature, the implications uncertainty regarding e.g. future production costs of green as well as conventional electricity has for the optimal choice of instrument to promote production of green electricity. The objective is to identify relevant effects the regulator need to assess before being able to make an informed choice. The instruments studied are:

(i) a feed-in tariff, i.e., an obligation for retailers of electricity to buy whatever quantity of green electricity is supplied at a price determined by the regulator,

(ii) a so-called environmental bonus, i.e., a fixed premium to producers of green electricity over and above the market price on electricity,

(iii) an obligation for the retailers to procure a certain quantity of green electricity, and

(iv) green electricity certificates, i.e., an obligation for retailers to purchase green electricity in an amount equal to a given share of their total electricity sale.

Concluding Remarks

In the literature on instruments to promote production of green electricity been suggested that price-based policies (e.g., fixed-in tariffs) would be superior to quantity-based policies (e.g., an obligation for retailers of electricity to procure a given amount of green electricity). The stated reason is that quantity-based policies tend to induce too much (little) green electricity whenever production costs turn out to be higher (lower) than expected. On the other hand, price-based policies induce too little (much) green electricity, and, as shown here quantity-based policies can be designed in ways making them superior to a fixed feed-in tariff in the sense of yielding a smaller expected efficiency loss.

It is also shown here that the green electricity certificate system and systems with so-called environmental bonuses are more complicated policy instruments than so far has been recognized. If future electricity prices are highly uncertain, an environmental bonus is likely to be inferior to the other instruments investigated here. If on the other hand, future electricity consumption is highly uncertain, a certificate system with a quota obligation depending on the consumption level is likely to be the inferior instrument.

Only if it can be argued that the stochastic elements of future costs of green electricity and the future electricity demand co-vary in certain ways or that the societal benefits of green electricity increase in the consumption of electricity, is there a rationale for certificate systems of the type currently in use in Sweden and several other countries. Given the absence of such arguments, it should be considered to fix the quota obligation. A system with a fixed quota obligation in combination with a so-called safety valve and opportunities to transfer certificates across compliance periods seem to be the most efficient policy instrument. Such a system would better protect us from outcomes where, on the margin, units of green electricity are milled in at costs by far exceed the societal benefit of these units.

The complete paper is available at
www.nordicenergyperspectives.org