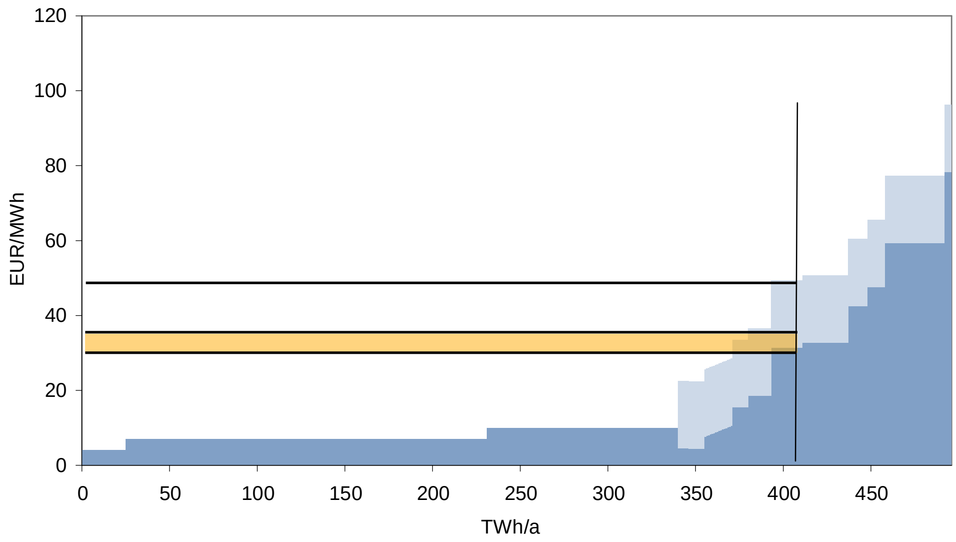
03.06.2009

Federation of Finnish Technology Industries

New Design for the Electricity Market



Pöyry Energy Consulting is Europe's leading energy consultancy, formed from the merger of the management consulting arms of Electrowatt-Ekono and Verbundplan, ILEX Energy Consulting and Convergence Utility Consultants. Pöyry Energy Consulting provides strategic, commercial, regulatory and policy advice to Europe's energy markets. Our team of over 250 energy specialists, located across fourteen European offices in twelve countries, offers unparalleled expertise in the rapidly changing energy sector.

Pöyry is a global consulting and engineering firm focusing on the energy, forest industry and infrastructure and environment sectors.

Pöyry Energy Oy is part of the Pöyry Group and Finland's largest independent consulting and engineering company in the energy field. Through fully integrated competence concerning energy markets, energy systems and environmental issues Pöyry Energy Oy provides value added services helping our Client establish commercially, technically and environmentally optimal solutions.

Disclaimer

While Pöyry Energy Oy ("Pöyry") considers that the information and opinions given in this work are sound, all parties must rely upon their own skill and judgement when making use of it. Pöyry does not make any representation or warranty, expressed or implied, as to the accuracy or completeness of the information contained in this report and assumes no responsibility for the accuracy or completeness of such information. Pöyry will not assume any liability to anyone for any loss or damage arising out of the provision of this report.

The report contains projections that are based on assumptions that are subject to uncertainties and contingencies. Because of the subjective judgements and inherent uncertainties of projections, and because events frequently do not occur as expected, there can be no assurance that the projections contained herein will be realised and actual results may be different from projected results. Hence the projections supplied are not to be regarded as firm predictions of the future, but rather as illustrations of what might happen. Parties are advised to base their actions on an awareness of the range of such projections.

TABLE OF CONTENTS

1 FOREWORD

The Federation of Finnish Technology Industries has proposed a new design for the wholesale electricity markets. In this new market design, part of the increasing effect of the emissions trading on electricity price would be avoided so that the electricity costs for consumers would be lower but the steering effect of the emissions trading on electricity production would remain. In the new market design, windfall profits for nuclear and hydro power producers in the form of higher electricity prices would be avoided as well.

This report analyses the impact of the new market design on the Nordic electricity market. It is assumed that this model would be applied to the Nord Pool market area, but a similar market design could be introduced in other electricity markets as well.

The report introduces the new market design and discusses shortly its functioning principles. To analyse the impact of the new market design, the power market has been modelled with Pöyry's BID electricity market model.

Contact

P.O. Box 93 (Tekniikantie 4 A)
FI-02151 Espoo
Finland
Domicile Espoo, Finland
Business ID. 0577450-7
Tel. +358 10 33 11
Fax +358 10 33 24 981
E-mail: energy.fi@poyry.com

Pöyry Energy Oy

2 SUMMARY

The Federation of Finnish Technology Industries has proposed a new market design for the electricity market to decrease the impact of emissions trading on electricity price. In the new design, the wholesale electricity market price in the Nordic power exchange Nord Pool would be set in a new way and the installations included in EU emissions trading scheme (EU ETS) would be treated differently from the other power production units, such as nuclear and hydro power. The installations included in the EU ETS, i.e. combustion installations using fossil fuels, peat or biomass, would receive the new wholesale market price and an additional CO_2 compensation, which is the same for all producers but dependent on the CO_2 price. Other power production installations would receive only the new wholesale market price. As a result, the EU ETS installations would bid their production to the market with a lower price assuming the markets are well functioning and there is perfect competition. Since these units are the most expensive generating units and setting the price in the market most of the time, the new market price would be lower.

The electricity users would pay this lower wholesale electricity price and an additional CO_2 compensation fee to cover the CO_2 compensation paid for the electricity production units included in the EU ETS. The CO_2 compensation paid for the producers would be allocated to all electricity use, and therefore the fee for the electricity users would be clearly lower in the unit €/MWh than the value of the compensation paid for the producers. The total price of electricity would be lower because the additional CO_2 compensation fee for consumers would be lower than the higher market price in current situation, where also the non-ETS installations receive the higher electricity prices.

In this report, the impact of the new system if applied to the Nordic power market has been analysed for the year 2015 comparing the current market design and the proposed new market design. The electricity market modelling shows that the impact of the new market model on electricity users would be 31 and 43% decrease in the electricity price compared to the current market system with CO_2 prices of 25 €/t and 50 €/t respectively. The total annual cost savings for electricity users in Finland, Sweden, Norway and Denmark would reach over 6 billion euros with the CO_2 prices of 25 €/t and with the price of 50 €/t, to over 12 billion euros.

The wholesale electricity price would decrease by 37 to 52%. The difference between the current market design price and the new market design price would be covered for the producers of EU ETS installations with the compensation. Other installation, such as hydro, nuclear and wind power producers would receive only the lower wholesale price. The existing and planned new incentive schemes for wind power and other renewable power generation in the Nordic Countries take into account the electricity price and the needed additional support. In the new market design, the support should be increased to compensate for the lower wholesale market price. Comparing the increase in the renewables support to the total savings for electricity users shows that the increase in support payments is low. For example in Finland in 2015 it would be below 3 % of the total savings.

3 YHTEENVETO

Teknologiateollisuus ry on ehdottanut uutta mallia sähkön tukkumarkkinoille päästökaupan sähkönhintoja korottavan vaikutuksen vähentämiseksi. Uudessa sähkömarkkinamallissa päästökauppaan kuuluvia sähköntuotantolaitoksia, eli polttolaitoksia, kohdeltaisiin eri tavoin kuin päästökauppaan kuulumatonta tuotantoa, kuten ydinvoimaa ja vesivoimaa. Tavoitteena mallissa on, että nämä päästökaupan ulkopuoliset tuotantolaitokset eivät jatkossa saisi markkinoilta korkeaa sähkönhintaa, jonka tason asettavat päästökauppaan kuuluvat tuotantolaitokset, vaan matalampaa uutta markkinahintaa. Sen sijaan päästökauppaan kuuluva sähköntuotanto saisi jatkossakin nykyistä hintaa vastaavan hinnan, joka muodostuisi sähkön uudesta, matalammasta markkinahinnasta sekä CO_2-kompensaatiosta, joka olisi yhtä suuri kaikille päästökauppaan kuuluville tuotantolaitoksille ja kattaisi nykyisen markkinahinnan ja uuden markkinahinnan erotuksen.

CO_2-kompensaatio olisi ennalta määrätty vakio, mutta sen arvo vaihtelisi päästöoikeuden markkinahinnan mukaan. Kilpailluilla markkinoilla päästökauppaan kuuluvat tuottajat vähentäisivät CO_2-kompensaation hinnasta, jolla tarjoavat sähköä markkinoille. Koska markkinahinta tyypillisesti määräytyy näiden tuottajien tarjouksien perusteella, laskisi sähkön markkinahinta CO_2-kompensaatiota vastaavan summan.

Sähkön kuluttajat maksaisivat uudessa mallissa matalamman markkinahinnan sähköstä. Lisäksi kuluttajat maksaisivat CO_2-kompensaatiota vastaavan summan erillisenä CO_2-maksuna. CO_2-maksu perittäisiin kaikelta kulutukselta markkinoilla. Koska merkittävä osa kulutuksesta katetaan tuotannolla, jolle CO_2-kompensaatiota ei makseta, jäisi CO_2-maksu sähkön käyttäjille selvästi matalammaksi, ja kokonaissähkönhinta laskisi merkittävästi.

Tässä työssä uuden sähkömarkkinamallin vaikutuksia Pohjoismaisen on arvioitu mallintamalla sähkömarkkinoiden toimintaa vuonna 2015 Pöyryn tuntitason mallinnukseen perustuvalla BID-sähkömarkkinamallilla. Mallinnukset tulokset osoittavat, että uusi sähkömarkkinamalli laskisi sähkön hintaa sähkön ostajille 31 - 43 % nykyiseen malliin verrattuna päästöoikeuden hinnoilla 25 €/t - 50 €/t. Kokonaissäästö kaikelle sähkönkulutukselle laskettuna olisi Suomessa, Ruotsissa, Norjassa ja Tanskassa yhteensä yli 6 miljardia euroa päästöoikeuden hinnalla 25 €/t ja päästöoikeuden hinnalla 50 €/t, yli 12 miljardia euroa.

Sähkön tukkumarkkinahinta laskisi uudessa mallissa 37 - 52%. Päästökaupan piirissä oleville tuottajille ero korvattaisiin CO_2-kompensaationa, kun taas muu tuotanto, kuten vesivoima, ydinvoima, ja tuulivoima saisi matalamman markkinahinnan. Tuulivoiman ja muun uuden uusiutuvan energian tuotannolle olemassa olevat tai suunnitteilla olevat tukijärjestelmät huomioivat markkinahinnan ja tukitaso muodostuisi korkeammaksi korvaamaan erotuksen. Tarvittavan uusiutuvan energian lisätuen kustannus jäisi kuitenkin hyvin pieneksi verrattuna säästöihin, joita uusi malli toisi sähkönkuluttajille. Esimerkiksi Suomessa lisäkustannukseksi arvioitiin vuonna 2015 alle 3 % kokonaissäästöistä sähkön käyttäjille.

4 ABBREVIATIONS AND GLOSSARY

BAT	Best available technology
CDM	Clean Development Mechanism. An emission reduction project executed in a country not listed in Kyoto protocol's annex I. The emission reduction credits can be used in EU ETS.
CHP	Combined Heat and Power production
Compensation Factor	The Compensation Factor is pre-defined value [CO_2/MWhe] and paid for all EU ETS installations production of electricity. Same Factor is paid for all EU ETS production units regardless of their fuels or emissions.
CO_2 Fee	A new fee collected from electricity users to cover the CO_2 compensation paid for the electricity production units within EU ETS
CO_2 Refund	Payment for the electricity producers within EU ETS to cover the difference between the new wholesale market price and the marginal production costs of the most expensive units in the merit order needed for electricity production
DSO	Distribution System Operator
Emission factor	Each fuel has its factor of emissions per unit of energy. The higher the factor, the more emitting is the fuel. Value of emission factor is t_{CO2}/MWh_{fuel}.
EUA	European Union Allowance for the emissions trading
EU ETS	European Union Emissions Trading Scheme
Forward	A tradable financial contract which enables fixing the price of future delivery in advance. In Nord Pool there are yearly, quarterly and monthly forwards available.
JI	Joint Implementation. An emission reduction project executed in a Kyoto protocol Annex I country, e.g. Russia.
LCP	Large Combustion Plant
Merit order	Electricity producers' bids in the market are put in merit order by price from the cheapest to the most expensive. The bids are accepted in this order.

NAP	National Allocation Plan. A plan according to which the emissions trading allowances are allocated in the first and second emission trading periods in EU ETS.
OTC	Over-the-counter market. Bi-lateral trade between two parties.
PSO	Public Service Obligation. In this report, the Danish system where renewable energy subsidies are passed on to the consumers as an equal PSO tariff on their total consumptions.
TSO	Transmission System Operator

5 THE IMPACT OF EMISSIONS TRADING ON ELECTRICITY PRICES

5.1 Emissions trading in EU

The European Emissions Trading Scheme (EU ETS) was introduced in 2005. It obliges energy producers and certain industries to acquire and annually surrender a sufficient amount of emission allowances (EUAs) to cover the emissions of carbon dioxide (CO_2). Besides power generation, the scheme covers currently cement, lime, oil refining, iron and steel, pulp and paper, glass and ceramics sectors.

EU ETS has been split into trading periods: the first trading period covered years 2005-2007, and the second period started in 2008 and will last until the end of 2012. The third trading period will cover years 2013-2020. For the two first trading periods, EU member states have prepared National Allocation Plans (NAPs) for the trading periods in which they:

set the total number of allowances to be issued; and

- detail how these allowances are allocated to the installations under the scheme

In the third trading period, the allocation of allowances will be carried out at European level and no National Allocation Plans will be needed. The amount of free allocation will decrease from the current period. Especially in the power sector the free allocation will be mostly abandoned and the allowances will be auctioned to the market.

The target of the emissions trading is to reach the emissions reduction targets with the least cost methods. Companies and industries having relatively high emission reduction costs can purchase allowances from companies that can achieve emission reductions at lower cost. EUAs are traded in the OTC market, in power exchanges and in a special climate exchange. Companies participating in the EU ETS can also cover a certain part of their allowance demand with emission reductions in other countries or other sectors with JI and CDM projects.

5.2 Nordic electricity market and emissions trading

In the Nordic countries electricity generation is largely based on hydro power, which accounts for 99 % of electricity production in Norway, about a half in Sweden and for approximately 20 % in Finland. In addition, Sweden and Finland have remarkable nuclear power capacity, while thermal power based on fossil fuels or biomass is mostly used in Denmark and Finland.

In the Nordic electricity market, the wholesale electricity price for Finland, Sweden, Norway and Denmark is set in the Nord Pool power market. The marginal production technology, i.e. the most expensive unit in the merit order that is needed to satisfy the demand in the area each hour sets the electricity price based on its variable production cost. If there are no bottlenecks in the transmission lines between countries and within countries, the whole Nordic area has the same electricity price. Figure 5-1 describes the merit order and marginal production costs including the emissions trading costs (grey area) and other variable costs.

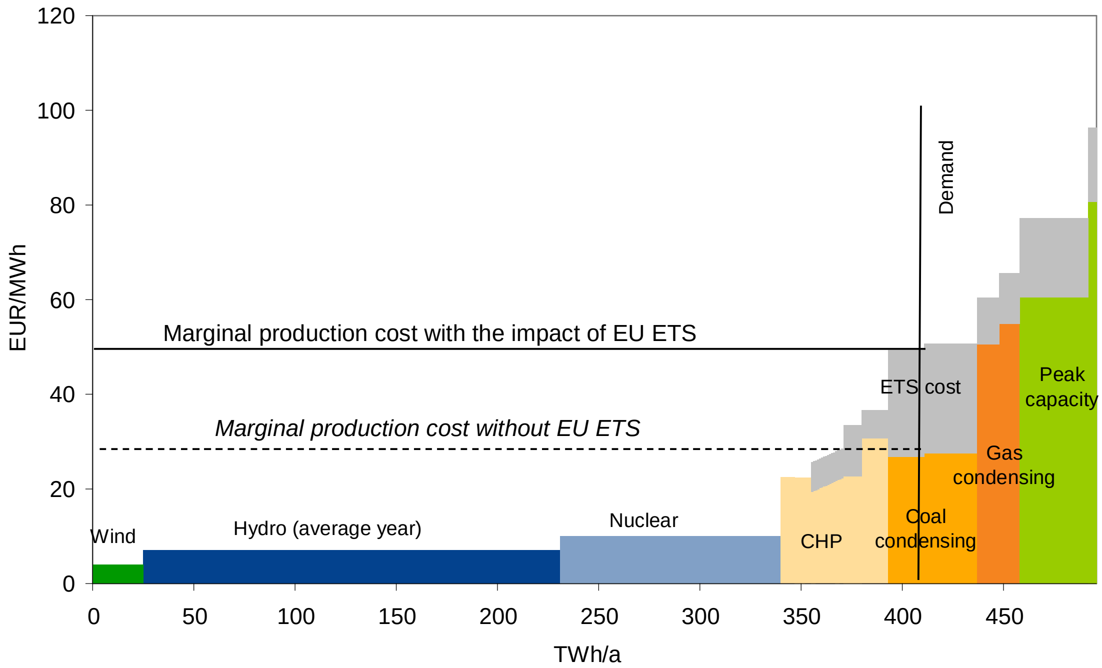


Figure 5-1 Marginal production costs with and without EU ETS in the Nordic electricity market

Figure 5-1 describes the average situation for one average year, but from year to year, there is variation especially in the hydro power production and power consumption. The same figure is applied on hourly level to define the system price in the wholesale market. The system price is calculated for each hour of year based on the hourly projected power consumption and capacities available to cover the demand. The system price is the marginal production cost of the most expensive unit required to run each hour. When power demand increases, the red vertical line in the picture moves to right and the power price increases, as more costly units have to be used to cover the electricity demand. The marginal production costs presented are estimates, and the costs also vary based on varying fuel costs and CO_2-costs.

The EU emissions trading increases the marginal production costs of the generation units using fossil fuels or peat as described in the figure above with a grey area. The marginal production cost of price setting unit excluding the impact of emissions trading is described with the dashed line and the marginal production cost with the upper red line. In the electricity market, the generation units fired with fossil fuels are often on the margin. Therefore, the impact of EUA price is reflected in the electricity price most of the time. Figure 5-2 describes the CO_2 (EUA) and electricity forward prices quoted from January 2008 to April 2009 in the the Nord Pool power exchange. The figure shows that there is a clear linkage between the CO_2-price and power forward price.

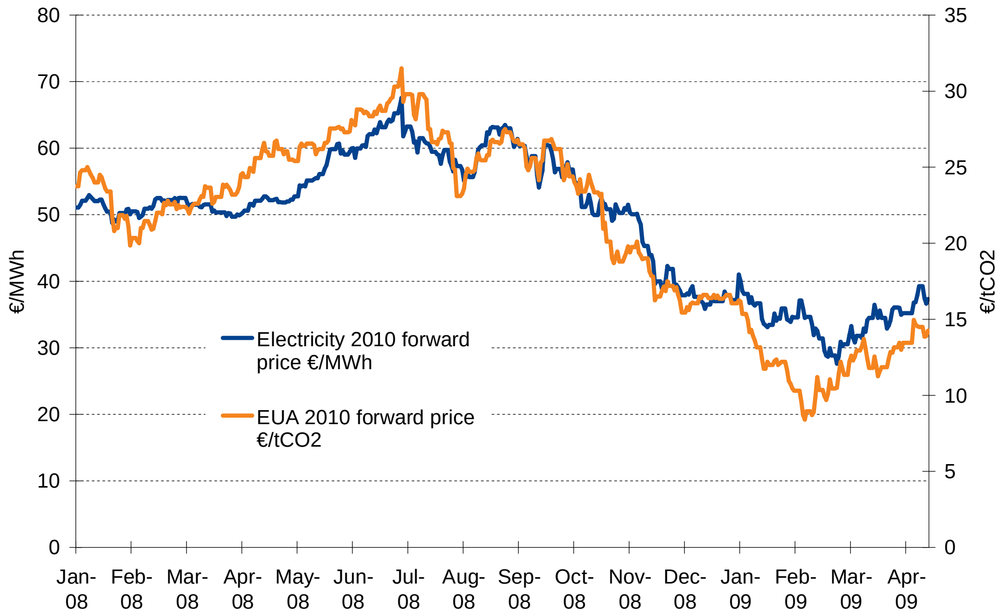


Figure 5-2 Forward prices for EUAs and Nord Pool electricity

Since the beginning of the emissions trading, authorities and electricity users in many countries have been concerned about windfall profits in the electricity market caused by emissions trading. Windfall gains or windfall profits refer to unearned or occasional profits. In electricity market, the increasing impact of emissions trading on electricity prices has resulted in increasing profits for non-fossil electricity generation, such as nuclear power and hydro power. If the investments have been made without taking into account the impact of emissions restrictions and emissions trading, it can be assumed that these generation units enjoy fortunate additional income, which can be called windfall gains.

5.3 Studies on the impact of emissions trading on the electricity market

The EU emissions trading began in 2005 with the first trading period covering years 2005-2007. Before the scheme was introduced, there were several studies on the possible impact of the forthcoming scheme on the electricity market.

In 2004, ECON Analysis (currently Pöyry Energy AS) conducted a study on the emissions trading and its impact on electricity price from the Swedish perspective. The study was commissioned by the Swedish Ministry of Industry. The analysis was based on modelling the Nordic power market along with Germany, Poland and the Netherlands, using CO_2-prices of 5 €/t, 10 €/t and 20 €/t. The modelling covered years 2006, 2008 and 2010. The study showed that as an example, with a CO_2-price of 20 €/t, the electricity prices in Finland would increase between 8 and 12 €/MWh in a normal hydrological year. The lowest increase in prices would be in 2010. The increase in electricity prices was lower than the increase in the marginal production costs of coal condensing plants in the Nordic area, where also other production technologies are on the margin during a year. In the longer run, the study concluded that the increase in electricity prices would be lower due to investments in gas-fired generation. The study also pointed out that emissions trading change the marginal production costs which decreases social economic efficiency and that regulation of prices would be needed to guarantee the functioning of the market.

Electrowatt-Ekono's (currently Pöyry Energy Oy) study from 2004 also used CO_2-prices of 5, 10 and 20 €/t and the modelling was carried out for the year 2010. Two scenarios were analysed, with the main difference arriving from the method of allocation of CO2 allowances. In the first scenario, allowances were allocated for free and in the other one, allowances were auctioned. As a result, the study showed that the method of allocation of allowances did not have an impact on the electricity price, because the allowances in any case created an opportunity cost to the producer. With the CO_2-price of 20 €/t, the electricity price was assumed to increase by about 15.5 €/MWh. This price increase was clearly higher than in the study of ECON Analysis. Part of the difference can probably be explained by the differing investment assumptions and electricity import and export assumptions.

In 2004, Professor Mikko Kara was commissioned by the Finnish Ministry of Trade and Industry to analyse the impact of emissions trading on the Nordic electricity market (Kara 2004). Also in this study the impact of emissions trading on the Nordic power prices had been analysed based on model simulations. The simulations showed that the impact of emissions trading on the electricity prices in the Nordic market is lower than the increase in the marginal production costs of coal condensing plants. The modelled increase in electricity price was close to 80% of the increase in costs of a coal condensing plant, because coal is not on the margin all the time in the Nordic power market. With CO_2-price of 20 €/t, the modelled increase in the electricity price was 15 €/MWh, which is slightly lower than in the analysis of Elektrowatt-Ekono, but higher than in the analysis of ECON.

ILEX Energy Consulting (currently Pöyry Energy Ltd) analysed also in 2004 the impact of emissions trading on the electricity retail and wholesale prices in several European countries including Finland, Sweden and Denmark. The study also examined the extent to which the impact of the emissions trading had been incorporated into forward electricity prices in different markets. The study was commissioned by the UK Department of Trade and Industry. The analysis of the impact of emissions trading on wholesale electricity prices was based on modelling the markets for the years 2005-2007 without CO_2-price and with a CO_2-price of 10 €/t. The study concluded that the impact of emissions trading with a CO_2-price of 10 €/t would be around 7 €/MWh in the Nordic markets and about 8.5 €/MWh in Germany and France. Of the analysed countries, the impact was lowest in Spain and Ireland being around 5 €/MWh.

A more recent study from Frondel et al. (2008) notes that the opportunity costs of the emissions allowances are equally price-relevant as the actual production costs such as fuel costs. Even if the allowances were allocated for free, the electricity producers would only produce electricity if the profit from electricity production covers also the price of allowances.

It has been noted in several studies (e.g. Electrowatt-Ekono 2004, Kara 2005, Frondel et al. 2008) that irrespective of the amount of free allocation of emission allowances for the electricity producers, the allowance price creates an opportunity cost for the producers and their value will be passed to the market price of electricity if the electricity markets are functioning according to economic reasoning. However, in the case of free allocation, the producers would also have an option not to pass all the costs of the emissions trading through to the electricity prices. Demonstration of this, as well as analysis of the impact of emissions allowance prices on the electricity price is however difficult. Especially in the Nordic power market, the electricity price is dependent on hydro power situation and many other factors impact the electricity price as well. Therefore, it is difficult to analyse the impact of emissions trading on the electricity prices during the last years.

6 THE PROPOSED NEW DESIGN FOR THE ELECTRICITY MARKET

6.1 Functioning of the new market design

The analysis of the new market design is based on the assumption that the Nordic power market is functioning perfectly and that there is no use of market power or portfolio management in the producers bidding behaviour. In perfect competition, all producers are bidding the production of their power plants to the market based on their marginal production costs. As an example, coal condensing power producers bid their production based on their variable costs of fuel, CO_2 emission allowances, operation and maintenance and other costs. Nuclear power producers bid the production to the market with different price because their marginal production costs are different. The price of the electricity in the wholesale market is set by the marginal production costs of the most expensive unit needed each hour.

In the new market design, it is assumed that the electricity producers would bid their electricity production to the power market as today. However, in the new design, the bidding price would change for the production units included in the EU ETS, while for other units it would remain the same as in the present market system. The installations included in EU ETS, i.e. combustion installations using fossil fuels, biomass or peat receive in addition a CO_2 Refund based on CO_2 Compensation Factor (defined in t_{CO2}/MWh of electricity produced), which is constant for all producers. The bidding price of the EU ETS units would therefore be based on the marginal production costs, but taking into account a Compensation Factor, which covers the costs of the emissions trading for certain, pre-defined plant type. Other power generation units, such as hydro power, wind power and nuclear power plants do not receive this CO_2 Refund but only the wholesale market price of electricity. The EU ETS installations and their place in the merit order are presented in Figure 6-1. The darker blue area describes the marginal production costs without the Compensation Factor, and the lighter blue area describes the Compensation Factor for EU ETS installations. The lighter blue area, i.e. the Compensation Factor, is the same for all installations within EU ETS, but other variable costs, such as fuel costs, vary as described by the darker blue area.

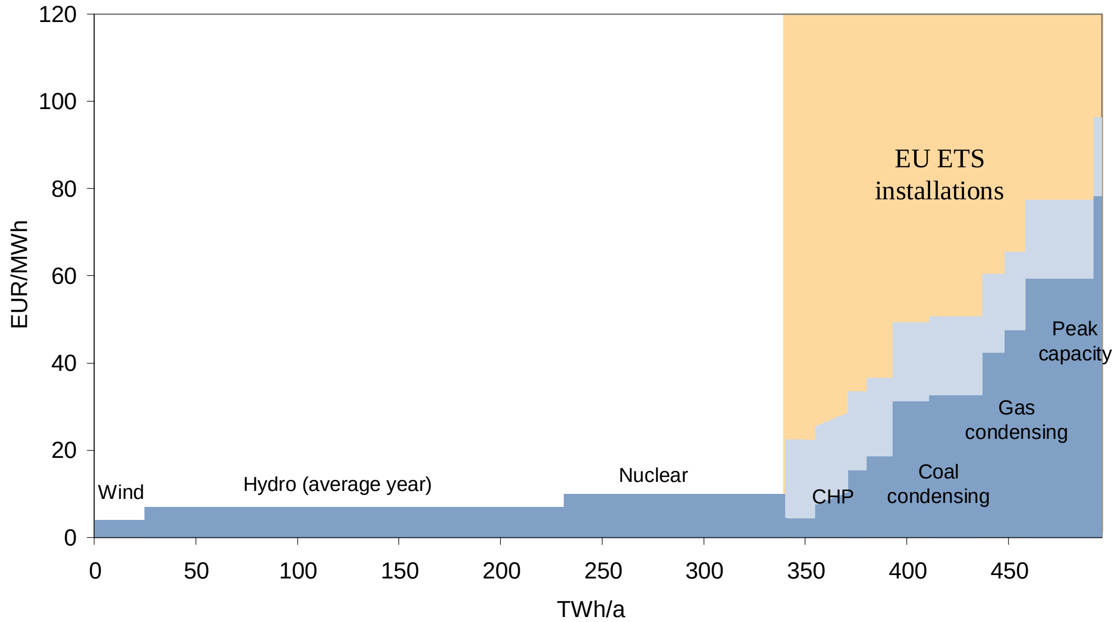


Figure 6-1 The variable production costs of generation units of the EU ETS installations and other generation in the Nordic market

The EU ETS installations would also in the new market design be obliged for emissions trading on their part, just like in the present market system. The power producers would have to acquire the allowances they need by themselves and they would be responsible for the emissions trading costs. They would take into account the real CO_2 emission costs and other variable costs and take off the Compensation Factor from the bidding price.

CO_2 Refund is paid to the EU ETS installations by an Authority Office, which could be for instance the transmission system operator (TSO) in each Nordic Country, and the corresponding amount collected from electricity users in electricity bills as a separate CO_2 Fee. The amount of the CO_2 Refund depends on the pre-defined Compensation Factor, which is constant for all producers within EU ETS, on the amount of electricity produced by ETS installation, and on the daily EUA price:

CO_2 Refund (€) = Energy produced by ETS installation (MWh) * Compensation Factor (t/MWh) * EUA price (€/t)

Figure 6-2 describes the amount of CO_2 Refund paid for the producers of EU ETS installations. The compensation is paid only for the power production of the production units included in the EU ETS, while other production units receive only the new market price. In the figure, it is assumed that the value of Compensation Factor is about 18 €/MWh and the amount of production for which it is paid is about 70 TWh in the whole Nordic market. The rest of the production, about 340 TWh, would not receive this Compensation Factor.

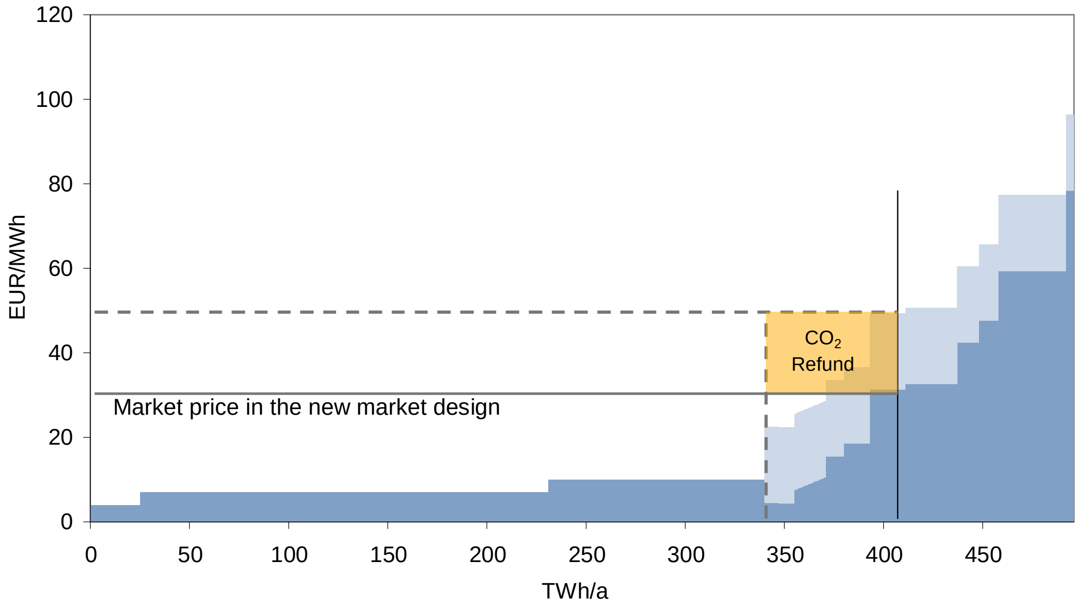


Figure 6-2 The CO2-compensation paid for the power produced in EU ETS installations

In the new market design, electricity price for users (excluding sales margins, distribution and taxes) would be the sum of the new wholesale electricity market price and the cost of emissions trading, called CO_2 Fee. In the present market design, the electricity users only pay the electricity wholesale price, which is higher than in the new market design.

This CO_2 Refund paid for the producers is divided to all consumption in the market and added to the electricity bills as a separate CO_2 Fee. Figure 6-3 describes this CO_2 Fee for the consumers. Because the share of the EU ETS installations of the total electricity production is relatively small, the CO_2 Fee paid by the consumers is significantly lower in €/MWh than the CO_2 Refund paid for the electricity producers. In Figure 6-3 the CO_2 Refund area described in Figure 6-2 is evenly distributed over all demand in the Nordic power market. As a result, the CO_2 Fee is below 4 €/MWh compared to the Compensation Factor of about 18 €/MWh paid for the producers of EU ETS installations.

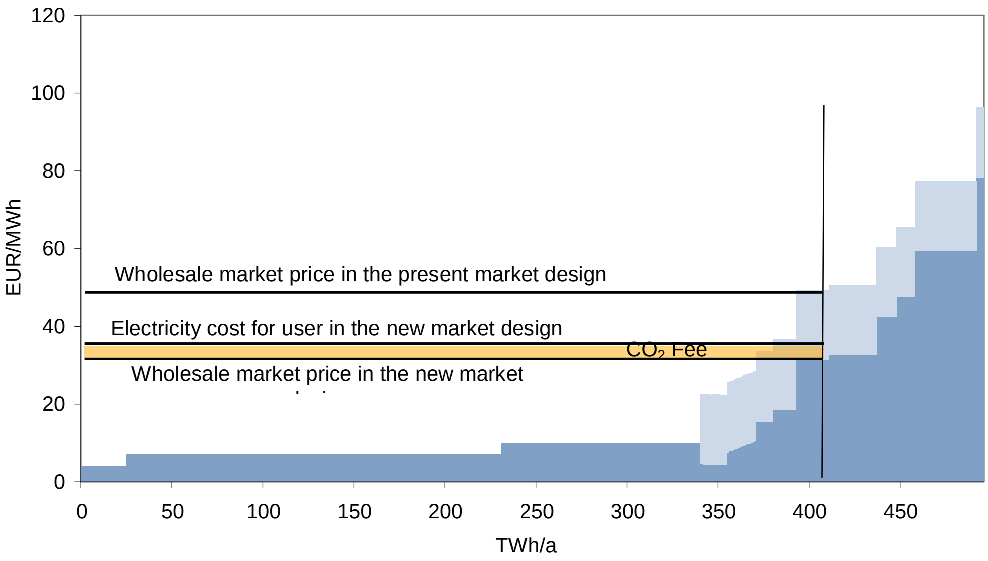


Figure 6-3 The CO2-compensation paid by the electricity users

6.2 Compensation Factor and CO_2 Fee for users

The Compensation Factor is pre-defined value in tonnes of CO_2 per MWh of electricity produced. The factor is the same for all production within EU ETS irrespective of the fuels used or the efficiency of the production. The Compensation Factor can be set to demonstrate the impact of the emissions trading on the electricity market. In the Nordic market, coal condensing power is often on the margin in the merit order and thus setting the electricity price. However, this does not apply throughout the year, and in the future it is possible that the situation changes and e.g. more gas would be on the margin.

For this study, the Compensation Factor was selected to be based on coal condensing power plant using Best Available Technology (BAT) for Large Combustion Plants (LCP). BAT defines the thermal efficiencies for new condensing coal plant (PC) units to be between 43-47 %. Taking this into account, and the CO_2 emissions from coal, the specific emissions from coal condensing plants per electricity unit produced would vary between 0.776 – 0.710 tCO2/MWhe. An average of 0.743 tCO2/MWhe is used as a compensation factor in this study.

The value of the Compensation Factor is based on the price of CO_2 emission allowances (EUAs). Assuming an EUA price of 25 €/tCO_2 gives a compensation factor value of 18.50 €/MWhe. In the market, the Compensation Factor value would be based on the actual spot EUA closing price in an exchange (e.g. Nord Pool, Bluenext) each day. The producers would also still buy the allowances they need from the market, and account themselves for the costs and surrendering of their allowances annually.

In the power market modelling carried out for this analysis, the EUA-price is kept constant during the modelled year. Therefore, the Compensation Factor value is also constant during the year.

Compensation Factor could be defined in the new market design e.g. each year, or every third year for the market area based on the marginal generation form in the past years. Gas condensing power in the margin in the future would result in a lower Compensation Factor value. It seems possible that the amount of gas condensing power increases in the future and as a result, less coal would be on the margin in the Nordic market. The situation in 2015 is analysed in more detail in section 7.3.

The CO_2 Fee paid by the electricity users would be based on the electricity use. The total amount of CO_2 Refund for the power producers would be based on the production in the EU ETS installations, and this would be distributed evenly to all electricity use. The CO_2 Fee for electricity users will be based on the equation:

CO_2 Fee (€/MWh) = Electricity produced in ETS installations (MWh) * Compensation factor (tCO_2/MWh) * CO_2-price (€/t CO_2) / Total electricity use (MWh)

CO_2 Refund is only paid for the amount of electricity used in the Nordic area. Therefore, it would not impact the competitive situation of electricity trade between the Nordic area and other countries. The practical treatment of imports and exports in the new market design is described in section 6.4.

6.3 Market price and bidding in the new market design

In the Nordic electricity market a substantial share of electricity is traded through Nord Pool electricity exchange. In 2008, the share of spot market trading at Nord Pool was approximately 70% of the total consumption in the area. For bilateral contracts and for financial market the daily spot-price of electricity serves as a reference point. The spot-price is effectively valid for all the physical transactions.

In the future, the volume of electricity traded through Nord Pool is assumed to increase both in relative and in absolute terms. New price areas within countries being established for congestion management purposes contribute to that development. By definition, all the transactions from one price area to another must be traded through Nord Pool. The proportion of electricity produced in Finland that is traded in the exchange is not assumed to increase significantly unless Finland is divided into two price areas.

It seems unlikely the new market design would decrease the interest of power producers to bid the electricity to the Nord Pool and instead sell electricity directly to power users. The CO_2 Fee would be charged from all electricity consumption in addition to the electricity price regardless of where the electricity is purchased. Therefore, the wholesale market price would be the highest price that the users are willing to pay for the electricity and the producers would not get any advantage of bilateral trading of electricity.

6.3.1 Installations included in the EU ETS

The installations included in the EU emissions trading include combustion installations using fossil fuels (coal, gas, oil), biomass or peat. The installations can be condensing power plants producing only electricity or combined heat and power plants (CHP).

The EU ETS installations will receive the new wholesale market price from the electricity market, and the CO_2 Refund from the Authority Office. Therefore, in perfectly functioning market these installations will bid to the electricity market based on their marginal production costs (including fuel and emissions costs and other variable costs) minus the compensation (e.g. 18.5 €/MWh with EUA price of 25 €/t).

In modelling, the compensation is set as a constant negative cost for the producers so that the bidding is based on the marginal production costs including fuel cost, CO_2 emissions cost and other variable costs of generation, minus the compensation.

Following simplified examples in Table 6-1, Table 6-2 and Table 6-3 demonstrate the price at which the EU ETS installations will bid to the market. In all examples, EUA price of 25 €/t has been used. The total variable production costs are calculated based on equation:

Variable total cost = (Coal price + Emission factor * EUA price + Other variable cost) / Efficiency

The bidding price is based on equation:

Biddign price = Variable total cost - Compensation

Table 6-1 The variable production costs, compensation and bidding price of a coal condensing plant, EUA price 25 €/t

	Coal condensing plant						
	Efficiency	Coal price	Emission factor	Other variable cost	Total cost	Compen-sation	Bidding price
Unit	%	€/MWh	t/MWh	€/MWh	€/MWh	€/MWh	€/MWh
Value	38	8	0.334	1.6	46	-18.5	27

Table 6-2 The variable production costs, compensation and bidding price of a gas condensing plant, EUA price 25 €/t

	Gas condensing plant						
	Efficiency	Gas price	Emission factor	Other variable cost	Total cost	Compen-sation	Bidding price
Unit	%	€/MWh	t/MWh	€/MWh	€/MWh	€/MWh	€/MWh
Value	59	29	0.201	1.0	59	-18.5	41

Table 6-3 The variable production costs, compensation and bidding price of a CHP plant using biomass (50%) and peat (50%), EUA price 25 €/t

	Biomass and peat (50%/50%) CHP plant						
	Efficiency	Fuel price	Emission factor (peat)	Other variable cost	Total cost	Compen-sation	Bidding price
Unit	%	€/MWh	t/MWh	€/MWh	€/MWh	€/MWh	€/MWh
Value	80	14	0.378	2.0	26	-18.5	7

As the examples above demonstrate, it is possible that the bidding price of the CHP plants could go very low and even below e.g. variable costs of the nuclear power plants or even other installations outside EU ETS. This would also change the merit order so that the CHP plants would be running before those plants. However, the amount of the electricity produced with the low-cost CHP is limited by the heat load: electricity with the high efficiency can only be produced when there is a need for the heat in either district heating or in industry. The bidding price of condensing power plants would be clearly higher because of the lower efficiency of the electricity production.

In practise, the power produced with the CHP mode is already most of the time competitive and the heat loads are well utilised for electricity production. Also when the demand in the Nordic area is low and could be covered with renewables and nuclear power, power generated with CHP is exported to Central Europe where electricity prices are typically higher. Naturally, the bidding price of CHP plants depends on the fuel used and the fuel price and other costs, and some CHP plants have higher electricity generation costs.

6.3.2 Installations outside EU ETS

The power production units that are outside the EU ETS and would not receive the additional income of the Compensation Factor in the new market design include hydro power plants, nuclear power plants and wind power plants. Also other renewable plants (excluding biomass combustion, which is included in EU ETS) such as solar power is included in this group.

The installation outside the EU ETS will receive only the new market price, which is set by the marginal production costs of the most expensive unit in the merit order, excluding the compensation.

These installations are assumed to bid to the electricity market based on their marginal production costs. The hydro power producers optimise their production based on the new market price, which is based on the marginal production costs of the most expensive unit needed to produce electricity in the market (taking into account the impact of CO2 price) minus the Compensation Factor. The impact of the new market design on hydro power based on modelling results will be discussed in more detail in section 7.2.2.

6.4 Transmission of electricity to and from the Nordic market area

It has been assumed in this study that the system would be applied only to the Nordic power market, although a similar system could be introduced in other electricity markets as well. However, not all the electricity markets are as deregulated as the Nordic power market.

In principle, the new market design should not face remarkable problems with exports and imports when the interconnectors are used on market basis and implicit auction is used. Implicit auction refers to a situation, where the flow on an interconnector is based on electricity market price of the marketplaces in the connected markets. The transmission capacity is used based on spot price differences and taking into account the transmission costs in the interconnection.

For the exported electricity, the Nordic power users should not pay the CO_2 Fee and therefore the Compensation Factor can not be applied for the exported electricity. If the Compensation Factor was applied to exports as well, the electricity would flow to other European markets having higher electricity prices most of the time and the Nordic power users would be supporting this export. It would also support investments of new power production based on fossil fuels to the Nordic area instead of other European countries, because the Nordic electricity users would compensate for the emission costs of these plants.

In the new market design, the Compensation Factor would be added to the electricity exported from the Nordic market area, and taken off from the electricity imported to the area. This would be the responsibility of the interconnector operator. The interconnector operator would be in charge of CO_2 payments to the Authority Office corresponding to the amount of electricity exported, as described in Figure 6-4. In reality, the price which the exported electricity gets from the German power market would in most cases be higher than in the example, but the price presented (60 €/MWh) reflects more the bidding price to the German market, without taking into account transmission losses and other costs.

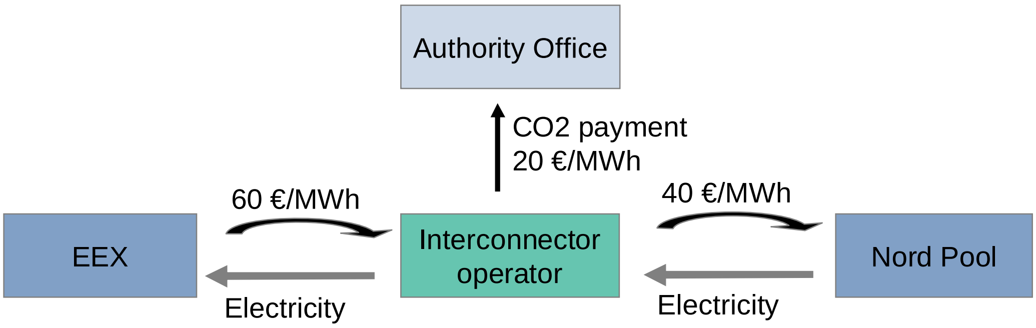


Figure 6-4 Example of the export of electricity from the Nord Pool area to Germany (EEX), and the role of the interconnector operator

For the electricity imported to the area, the Compensation Factor should be paid so that imports would not change the merit order. This way the competitive situation would also not change from the current situation. The interconnector operator would get CO_2 Refund from the Authority Office corresponding to the amount of electricity imported to the area, and can therefore offer the electricity with a lower and comparable price to Nord Pool market. This is illustrated in Figure 6-5.

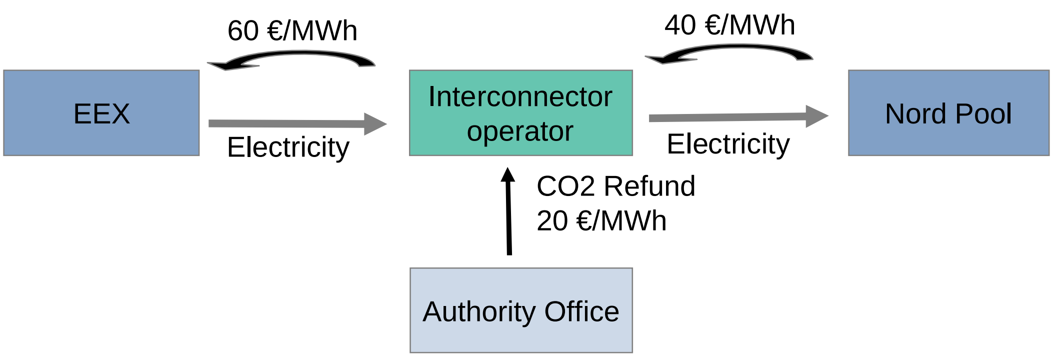


Figure 6-5 Example of the import of electricity from the Germany (EEX) to Nord Pool, and the role of the interconnector operator

Taking the Compensation Factor into account in the pricing of the imports and exports to and from the Nordic market area could bring certain difficulties when the use of interconnections is not implicitly auctioned. When the use of interconnectors is decided in advance, the flow of electricity is not always operating perfectly based on price differences. However, it is possible to take the impact of the Compensation Factor into account in the agreements made in advance as well and the change in market design would not significantly change the situation.

The interconnector operators should be responsible for applying the Compensation Factor for the price of the interconnector use, and for the monetary transactions to the Authority Office. It is assumed that in the future, market coupling proceeds and the interconnectors will be used more and more on market basis. If the new market design would be applied in other markets as well, this kind of system to take into account Compensation Factor in exports and imports would not be needed.

6.5 Practical organisation of the new market design

6.5.1 CO_2 Refund and CO_2 Fee payments

Power producers with generation capacity included in EU ETS (ETS installations) would have to register to the Authority Office to be able to get the CO_2 Refund. This Authority Office takes care of the Refund to power producers, and collection of the corresponding CO_2 Fee from electricity users. This Authority Office could be for example the Transmission System Operators (TSOs) in each country, or Energy Market Authorities or similar authorities or their affiliates. In many countries, the TSOs are already responsible for the collection of the costs of renewable energy feed-in tariff or other support mechanisms from the electricity users and the refunds for power producers.

The CO_2 Refund for the power producers could be paid once a month afterwards. The power producers report their power production in ETS installations for each day of the month, because the CO_2 compensation refund is calculated for each day based on quoted daily CO_2-prices (EUA price) in an exchange, such as Nord Pool. The refund for the power producers would be:

Refund (€) = Electricity produced (MWh) * Compensation factor (tCO_2/MWh) * CO_2-price (€/t CO_2)

To collect the corresponding compensation from the market, the Authority Office charges power users for the electricity consumed. This could be organised through the TSOs, who could charge it as a separate component in the grid service fees. The clients of TSOs include large power users and distribution network operators, which could pass the costs further to the power users connected to their distribution networks. The system is described in Figure 6-6.

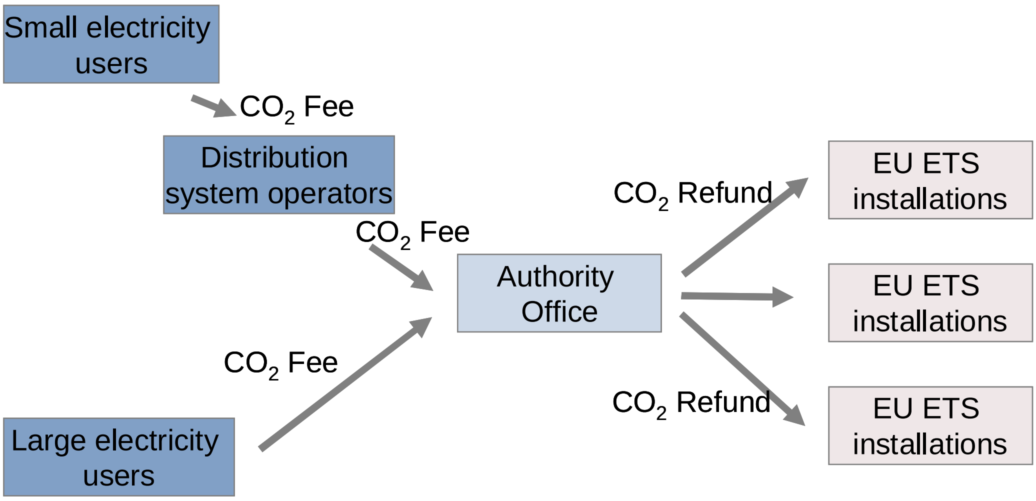


Figure 6-6 Collection of the CO_2 Fee and payments of the CO_2 Refund for the producers

6.5.2 Definition of the CO_2 Fee in advance

Because the CO_2-price changes daily and the electricity production in ETS installations and total electricity demand in the market vary, the final value of the CO_2 Fee can be defined only afterwards. However, the grid companies would have to announce the fees in advance so that the electricity users would know their costs. The advance fee can be defined e.g. four times a year, taking into account the difference between real costs and collected fees in the definition of next quarter's fee. Other frequencies of revision of the fee are also possible. The functioning could be analogous to the proposed feed-in-tariff in Finland.

The distribution network owners could charge the advance fee from electricity users based on a confirmed fee. The fee could be confirmed by the Energy Market Authorities of all Nordic Countries together, based on forward EUA prices for the next period and electricity demand and generation forecasts.

The advance fee would be based on following estimations:

- CO_2-price for the period;
- Electricity generation by the EU ETS installations for the period;
- Electricity demand for the period; and
- Correction of the former period advance prices and realised prices.

The CO_2 Fee could also include the administrative costs of the new system for the market authorities and the Authority Office.

6.5.3 Invoicing and payments

In the new market design, the CO_2 Fee paid by the electricity users would be charged from the users as a part of the grid fees. The TSOs charge the Compensation Fee from the distribution network operators as a part of the national transmission grid fees. In practise, there would be about one moths delay before the TSO has received the CO_2

Fees from the electricity users. The CO_2 Refund can be paid for the EU ETS installation after the CO_2 Fees have been received. Compared to the current system, the power producers could have a delay of about one month in part of their income.

6.5.4 Required changes to electricity market legislation in Finland

As an example, the required changes of the new market design in the legislation in Finland are discussed shortly below.

The new market design would incur new tasks for the TSOs and DSOs who would be in charge of collecting the CO_2 Fee from the electricity users and accounting it further to electricity producers. These new tasks should be defined in the Electricity Market Act in Finland. The impact of these new tasks should also be taken into account in the supervising of these operators. The costs of the administration of this system for these operators should be taken into account in the CO_2 Fee.

The Electricity Market Act in Finland provides that distribution system operators may change the prices and other terms of the service contract only on certain conditions, and the clients must be informed at least a month before the changes come into effect. However, this does not apply, if the changes are based on the decisions of authorities. Therefore, if the Energy Market Authorities would define the advance CO_2 Fee, it could be charged by the transmission system operators within a short period. Also in Denmark the TSO Energinet.dk publishes the advance estimate of the public service obligation (PSO) fee.

7 IMPACTS OF THE NEW MARKET DESIGN

7.1 Electricity market modelling

The impacts of the new market design has been analysed based on modelling the Nordic electricity market with the new design and current market design. The modelling has been done with Econ Pöyry's BID model. BID is model based on fundamental analysis that estimates the price by calculating the intersections between supply and demand. The model has a regional structure with specified transmission capacity and trading regime between the regions. For each region, there are specified demand curves and the supply curve is constructed as a merit order curve defined by production capacities and short term marginal costs.

Geographically the model covers the Nordic region (except Iceland), Germany, the Netherlands, Belgium, France, Poland, Switzerland, Austria and UK. Some of these countries are divided into several zones: Norway into 7 regions, Sweden into 4 regions and Denmark into 2 regions. All data is specified on this regional level. Other regions are also specified to enable modelling of electricity trade into and out of the modelled region. The transmission on these lines may either be specified by price pattern or by fixed trade.

Simulations in BID are run on a two-level time resolution. The water values are optimised for every week of the year, and the simulation of the merit order is then carried out for each hour of the year.

A special strength of the BID model is the calculations of the short term supply from the regulated hydro power plants. The model simulates the way hydro power is priced and operated in the market. Hydro in general is split in the model into Reservoir (or storage) hydro and Run-Of-River (that is, hydro plant with very small or no effective storage) hydro. Inflows are modelled on multiple levels, with inflow expectation, the ability of generators to forecast inflows ahead of time, and actual inflow levels. In each modelled region, hydro reservoir is calculated as the sum of all the hydro reservoirs in the region. Release from each reservoir is in the form of spill and generation. Spill occurs when either the reservoir storage levels exceed the maximum, or else generation levels in a given period are less than the minimum release level required for that period, and the shortfall is met by spilled release. Total release in a period is also subject to a specified maximum release level.

Rather than model each individual plant within a given region, BID specifies the generation set at the plant type level of detail. Each plant type has several general technical properties (such as efficiencies) that are constant, and other technical properties (such as capacities and costs) that differ by region. Each plant group has a specified capacity and short run marginal cost within each region. The marginal costs are built up by several components: efficiency, fuel and CO_2-cost, transportation cost for fuel, O&M costs etc.

All prices presented are real 2008 values.

7.2 Assumptions for the Nordic electricity market development until 2015

7.2.1 Demand

It is assumed that demand in each Nordic country increases slightly from the current level. The growth in demand is largest in Finland. Assumption of the demand in 2015 compared to 2008 figures are presented in the Table 7-1.

Table 7-1 Electricity demand development to 2015 in Nordic countries, TWh

	2008	2015
Sweden	146	151
Finland	87	92
Norway	128	130
Denmark	35	37

7.2.2 Generation

Hydro power generation is assumed to increase mainly due to plant upgrades, small run-of-river hydro plants and technology improvements of existing reservoirs. The increase in generation in a normal hydro year is presented in Table 7-2.

Table 7-2 Hydro power generation development to 2015 in Nordic countries, TWh

	2008	2015
Sweden	65	66
Finland	13	14
Norway	122	128

Wind power capacity is assumed to increase significantly especially in Sweden, where there is a large number of projects in pipeline and wind power is supported with a certificate system. In Norway, the wind conditions are good and there are several large scale projects planned. It is assumed that wind power will be supported by either feed-in tariff or certificates in Norway. Also the wind power increase in Finland and Denmark is dependent on support systems. The assumed increase in wind power generation in a normal year is presented in Table 7-3.

Table 7-3 Wind power generation development to 2015 in Nordic countries, TWh

	2008	2015
Sweden	2.1	8.1
Finland	0.3	2.0
Norway	1.0	5.9
Denmark	7.1	9.5

Nuclear power capacity is assumed to increase by one unit currently under construction in Finland, and due to plant upgradings in Sweden. The assumed nuclear power capacity used in the modelling in 2015 is presented in Table 7-4.

Table 7-4 Nuclear power capacity development to 2015 in Nordic countries, MW

	2008	2015
Finland	2620	4220
Sweden	9120	9920

In condensing and CHP capacity the largest new investments by 2015 are presented in Table 7-5.

Table 7-5 Largest new CHP and condensing power plant investments in Nordic countries, MW

	Type	MWe
Suomenoja	Gas CHP	234
Malmö	Gas CHP	400
Kårsto	Gas condensing	420
Mongstad	Gas CHP	280

In addition, there are replacement investments in CHP (combined heat and power) and peak capacity, and some of the oldest condensing capacity will be decommissioned. Power generation with CHP-plants depends on the heat loads that can be utilised for power generation, either in industry or district heating. As a result of capacity changes and decrease in some industrial heat demand, it is assumed that the CHP generation clearly increases only in Sweden, where there are still unutilised heat loads and a large number of investments are planned. In Finland, no remarkable increase is assumed In Norway, the increase is consequence of Mongstad new CHP-plant. In Denmark, the power generation in CHP-plants is assumed to decrease due to power plant retirements.

7.2.3 Fuel- and CO_2-prices

CO_2 – (EUA) prices used in the modelling are 25 €/t and 50 €/t.

Fuel prices used in the modelling are based on a long-term view of supply-demand equilibrium and price projections provided by IEA and EIA. The fuel prices used in the base case are presented in Table 7-6. As a sensitivity analysis, modelling has been carried out also for higher fuel prices by increasing the fossil fuel prices by 20%.

Table 7-6 Fuel prices, real 2008 prices

	Unit	2008	2015	2015 +20%
Oil	$/bbl	97.0	72.0	86.0
Coal	$/tonne	148.0	70.0	84.0
Gas	€/MWh	30.0	28.0	34.0

7.2.4 Other assumptions in the modelling

In the new market design, it is assumed that only the electricity consumed in the Nordic area is refunded with the Compensation Factor. If the new market design is applied only in the Nordic market, the electricity exported e.g. to Germany would not be priced based on the Nordic market price, but instead the Compensation Factor (0.743 * EUA price per MWhe) will be added to the price. This way the Nordic power users will not be paying for the CO2-compensation to the German market.

In practise, power producers bid to the market based on their production costs minus the Compensation Factor regardless of if the electricity is sold to Nordic consumers or other market areas. The difference in the electricity market design in the Nordic area and other markets will be only taken into account in the use of transmission lines from the area. When electricity is exported, the Compensation Factor is added to the Nordic market price by the interconnection operator. For the electricity imported to the Nordic area, the Compensation Factor is taken off from the price, and this is compensated with the Compensation Factor to the transmission line operator.

The BID model allows using price-elasticities when modelling the electricity demand. In reality, the electricity demand depends to some extent on the electricity price. However, forecasting the degree of this dependency is not a straightforward task. In this modelling, no price-elasticity has been used.

No floor price for electricity has been set in the modelling, and also negative bidding prices are possible.

7.3 Modelled impact of the emissions trading on the electricity price

To demonstrate the impact of emissions trading on power prices in the Nordic area, the model was run with the present market design for 2015 base case also with the CO_2-price (EUA) of 0 €/t. The results of the modelling as average annual prices for the Nordic Countries are presented in Table 7-7.

Table 7-7 Modelled average wholesale electricity prices in 2015 in the present market design with different CO_2-prices and the total cost of electricity for power users in Nordic Countries

	Present market design €/MWh	Total cost in Nordic Countries bn €
Base - EUA 0 €/t	28.2	11.5
Base - EUA 25 €/t	49.7	20.3
Base - EUA 50 €/t	70.5	28.8

The modelling results show that the electricity wholesale price in the Nordic market is very much dependent on the CO_2-price. Without carbon price, the electricity price in the Nordic market would be below 30 €/MWh in 2015 in a normal year. Increasing carbon price to 25 €/t increases the power price by 20 €/MWh, and further increase of carbon price to 50 €/t raise the electricity price to over 70 €/MWh.

The increase in the modelled electricity price due to emissions trading is very close to the increase in the variable production costs of coal condensing plants due to emission costs. With the CO_2-price of 25 €/t, the increase in electricity price about 2 €/MWh higher than the Compensation Factor used in this study. Therefore, it seems reasonable to use the selected Compensation Factor in this study.

The total cost of electricity for the power users in the Nordic Countries has been calculated simply by multiplying the electricity price by the total demand (about 409 TWh) in the Nordic Countries. The impact of the emissions trading with a carbon price of 25 €/t in the total cost is close to 9 billion euros, and the impact is over 17 billion with a carbon price of 50 €/t. This calculation assumes that all electricity consumed in the Nordic market is priced according to the exchange spot price.

To compare this impact on electricity prices to the cost of the allowances, the total emissions from EU ETS installations and their acquisition costs from the market has been calculated. No free allocation has been assumed in these calculations. The results are shown in Table 7-8.

Table 7-8 The annual total costs of allowances compared to the increase in electricity costs in the Nordic Countries as a total

	Cost of allowances (EUAs) bn €/a	Total cost impact of EU ETS bn €/a	Share of the costs of EUAs of the total costs
Base - EUA 25 €/t	0.9	8.8	10 %
Base - EUA 50 €/t	1.6	17.3	9 %

The increase in the total electricity costs is about 10-times the costs of the price of the EUAs. This is because in the Nordic power market, a significant share of the electricity production is based on hydro power, nuclear power and increasingly wind power. These production technologies have no emissions and no costs from the emissions trading, but receive the higher market price, which is set by the production costs of the most expensive units needed to cover the demand. Typically the price is set by EU ETS installations. It is assumed in the modelling that towards 2015, the transmission lines from the Nordic area are used more and more on market-based. This impacts also the Nordic power price so that if the demand in the Nordic area could be covered with emission-free production with low variable production costs, electricity is exported to neighbouring countries so that also the more expensive units will be used in the Nordic area.

7.4 Modelled impact of the new design on electricity prices in Nordic countries

7.4.1 Electricity generation and CO_2 emissions from electricity generation

Compared to the current situation, electricity generation increases remarkably by 2015 in the Nordic area mainly due to investments in nuclear power, wind power and improvements in hydro power capacity. Also CHP-production increases as a total despite of the decrease in CHP-production in Denmark. As a result, the Nordic electricity generation in 2015 in all scenarios increases by approximately 35-40 TWh from the current normal year level. Since the total demand is projected to increase only by 13 TWh, the Nord Pool area becomes a net exporter of electricity.

The results of the modelling show that electricity generation in the present and new market design does not vary significantly. Because the hydro power production depends on the electricity price and the expectations of the future price, there are some differences in the use of hydro power capacity during the year. The new market design results in lower electricity prices in general, and cuts also the highest peaks from electricity price. The value of water in reservoirs is therefore lower and the expectations of the producers concerning future power price is different. However, based on modelling results, the impact on hydro power use within a year is rather small. Figure 7-1 demonstrates the hydro power use within a year in the present and new market design including reservoir usage and run of river hydro generation.

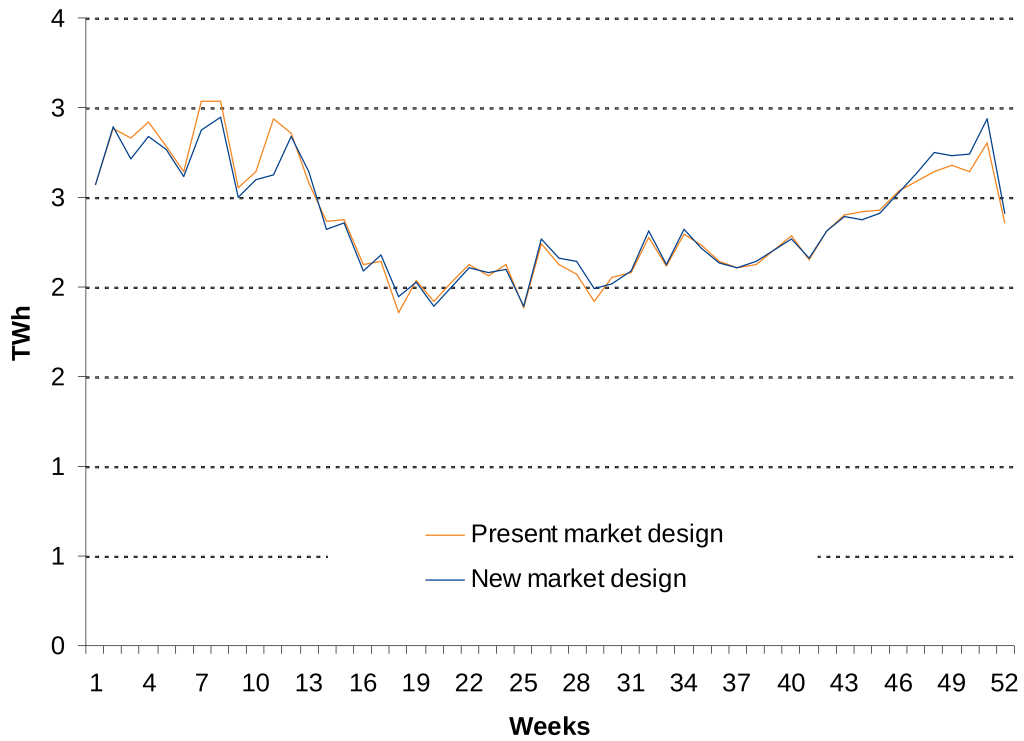


Figure 7-1 Modelled hydro generation in Norway, base scenario with CO_2-price of 25 €/t

The small differences in the hydro power generation are also reflected in the use of other generation capacity. Lower annual hydro power production is replaced mainly with fossil fuels, and respectively, higher annual hydro power production results in lower utilisation of fossil fuel capacity. From the point of view of the average annual electricity prices, these differences are however close to negligible. The difference can be seen in the total CO_2 emissions from the fossil fuel based power production in the Nordic market area, as presented in Table 7-9. The differences in emissions between the new market design and present market design are however lower than the differences caused by CO_2 (EUA) –price and fuel prices (base scenario and high scenario with 20 % higher fuel prices). Part of the difference is explained also by the changes in net export from the area (see Table 7-10).

Table 7-9 Modelled CO_2 emissions from the power sector in Nordic countries, million tonnes

	Present market design Mt	New market design Mt
Base - EUA 25 €/t	35	36
Base - EUA 50 €/t	32	31
High - EUA 25 €/t	38	36
High - EUA 50 €/t	30	30

The total production in EU ETS installations is mainly dependent on CO_2-prices: with higher carbon prices, the production of EU ETS installations decreases. As the Nordic countries as a whole are net exporters of electricity, this difference is reflected in the decrease in electricity exports. Also higher fuel prices result in small decrease in the production of the ET ETS installations. To define the Compensation Fee paid by electricity users in the Nordic area, the electricity generation of EU ETS installations, i.e. condensing and CHP producers have been calculated in each modelled scenario.The production of EU ETS installations and other units as well as the net export from the Nordic Countries are presented in Table 7-10.

Table 7-10 Modelled production in EU ETS installations and other installations in the Nordic countries and net export from the area, TWh

	EU ETS installations	Other	Net export
Base - EUA 25 €/t	93	337	21
Base - EUA 50 €/t	91	337	19
High - EUA 25 €/t	92	337	20
High - EUA 50 €/t	89	337	17

7.4.2 Wholesale electricity price

Electricity price projections have been carried out for four different scenarios varying CO_2- (EUA 25 €/t CO_2 and EUA 50 €/t CO_2) and fuel prices (Base and High with 20% higher oil and coal prices). As a result, the model gives electricity prices for each modelled area, i.e. Finland, two areas in Sweden, two in Denmark and seven areas in Norway. The Table 7-11 presents average Nordic electricity prices in the present market design and in the new market design. The difference of the new market design price to the present market design price is presented in the column on right.

Table 7-11 Modelled wholesale electricity prices, average Nordic Countries

	Present market design €/MWh	New market design €/MWh	Difference €/MWh	Difference %
Base - EUA 25 €/t	49.7	31.2	18.5	37 %
Base - EUA 50 €/t	70.5	33.8	36.7	52 %
High - EUA 25 €/t	54.7	35.8	19.0	35 %
High - EUA 50 €/t	74.2	37.9	36.3	49 %

For the present market design, the modelled electricity price is close to 50 €/MWh with CO_2-price of 25 €/t, and if the CO_2-price increases to 50 €/t, electricity price increases to close to 70 €/MWh. 20 % higher fuel prices increase the power prices by 4 to 5 €/MWh. In the new market design, the wholesale electricity price is clearly lower than in the current design. The difference increases as the CO_2-price increase, because the Compensation Factor depends on the CO_2-price. With the CO_2-price of 25 €/t, the difference is about 35 % and with the CO_2-price of 50 €/t, the difference is about 50 %. The impact of varying CO_2-price in electricity price is small compared to the present market system. Thus, the electricity price would not be very sensitive to CO_2-price in the new market design.

The modelling has been carried out on hourly level resolution. As an example, the average hourly electricity price over a week in Finland in the present and new market design is presented in Figure 7-2.

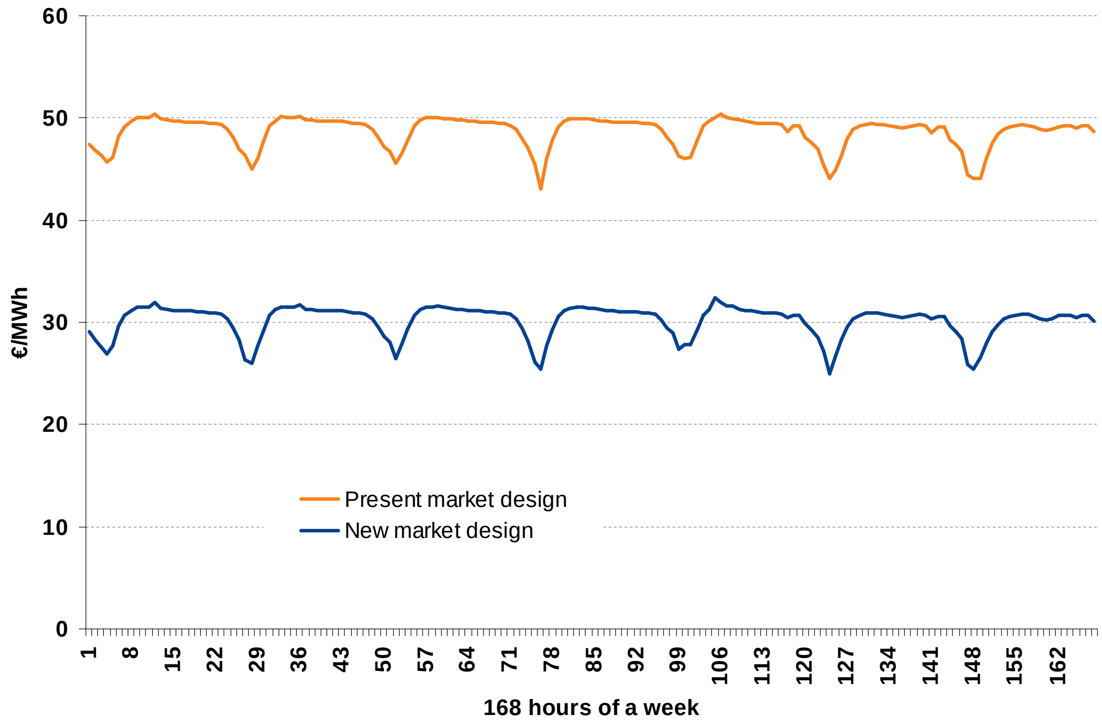


Figure 7-2 Modelled electricity price during 2015 in Finland, base scenario with CO_2-price of 25 €/t

The figure shows that electricity prices in the present and new market design follow a similar pattern during the year. The price is lower throughout the year in the new market design and the price goes even to zero in some hours of the year. However, there are only about 40 hours when the price goes to zero, from the total of 8760 hours of the year.

Table 7-12 presents the hours during the year 2015 when the modelled electricity price is below 10 €/MWh and when the price reaches zero. The volume and intermittent of wind power in the Nordic area explains the occurrence of prices reaching levels below zero.

Table 7-12 Number of hours per year electricity price is low in Finland

Number of hours / year	EAU 25 €/t		EUA 50 €/t	
	Present market design	New market design	Present market design	New market design
Price < 10 €/MWh	23	60	19	55
Price ≤ 0 €/MWh	19	37	19	34

The price volatility in the new market design does not differ from the volatility observed in present market design.

Due to slightly different price profile and use of hydro power over the year, the new market design will increase use of coal in Finland. The difference is small, but observable. This result applies to low CO_2-price scenarios, but in the high CO_2-price scenarios, the price profile over the year between the current market design and the new market design is slightly different resulting in a reduction in coal use. The price difference between the market designs in the winter is relatively higher than in summer. In the winter, the decrease in electricity price is greater than the effect of Compensation Factor to coal plants resulting in decreased use of coal. In the summer, when the price difference is smaller, the condensing coal plant will not run anyway.

7.4.3 Consumer electricity price

Consumer electricity prices are calculated from the wholesale electricity prices by adding the CO_2 Fee, which covers the value of Compensation Factor paid for the production units included in EU ETS. The modelled consumer electricity prices are presented in Table 7-13, Figure 7-3 and Figure 7-4. The consumer electricity price does not include sales margin or any other costs in addition to electricity.

Table 7-13 Modelled consumer electricity prices without taxes

	Present market design €/MWh	New market design €/MWh	Difference €/MWh	Difference %
Base - EUA 25 €/t	49.7	34.4	15.3	31 %
Base - EUA 50 €/t	70.5	40.3	30.2	43 %
High - EUA 25 €/t	54.7	39.0	15.7	29 %
High - EUA 50 €/t	74.2	44.1	30.1	41 %

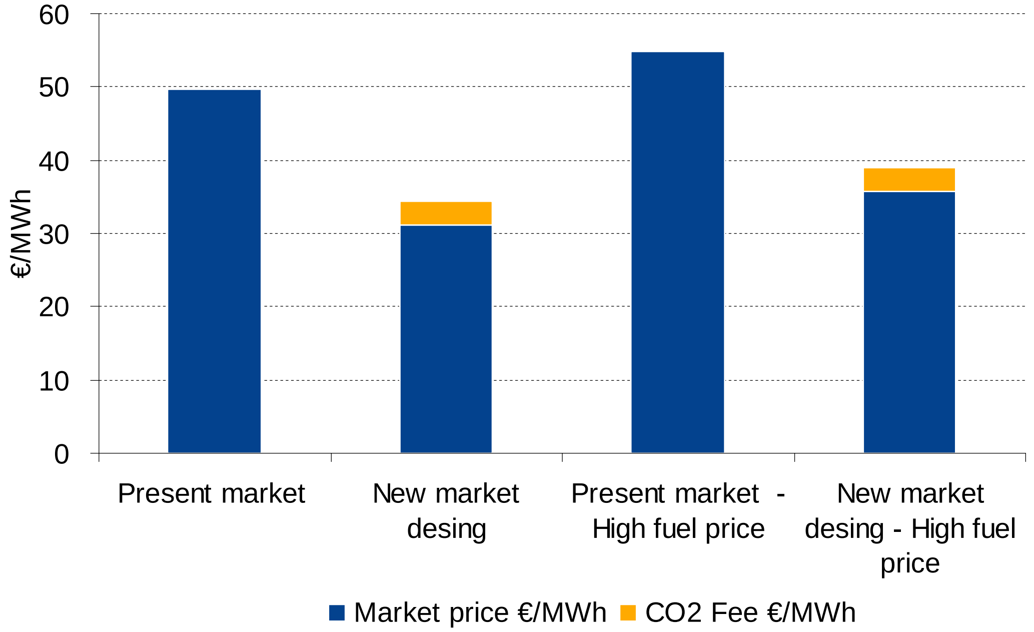


Figure 7-3 Modelled consumer electricity price including wholesale market price and the Compensation with CO_2-price of 25 €/t

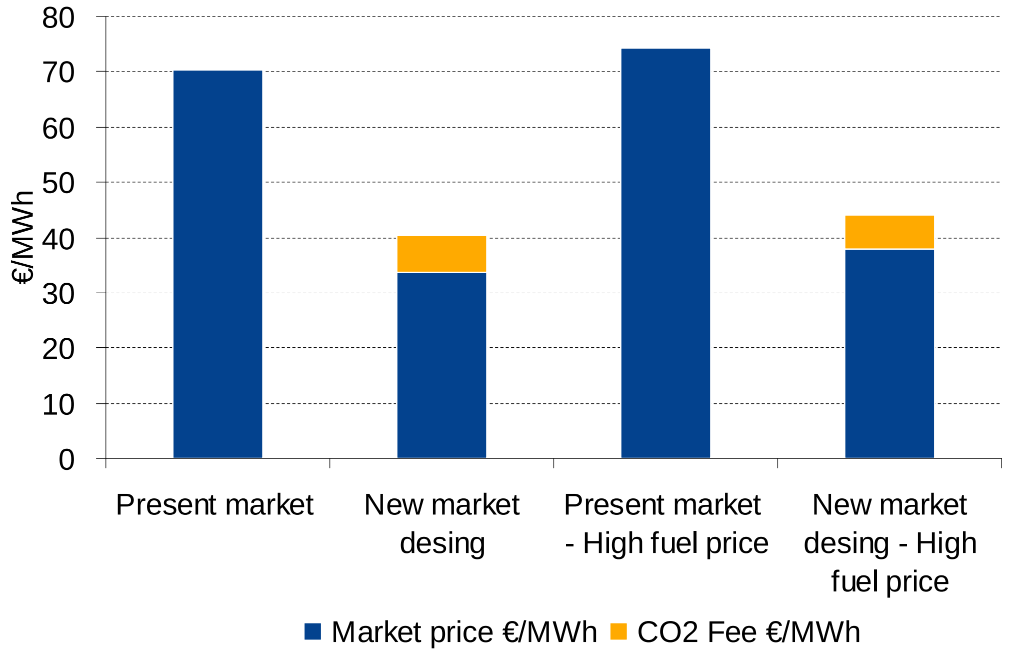


Figure 7-4 Modelled consumer electricity price including wholesale market price and the Compensation with CO_2-price of 50 €/t

The total cost impact of the new market design to the power users in the Nordic Countries has been calculated based on the average annual power prices per country and the power demand in each country. The impact in billion euros is presented in

Table 7-14.

Table 7-14 Total annual cost savings for power users in 2015, billion euros

	Finland	Sweden	Norway	Denmark	Total
Base - EUA 25 €/t	1.4	2.3	2.0	0.6	6.3
Base - EUA 50 €/t	2.7	4.5	3.9	1.1	12.3
High - EUA 25 €/t	1.4	2.4	2.0	0.6	6.4
High - EUA 50 €/t	2.7	4.5	3.9	1.1	12.3

The total impact naturally depends on the CO_2 price: the higher the CO_2 price, the larger the impact on electricity costs. With the CO_2 price of 25 €/t, the total impact on electricity users in all four countries is about 6.3 billion euros. Increasing the CO_2 price to 50 €/t almost doubles this impact. In these calculations, it is assumed that all electricity users pay the market price for the electricity they use.

7.5 Impact on the actors in the market

The new market design naturally affects especially hydro and nuclear power producers' income from the power market, because the market price decreases. Biggest market actors in the Nordic area have versatile generation portfolio including hydro, thermal, and few of them nuclear generation. The market modelling for this report does not capture the effects that the new market design might have on bidding behaviour of such producers. It is assumed that there is perfect competition in the market and no use of market power. The impact on investments in the power market is discussed in more detail in the next section.

The new market design requires an Authority Office responsible for the CO_2 Refund for the producers, and collecting the CO_2 Fee from the electricity users. If the Authority Offices are the TSOs in each country, the tasks of the TSOs increase from the current system. The administrative costs have not been assessed in this report. If the CO_2 Fee is collected as a part of the grid fees, also distribution network operators would have to charge this new component from the electricity users and account it further to the Authority Office.

The new market design also requires the electricity producers to report their daily electricity production in EU ETS installations at a plant level to the Authority Office. If the TSOs take the responsibility to the Authority Office, this information exchange could be carried out as a part of the balance services.

7.6 Impact on investments in the market and required support for renewable electricity

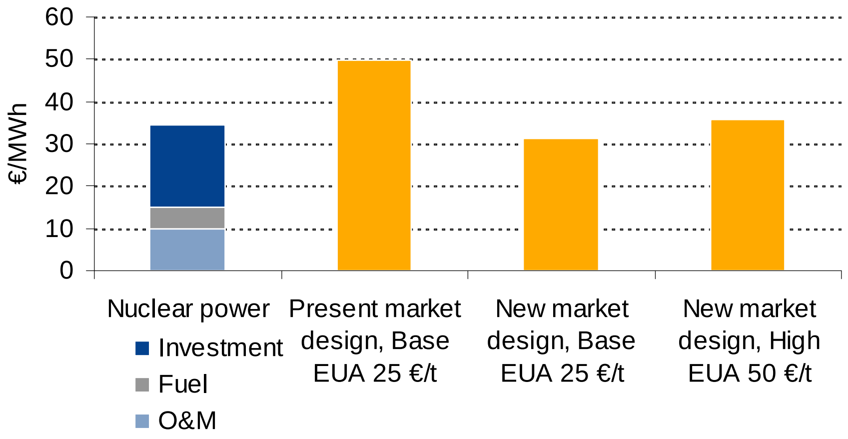
The incentive effect of emission trading is two-sided. On one hand it puts cleaner technology in better position in the merit order hence reducing emissions. On the other hand, the emission trading affects investment decisions. Higher electricity price -thanks to ETS, awards non-emitting investments. Higher income expectations encourage investments in carbon free technologies leading to lower emission levels in the long-run.

The proposed new market design decreases the yield expectations for new hydro power and nuclear power producers because of the lower electricity prices. This would apply also for wind power, if the support mechanisms would not take into account the electricity price (e.g. investment support or fixed premium tariff paid in addition to electricity price). However, the current and proposed new renewables support systems in the Nordic countries are constructed so that the total income from electricity price and support is constant.

7.6.1 Nuclear power investments

The new wholesale power price would be slightly below or just in the level of the costs of new nuclear power investments. However, there is a large variation in the calculations of the investment costs of the nuclear power in various sources, and there is no general rule of thumb for the calculation of those costs. It is possible that the new electricity price could be too low for some investments. This depends also on the type of the investor. E.g. industrial power users investing in nuclear power have different requirements and expectations for their investments than power companies. It is also worth noting that if the system would apply only to the Nordic Countries and for a limited time (e.g. until other countries outside EU implement emissions trading systems), the (dis)incentive effect would be limited. New investments in nuclear power take years, and if this design would be applied only to e.g. until 2025, the power price would be again higher soon after the completion of the investment. Figure 7-5 presents the nuclear power long-run production costs and the modelled electricity price in the current and new market design with two fuel prices, base and high (+20%).

Figure 7-5 Nuclear power production costs and the modelled electricity price with the present and new market designs



Source of nuclear power costs: Tarjanne 2008

The new market design could have an impact on the investment decisions of new nuclear power plants proposed in Finland and possible investments in Sweden as well. In addition, there is a nuclear power plants Olkiluoto 3 under construction in Finland currently. The new market design would have a large impact on the yield expectations of this investment, which has been decided expecting higher electricity prices for the payback period.

7.6.2 Renewable electricity production

New renewable electricity production in the Nordic Countries is mainly wind power, which is supported with different support systems in all Nordic Countries.

In Finland, a new renewable electricity support system will be introduced in the near future. The proposal from April 2009 suggests that the support would be based on market-based guarantee price. At this stage, this guarantee price has been proposed for wind power producers only. In the guarantee-price system, wind power producers would sell the electricity in the market normally. In addition to the electricity price, they would receive a tariff, which depends on the electricity market price in Finland, so that the total amount of the two components is constant:

Guarantee price = realized electricity price + tariff

A guarantee price of 83.5 €/MWh has been proposed for 12 years. In the proposition, the door has been left open to introduce even higher guarantee price for the first few years. If the electricity price is lower, the tariff increases because the guarantee price stays fixed.

The impact of the new market design to the support system has been analysed in the following by using the base scenario fuel prices and CO_2-price of 25 €/t. The results are summarised in Table 7-15.

In the present market system, the modelled wholesale electricity price for 2015 is 49.7 €/MWh. To achieve the guarantee price, the tariff paid for the wind power producer should be 33.8 €/MWh. Assuming that the amount of wind power production in 2015 would be about 2 TWh, the total cost for the Finnish power users would be about 68 million euros.

In the new market design, the modelled wholesale electricity price the modelled electricity price for 2015 would be 31.2 €/MWh. To achieve the guarantee price, the tariff should be increased to 52.3 €/MWh. The total cost for the Finnish power users would reach almost 105 million euros.

The increase in the total cost for the Finnish power users would be 37 million euros in 2015. Compared to the total savings of 1 400 million euros in the electricity price in Finland, this increase is rather small. The total impact increases as the amount of wind power increases so it can be assumed that the total costs are higher in 2020.

Table 7-15 The impact of the new market design on wind power support system in Finland

	Present market design	New market design
Guarantee price €/MWh	83.5	83.5
Electricity price €/MWh	49.7	31.2
Tariff €/MWh	33.8	52.3
Total cost, million €/a	68	105

Sweden supports renewable electricity production with a green certificate system, in which renewable electricity producers receive one certificate for each MWh of electricity produced, and the electricity users must cover a certain part of their consumption with the certificates. The price of certificates is set in the market. The income for renewable electricity producer consists of electricity price and certificate price. The producers offer the certificates to the market with a price that covers their investment and operational costs exceeding the electricity price. Therefore, lower electricity market price would increase the certificate price. The certificate price increase has not been modelled within this study, but it can be assumed that the increase would be similar than in the Finnish feed-in tariff. This is because it is typically wind power that sets the certificate price, because wind power is currently the most expensive technology needed to achieve the renewables target. However, since the amount of wind power and other renewable power supported in Sweden is higher than in Finland, the total impact to power users in Sweden is higher.

Norway has been pondering on joining the Swedish certificate system. Another option for renewables support in Norway would be a feed-in tariff.

In Denmark the renewable electricity support system varies for different renewable energy investment and is given in the form of premium and/or as a fixed feed in tariff. The premium could be adjusted to take into account the new market price. A fixed feed-in tariff does not depend on the electricity price. All subsidies are passed on to the consumers as an equal Public Service Obligation (PSO) tariff on their total consumptions. The PSO tariff for the electricity users would increase but clearly less than the total savings in electricity bills.

7.7 Impact on energy use and final consumer prices

The modelling has not been carried out with price elasticity of electricity consumption. Therefore, the appraisal of the impact of lower electricity prices on the electricity demand is only based on qualitative reasoning.

The consumer electricity price would decrease in the new system by approximately 30 to 40 %. However, the new market design would not impact the transmission costs, sales margin, or taxation (although it would be possible to change e.g. the private electricity users' taxation), so the relative costs savings in electricity use would be lower. For private household users living in an apartment house and using 2000 kW of electricity in a year, the saving is about 13 to 25 %. For a detached house with electric heating, the cost saving would be about 20 to 39 % depending on CO_2-price. Fuel prices (base and high scenarios) do not significantly impact the total cost savings for consumers. The impact is also presented in euros per year in Table 7-16.

Table 7-16 The impact of the new market design Finnish private electricity users living in an apartment house and in a one-family house, including VAT (22%)

	Apartment house 2000 kW/year		One-family house 20 000 kW/year	
	Cost saving %	Cost saving €/year	Cost saving %	Cost saving €/year
Base - EUA 25 €/t	13 %	37	20 %	373
Base - EUA 50 €/t	25 %	74	39 %	736
High - EUA 25 €/t	13 %	38	20 %	384
High - EUA 50 €/t	25 %	73	38 %	733

The household electricity use is not as price elastic as in many industries, i.e. the electricity price does not impact the demand and investments in energy saving as much in household as in industries. Naturally, this depends on the type of industry. The households can put more emphasis on e.g. environmental issues when acquiring less electricity using appliances, and the calculations on electricity saving investments are not always as much based on electricity price as in industry.

In many industries, the lower electricity prices would increase the pay-back period of the electricity saving investments. Therefore, some investments would most likely be abandoned or postponed due to lower electricity price.

REFERENCES

Frondel, Manuel, Schmidt, Christoph M. & Vance, Colin. 2008. Emissions Trading: Impact on Electricity Prices and Energy-Intensice Industries. Ruhr Economic Papers.

Tarjanne, Risto. 2008. Sähkön tuotantokustannusvertailu. [Electricity production cost comparison] Työ- ja elinkeinoministeriön kapasiteettiseminaari 14.2.2008.

Kara, Mikko. 2005. Päästökaupan vaikutus pohjoismaiseen sähkökauppaan, Ehdotus Suomen strategiaksi. [The Impact of EU CO2 Emission Trading on Nordic Electricity Market. A Proposal for Finnish Strategy]. VTT tiedotteita – Research Notes 2280.

Electrowatt-Ekono. 2004. Emission trading and the Nordic electricity market.

Econ Analysis. 2004. Utsläppsrätter och elhandel.

ILEX Energy Consulting. 2004. Impact of the EU ETS on European Electricity Prices.