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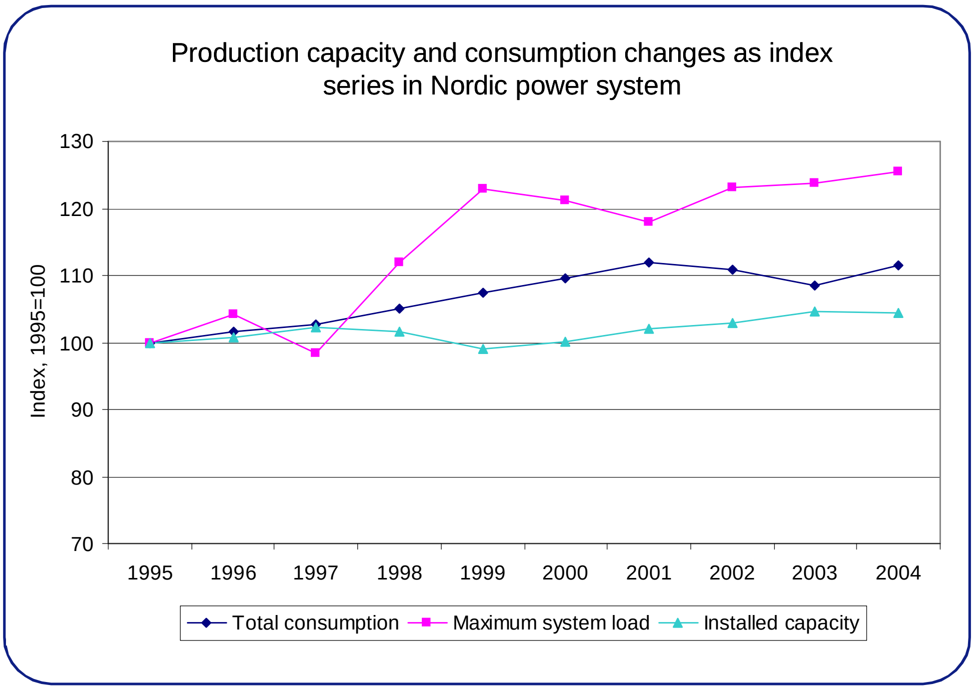

Mikko Kara

Electricity and emission allowance markets from Finnish viewpoint

Study

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Abstract

During 1995–2005 the Nordic energy system has experienced two major changes, the opening of the electricity market for competition and emissions trading within the EU. The European Union's emissions trading scheme (EU ETS) that began operating at the beginning of 2005 has weakened the competitiveness of Finnish electricity production and raised electricity prices. Most electricity producers have accumulated large profits thanks to higher prices. The payers have been nearly all electricity users. This report studies the effects of emissions trading on the electricity market and the functionality of the power market.

Very little investment has been made in power production capacity in the Nordic countries over the past ten years. Considerable increases have mainly been made in Danish wind power capacity. Simultaneously, the total consumption of electricity and maximum system load have increased more than installed capacity has grown. In the next few years the power and energy balances may be threatened.

In previous years, Finland has often been separated as its own market price area on the Nordic power exchange. The formation of price areas has been affected by the limited capacity in transmission interconnectors, network reparation work and the operating method of the Swedish national system operator, Svenska Kraftnät (transferring domestic bottlenecks to the borders). This study reviews the scale of price differences and the effect on market activities.

On the common Nordic electricity market, Finnish coal and peat condensing power capacity is mainly used during poor precipitation years. These plants were once built for base load production. Carbon dioxide emissions trading has further weakened the competitiveness of these plants.

The biggest problem for the Nordic power exchange, Nord Pool, is regarded to be that market concentration in electricity production is high. Market concentration decreases the investment willingness of existing players as new power production capacity would lower electricity prices. There are also high barriers for market entry.

Due to emissions trading and the good precipitation situation in the Nordic countries, a record level of electricity was imported to Finland in 2005, approximately one-fifth of electricity consumption. Approximately two-thirds of the imports came from Russia.

This study makes several improvement suggestions that would affect market activities. These include clearer financing principles for building new transmission lines, increased Nordic cooperation in power exchange surveillance and restraining the growth in electricity imports. The study also suggests that players who gain windfall profits should be obliged to maintain otherwise possibly unproductive condensing power plants in reserve.

Preface

The European energy system has experienced two significant changes over a short period of time, the gradual opening of EU's electricity markets and EU's carbon dioxide emissions trading that was introduced at the beginning of 2005. The energy sector is now heavily influenced by the carbon dioxide emissions trading that is determined for three to five years at a time. These periods can be compared to operational lifetimes of energy sector investments, which usually amount to dozens of years.

The European national economies are developing towards post-industrial societies where the share of heavy industry in GDP is decreasing. The increasing effect that emissions trading has on energy prices accelerates this development.

In Finland, the share of electricity consumption to GDP is high, because the energy intensive export industry is an important part of its economy. Even though the economic structure in Finland has changed, it has only become recently visible that GDP development is partly withdrawing from the development of electricity consumption. Finland is a small market area where the chances of internal flexibility are extremely limited. Energy use is highly efficient in Finland, for instance, in terms of average energy production fuel economy we are among the best in Europe. Due to these factors, EU's emissions trading is exceptionally significant for Finland and its effects should be monitored closely.

This study assesses the functionality of the electricity markets and emissions trading from Finland's viewpoint. There have been public suggestions that the additional profits, so-called windfall profits, that electrical companies gain from emissions trading, should be taxed by the state. This study also assesses whether cutting any additional profits would be justified to rectify the distortion caused by emissions trading and to direct development towards the aim of emissions trading and climate policy.

This study was carried out as an assignment by the Ministry of Trade and Industry. The executor has widely interviewed different parties during the study. The material for the report has been produced by Senior Research Scientist Veikko Kekkonen, Technology Manager Satu Helynen, Research Scientist Tiina Koljonen, Research Scientist Bettina Lemström and Senior Research Scientist Sanna Syri from VTT. Research Scientist Maija Ruska acted as the technical secretary of the executor.

Finland is facing a rather challenging situation in terms of developing its energy system and its social impacts. We hope that this and the previous study (M. Kara, The Impact of EU CO_2 Emissions trading on Nordic Electricity Market. A Proposal for Finnish Strategy, 2005) will provide ideas for further development of the electricity and emission markets. We thank all of the parties involved, who through interviews and providing information have helped this study along.

After completing his extremely challenging work, the executor delivers the study to the Minister of Trade and Industry.

Espoo, 20 December 2005

Mikko Kara

Contents

1. Introduction

The Ministry of Trade and Industry has defined three basic starting points for its energy policy: energy, economy and environment. The key aims are to ensure the security of supply, competitive prices of energy and maintaining generated environmental emissions within the limits defined in treaties. The aim of the Government's energy policy is to promote a diverse energy production structure and to try to increase self-sufficiency. The Government also promotes the use of renewable energy sources and energy efficiency, for instance, through taxes and investment subsidies.

Finnish electricity production is extremely diverse in international comparison. Approximately one-third of the electricity production is emission-free nuclear power. The available major hydropower resources permitted by current legislation have been built. Finland uses a lot of combined heat and power production both in industry and district heating. The combined heat and power production is competitively priced and emissions are low per produced energy unit. In European comparison, the electricity price in Finland is cheap for the end user.

In the early 1990s, international development towards free electricity markets began. Electricity production and sales operations began opening up to competition. The Finnish Electricity Market Act became effective in 1995. In Finland, the reform aimed at more efficient operations and the wish to integrate the Finnish electricity market with the Nordic electricity market. The objectives of the Electricity Market Act state that its purpose is "to improve the functioning of the electricity market so as to secure sound and well-functioning economic competition in electricity generation, transmission and distribution systems also in the future. Simultaneously, the Finnish electricity markets are prepared for the integrated Nordic and possibly opening European markets." Increased competition has been seen as improving the use of resources and creating cost savings for consumers and the national economy.

The aim of the EU is an internal electricity market. End consumers in all member states should be able to freely choose their electricity supplier after mid 2007. Several regional electricity exchanges have been born in Europe, of which the Nordic exchange, Nord Pool, is considered to operate the best. For a true EU wide internal market, local and regional electricity transmission links must be significantly improved. In certain member countries, the states have wanted to keep control of the former national power companies. For instance, in France, only 15 per cent of the national energy company EdF is now being privatised.

Finland has, like many other countries, signed the Kyoto protocol where countries commit to reducing the amount of greenhouse gas emissions. The EU emissions trading scheme is one way to reach this target. The emissions trading system started operating at the beginning of 2005. The Government's proposal to Parliament on the Emissions trading Act states that: "The purpose of the Act is to promote lower greenhouse gas emissions cost-effectively and economically." In the first period of emissions trading, nearly all emission allowances were distributed to the players for free. In 2004, it was assumed that the prices for the emission allowances would be around 5–10 €/tCO_2 because the players had received nearly all of the allowances they needed for free.

The emission allowance prices rose as high as 20–30 €/tCO_2 in the summer of 2005 and at year end, the price was above 20 €/tCO_2. The price level has been clearly higher than estimated. In addition, the prices for oil and natural gas have been high. These factors have together resulted in higher electricity prices. A higher electricity price, the changes in Finnish electricity production competitiveness and the huge profits certain electricity producers have gained and the possible taxation on these have been under discussion in Finland and elsewhere in Europe.

The rise in electricity prices has attracted attention towards market functionality elsewhere also. In a report published by the European Commission's Competition Directorate General on 15 November 2005, attention was drawn to market concentration in electricity generation. When a few large producers dominate the market, they can exert market power. The Swedish Financial Supervision, Finansinspektionen, published a report in the spring of 2005 that mainly criticised the availability of information in the electricity market.

In Europe, attention has also been paid to the functionality of the markets. In Germany, power companies have been criticised for how the emission allowances that they have received for free can raise the electricity price. In Finland and Sweden, the windfall profits mainly refer to the profits gained from emission free production (hydro and nuclear power).

This study examines:

- the power exchange's operations, particularly from Finnish players' viewpoint
- the effect emissions trading has on the electricity market's activities
- transmission links and particularly their effects on electricity prices
- the preconditions created by the structure of the electricity markets for new investments
- changes in electricity production structures
- effects of emissions trading and free electricity markets on self-sufficiency, and
- electricity imports.

2. Energy infrastructure

2.1 Electricity production

2.1.1 Power plants

The need for electricity varies depending on the time of year, weekday and time of day. In the Nordic countries, a lot of electricity is used for heating so the outside temperature has a significant effect on the need for electricity. It is part of the electricity systems nature that electricity consumption and production must be in balance at all times. Because storing electricity on a larger scale is not economically viable, the production of electricity must immediately be changed to correspond with the new situation when consumption increases.

Electricity is produced in power plants with varying properties. When consumption is at its highest, typically on a cold winter working day, nearly all of the capacity that is installed in the power system is in use. In the summer, the majority of thermal power plants are at a standstill.

In this study, electricity production is reviewed mainly from the viewpoint of profitability as part of the Nordic electricity market. The thrift of power plants can be roughly considered with the help of three separate factors:

- Operating costs that accumulate in proportion to produced energy. In thermal power plants, the main cost factor is fuel consumption.
- Fixed costs do not depend on production amounts. They include, e.g., the power plant's investment costs.
- Peak operating time is derived by dividing the plant's annual production (MWh) with the nominal power (MW). For a base load plant, the peak operating time may be over 8000 h per year and for peak load capacity, it may be less than 500 h.

An economically optimal electricity production system contains several different types of power plants. The construction decision for a power plant depends on whether the investments can be covered with the income from its production. In thermal power plants with extremely high capital costs compared to operating costs, the plant should be run at full capacity almost throughout the year (for instance a nuclear power plant) in order for the investment to be profitable. If operating costs are high but capital costs are relatively small, the plant is used for peak load purposes (for instance, gas turbines).

Wind power and river hydropower are always generated when possible. Reservoir controlled hydropower is produced to even out the differences between consumption and production structures, under many control regulations, however. Theoretically, the electricity markets ensure that the reservoirs' are optimally utilised even during a period of more than a year. The timing of long-term water storage is, however, hard due to the difficulty in predicting precipitation. The annual fluctuation in electricity produced by hydropower is one of the biggest uncertainty factors on the Nordic electricity market.

In combined heat and power production (CHP), the majority of fuel energy is produced as heat either for industrial processes or district heating for communities and some is produced as electricity. Here it is noteworthy that the need for heat primarily determines the momentary use of the power plant. Electricity produced in proportion to heat production is considerably inexpensive in terms of operating costs. The power plant can also produce electricity separately either as an extra that exceeds the need for heat or, particularly in the summer, completely without simultaneous heat production. The efficiency of separate electricity production is, however, clearly lower than in combined production.

Condensing power is produced in nuclear power plants and in conventional condensing power plants that use fossil fuels and renewable fuels. Condensing power can also be produced in CHP plants that are technically prepared with turbine condensing parts or auxiliary coolers.

Different power plants have different possibilities for partaking in power regulation. There must be enough reserve power in the network. The frequency controlled disturbance reserve is automatically activated when the power system's frequency changes. Fast disturbance reserve will be taken into use at the request of the system operator and there must be an amount corresponding to the power of the largest plant in the network at all times. In addition to production, loads that can be disconnected are also used as power reserves. Gas turbines are used to cover peak power needs and they can also be used for auxiliary power.

Finland has, in many situations, relatively little capacity in production that is suitable for regulation, because the share of hydropower and condensing power in production is low. Therefore, CHP production plants' condensing parts and industrial electricity loads that can be disconnected are important as regulating capacity. In the future, nuclear power will probably also be increasingly used for daily regulation.

2.1.2 Changes in the ownership structure of production capacity

In the years following the deregulation of the electricity market, large power companies built up their operations by acquiring small electricity companies from neighbouring countries. Now the number of acquisitions on the Nordic market is decreasing and large companies are focusing on increasing operating efficiency. Finland’s Fortum has expanded its focus market area into Sweden and other countries around the Baltic Sea. Sweden’s Vattenfall has in turn acquired electrical companies in Finland and, since the beginning of 2006, has also owned a considerable amount of Danish production capacity. Vattenfall’s main market area now also comprises Germany and Poland. A new player on the Nordic market is the German E.ON that owns electricity capacity in Finland and Sweden.

Since the deregulation of the electricity markets, the Nordic market has offered cheap electricity and price development seemed positive for consumers. Many industrial companies made the strategic decision to give up on their own power production and power plants and plant shares were sold. At the end of 2002, the price of electricity started rising steeply due to the weak precipitation situation. The price of electricity rose to unprecedented levels.

Poor precipitation years can temporarily raise the electricity price to extremely high levels and due to emissions trading the price of electricity has become even harder to predict. Industrial companies that previously outsourced their power production have recently started to repurchase their own or cooperative power plant production. Finland’s fifth nuclear reactor built by Teollisuuden Voima is an example of this. In Sweden, an industrial joint venture, BasEl i Sverige AB, has been formed with the aim of acquiring cheap electricity for its shareholders outside the Nordic power exchange Nord Pool.

The aim of own production among industrial companies is not necessarily always to acquire electricity cheaper than the market price but to secure the price and lower availability risk.

Before the electricity markets were deregulated, large publicly owned power companies produced and transferred electricity in Finland. Smaller municipal electricity utilities distributed electricity to consumers. Municipal electricity utilities also had their own production. In the early 1990s, approximately 10 per cent of the electricity used in Finland was imported, mainly from Russia. The biggest electricity producer was Imatran Voima, which produced approximately 45 per cent of electricity production.

In 2004, approximately 82 TWh of electricity was produced in Finland. The biggest electricity producer was Fortum, whose electricity production in Finland amounted to 24 TWh (29%). The electricity production of Pohjolan Voima's own and cooperative plants was 18 TWh (22%) and the electricity supply of Helsingin Energia was 9 TWh (8%).

2.1.3 Development of power plant capacity

The cooperation organisation for Nordic system operators, Nordel, prepares annual statistics in the changes in power plant capacity (Nordel 1995–2004). The Nordic electricity market area consists of the Finnish, Swedish, Norwegian and Danish electricity systems. In this study, the Nordic countries refer to these countries. The development of Nordic electricity production capacity and electricity consumption is presented in Figure 1. The changes are presented as index series so that the year 1995 has the value 100. During 1995–2004, the situation has developed as follows:

- The total consumption of electricity has grown by a total of 40.4 TWh and in 2004 a total of 390.5 TWh of electricity was used in the Nordic countries. The average growth amounts to 1.3 per cent per year.
- The combined maximum system load has grown by 13,800 MWh/h. In 2004, the maximum system load was 67,800 MWh/h. The average growth amounts to 3.1 per cent per year.
- The installed production capacity has grown by 3,800 MW during the period and amounted to 91,100 MWh/h in 2004. The average growth factor has been 0.4 per cent per year.

In Finland, both electricity demand and power production capacity has grown more rapidly than in the other Nordic countries combined.

In a balanced electricity system, these factors should develop roughly at the same pace. The key indicators for electricity consumption and particularly maximum load have, however, grown clearly, but the capacity has remained nearly unchanged. The general view is that there has been over-capacity in the market area, which now is being dissolved thanks to deregulation. There have not been many new investment decisions. A small margin between the maximum system load and installed capacity is particularly notable in low precipitation years and peak load situations. In such situations, the electricity price may climb to extreme levels. The availability of electricity is not under threat except in unlikely major disturbance situations.

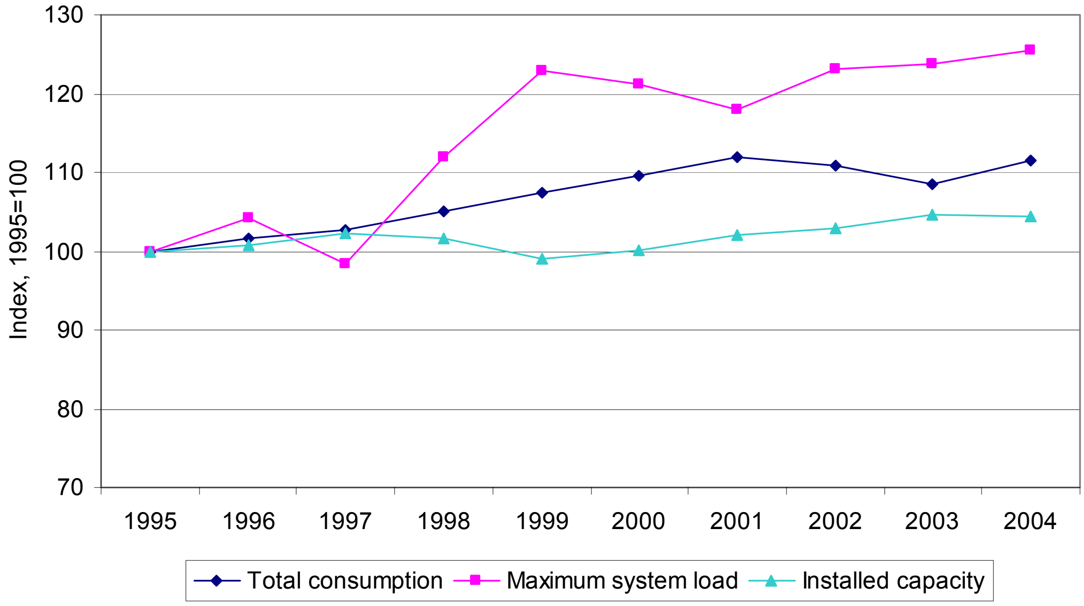

Figure 1. Production capacity and consumption changes as index series in Finland, Sweden, Norway and Denmark 1995–2004 (data Nordel 1995–2004).

The announced capacity changes are not exact and it is typical that there is clearly more new capacity visible in the statistics than how the installed overall capacity grows. The statistics' practices have also changed slightly during the years and the capacity numbers are not fully comparable. The source material includes temporary shutdowns that have lasted for over a year. For instance, Danish condensing production capacity has nearly disappeared during 1995–2001 and, simultaneously, combined heat and power production capacity has grown in a similar fashion, because these are the same power plants where the technical properties have changed and it is possible that the fuel has also been changed. Since the deregulation of electricity markets, the capacity and operation data of individual plants have become business secrets and accurate data is no longer publicly available.

The overall capacity changes by class are presented in Figure 2:

- Nuclear power plants have been removed from use but the power of remaining units has been up-rated.
- There are both commissions and decommissions in hydropower capacity. When a hydropower plant reaches the end of its service life, it is typically replaced by a new unit with higher power.
- CHP production in district heating with natural gas has increased considerably.
- Wind power capacity has increased the most.
- The growth in the share of biomass fuels is not yet fully visible at an overall level.

- The oil and coal condense includes temporary shutdowns and changes in classification type. Several new condensing power plants have also been built in Denmark.
- A new nuclear power plant is being built in Finland and in Sweden the power of existing plants is being up-rated. Wind power capacity is expected to continue growing considerably in all Nordic countries. Increases in natural gas power production are planned in Sweden and Norway. CHP plants using biomass fuels have been planned for both district heating and industry in Finland.

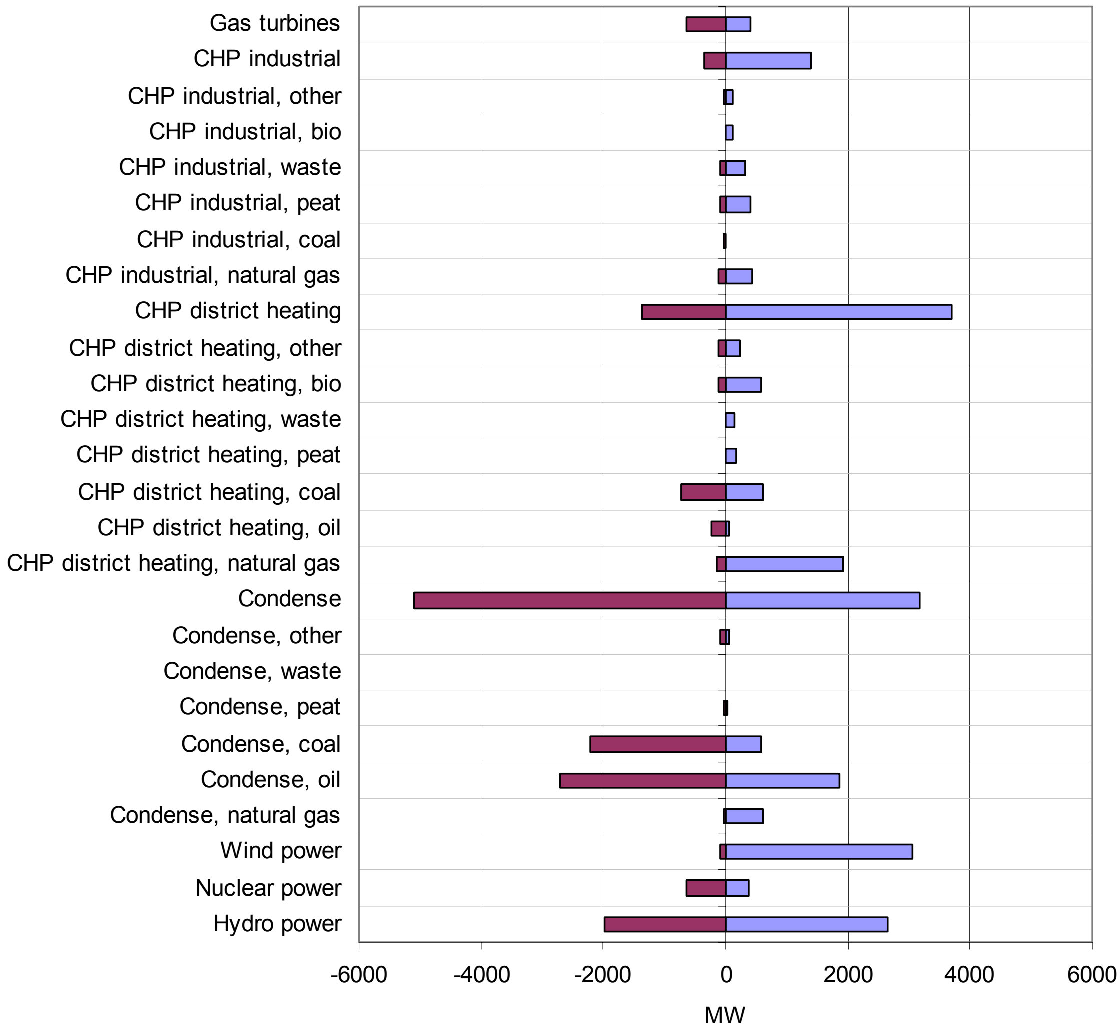

Figure 2. Capacity changes in Nordic electricity market area during 1995–2004 by class (data Nordel 1995–2004).

2.1.4 Changes in electricity production structures

Changes in Finnish electricity production structure during 1995–2005 are presented in Figure 3. The share of electricity produced by nuclear power in electricity supply has decreased during the period from approximately 30 per cent to 25 per cent. The apparent growth in the share of nuclear power in 2005 is due to the fact that statistics are only available until the end of September of that year. The share of condensing power, combined power and heat production and net imports vary annually.

The amount of electricity produced with hydropower in the Nordic countries has varied between 175 TWh (2003) and 241 TWh (2000) over the past few years. Capacity is needed in case of poor precipitation years to compensate for the lack in hydropower production. Finnish condensing power production is such capacity. Figure 4 shows that the total share of hydropower and condensing power production and net imports in electricity used in Finland has remained unchanged during 1995–2005.

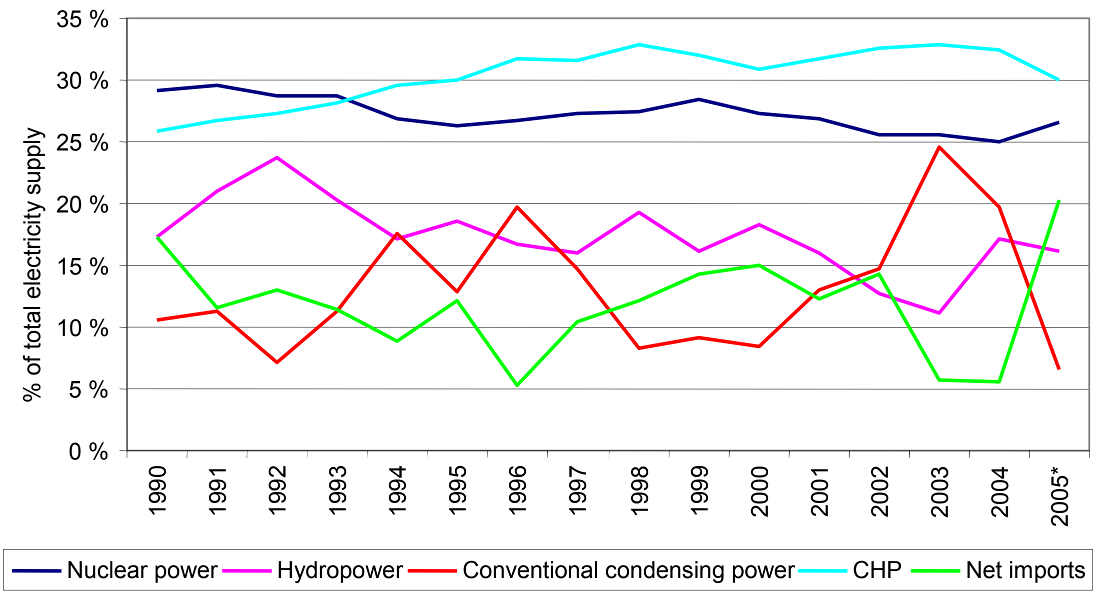

Figure 3. Finnish electricity supply as a percentage of overall electricity consumption 1995–2005. 2005 data until end of November (data www.energia.fi).

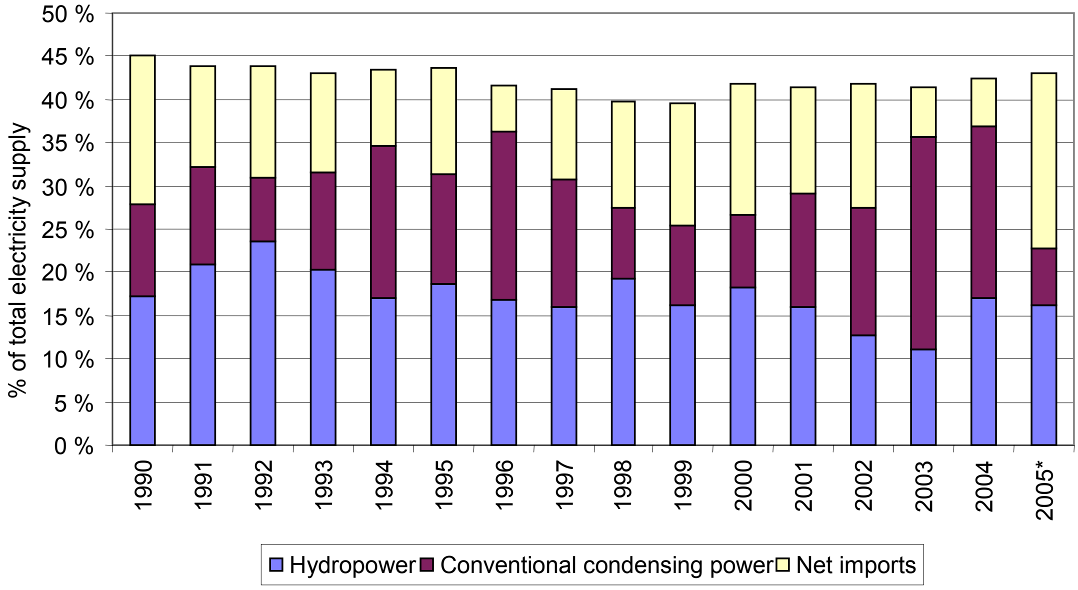

Figure 4. Finnish production of conventional condensing power and hydropower and net imports as percentages of total consumption during 1995–2005. 2005 data until end of November (data www.energia.fi).

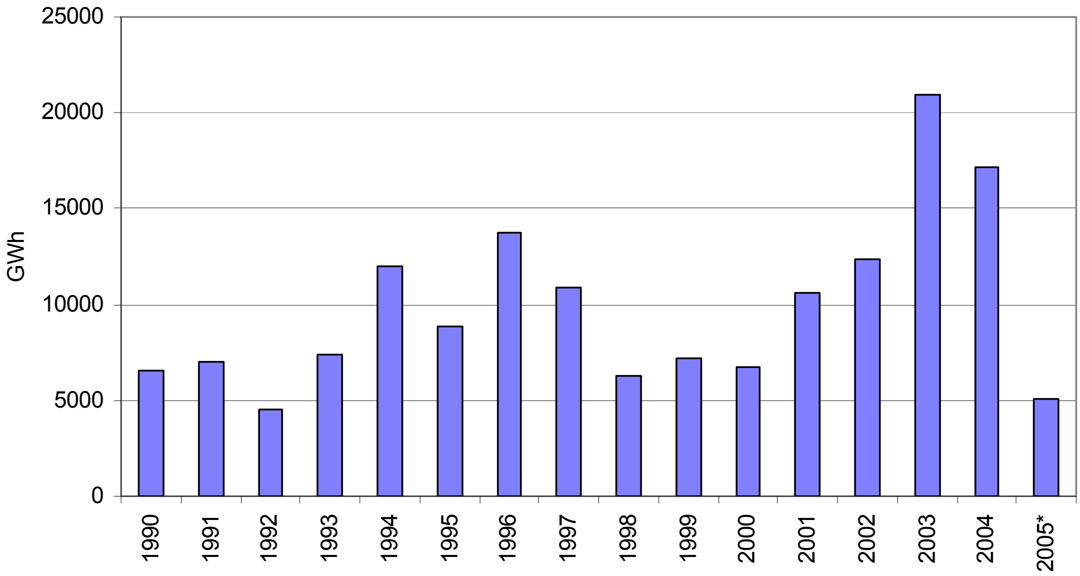

Figure 5. Finnish conventional condensing power annual productions 1995–2005, 2005 data until end of November (data www.energia.fi).

Figure 5 shows Finnish conventional condensing power plants' production during 1995–2005. At its lowest, condensing power has produced approximately 5 TWh of electricity and at most over 20 TWh. In 2005, the amount of electricity produced by condensing power was low.

The majority of condensing power plants that use coal, peat and oil have steam boilers and steam turbines that are designed to run at a constant power for a long time. The basis for the design has been that the plants are started up in the autumn after the summer shutdown and they are run until the following summer's shutdown. Even though the investment costs for power plants have been high, operating costs have been cheap despite a poor thermal efficiency.

The current use of condensing power plants deviates from the plans considerably. The plants are only put in operation when the market price of electricity is estimated to stay above the plant's variable costs and the fixed costs related to the starting-up of the plant for long enough. Cold start-up takes approximately one day depending on the plant and each start-up corresponds to hundreds of hours of operation at constant power in terms of the service life of the plant's boiler house and turbine installation. The costs of shutdown and maintaining the plant in stand-by condition must also be covered with the electricity sales income accumulated when the plant is running. When electricity market prices drop during the night time and at weekends, many plants are run at partial power if necessary, which also causes the service life to shorten. When the electricity market price decreases, plants must decide whether the plant is run down or run at minimum power while kept connected to the network or disconnected to the network but warm, which enables a quicker increase in power but causes additional costs.

Especially the competitiveness of coal and peat power plants has weakened further due to the effects of emissions trading. The uncertainty of natural gas prices connected to constructing natural gas condensing is the significant risk factor in this form of production.

Start-ups and changes in output power level also cause increased emissions. In production level changes, the plants and their emission reduction equipment are not operating at their optimum points so carbon monoxide and particle emissions, in particular, increase.

If a shutdown period of several years is forecasted for a condensing plant, the plant can be stored for a long-term shutdown. Another option is that the plant is completely removed from use to minimise maintenance and personnel costs.

Even though condensing plants are built for a long annual operation time, they have taken over the position of peak power plants in the electricity markets, which means that they are only used when the electricity price is exceptionally high. Building new condensing power plants seems unlikely in terms of profitability and even the premature shutdown of old plants may take place. Condensing power plants are, however, always needed during poor precipitation conditions and also as a slow disturbance reserve.

There is reason to seriously doubt that the electricity market will lead to an unsatisfactory situation in terms of the functionality of the electricity systems and electricity prices due to a reduced share of condensing power capacity.

The best position is held, particularly in terms of fixed costs, by the condensing plants that can utilise the operating and maintenance personnel of other plants in the same area. Synergy benefits are highest at CHP plants' condensing parts, i.e., auxiliary condensing turbines, where both investment and personnel costs are clearly lower than in separate condensing plants. A typical 2–4 percentage points lower auxiliary condensing turbines thermal efficiency changes the cost optimum to separate plants only when the annual operation time of the condensing production is long enough.

Because the construction of conventional condensing production seems unlikely in Finland due to weak profitability, separate electricity production capacity would be cheapest to build by regularly equipping new CHP plants with auxiliary condensing turbines and in smaller plants with auxiliary coolers that allow reaching full electricity power even with small heat loads. The start-up of auxiliary condensing turbines and auxiliary coolers is clearly faster than starting up separate condensing plants so they are more suitable as regulating plants than condensing plants.

Decommissioning of condensing power plants

Condensing power plants have to make decisions on the continued use if short-term annual operating times are estimated to continue to the extent that operating costs exceed income. A similar situation lies ahead if the continued service life requires considerable investments.

A majority of Finnish condensing power plants are old plants that are reaching the end of their service life. Plants built in the 1970s or earlier (Inkoo, Tahkoluoto, Kristiina, Naantali, Mussalo) will be removed from use by the year 2020. Technically, decommissioning is, for most plants, caused by the plants' maximum operating hours related to environmental licenses, because the plants do not meet the emission limits set for large plants and the investment to reduce emissions would be huge. The maintenance costs for plants grow constantly as they become older, so possible removal due to the low use of a plant in the near future would cause a clear weakening in the capacity situation. No new similar capacity is being built, because the profitability of the investment is weak due to high fluctuations in annual production times.

2.1.5 Power and energy balances in the near future

Nordel published an estimate on the development of the Nordic electricity market area's power and energy balances until 2008 in June 2005 (Nordel 2005a).–The consumption of electricity is estimated to grow by 20 TWh during 2005–2008 in the Nordel region. The production capacity will grow by 1,500 MW during the same period and annual production by approximately 10 TWh/a under normal conditions. The estimate is based on the following expected capacity changes:

- In Denmark, wind power capacity will increase by approximately 550 MW. An old 230 MW CHP plant that runs on oil will be removed from production. A 70 MW coal plant will be renewed to run on coal and biomass, the plant will start-up in 2008. In addition, there will be a few smaller new plants.
- In Finland, hydropower capacity will grow by 50 MW, there will be a 180 MW increase in thermal power (biomass) and 100 MW in gas turbines will be taken into use as interruption reserves. A new 1,600 MW nuclear power plant will be taken into use in 2009.
- Norwegian hydropower capacity will increase by 300 MW, thermal power by 200 MW and wind power by 400 MW between 2005 and 2008.
- In Sweden, Barsebäck 2 was shut down in 2005 but the power of other nuclear power plants has been up-rated. The estimate takes into account the new 260 MW CCGT plant that runs on natural gas. The combined heat and power production capacity will grow by approximately 350 MW and wind power capacity by 300 MW.
- Of new transmission links, the Estlink between Finland and Estonia (350 MW) and NorNed between Norway and the Netherlands (700 MW) have been taken into account.

If the year 2008 is an average in terms of precipitation situation and temperature, the situation is good. The electricity demand can be covered and the production capacity exceeds the estimated electricity demand by 3.8 per cent. Finland and Norway are net importers. Denmark can produce more electricity than it consumes, but the transmission links between countries prevent a more efficient use of the Danish capacity. If the planned improvements in transmission links are carried out, the situation will improve.

If the year 2008 happens to be an extremely poor precipitation year, 42 TWh less electricity will be produced by hydropower than during a normal year. According to Nordel's estimate, such a year would require 26 TWh more import or the demand for electricity must bend. In certain areas, the use of electricity must be regulated.

If the winter 2008/2009 is an average in terms of temperature, Nordic production capacity will exceed the peak power by more than 1,500 MWh/h. Finland’s own electricity production will not be sufficient to cover consumption and approximately 500 MWh/h of imports will be required. In other areas, the electricity production capacity will exceed the need for peak power.

In a colder than average winter (statistically 1 winter in 10) the power balance will be threatened. High electricity price will reduce consumption somewhat, which balances the situation. 1,900 MWh/h in electricity must be imported to the Nordic system from Russia, Germany and Estonia. Finland, Sweden and Norway are all dependent on electricity imports; Denmark may have extra capacity and an import possibility from Germany.

2.1.6 Investments in electricity production

The decision to build new power plants is made purely on a financial basis. Electricity production is highly capital-intensive and the service life of power plants is several decades so when making the building decision, one must predict the development of the system far into the future. Central factors that affect the investment decision are:

- Electricity price development. The power exchange Nord Pool quotes futures for four years onwards. The future prices depict the markets’ view of the electricity price in the future. When planning to build power plants, price estimates are needed for a longer period.
- Political steering. For instance, emissions trading has changed the profitability of completed investments considerably. Other political risks are the attitude to nuclear power and changes in taxation.
- Price development of fuels and emission allowances.
- Electricity consumption estimates. Electricity consumption will continue to grow evenly by 1–2 per cent per year. For instance, the moving of the electricity intensive paper industry outside the Nordic countries could change the growth in electricity consumption.
- The decisions of other actors in power plant investments and removals.

Large power companies work in several different market areas and investments are always made where they are considered to be the most lucrative. So far, the electricity price has been higher in Central Europe than in the Nordic countries so investments are more lucrative there from this viewpoint.-Electricity production costs are in turn cheaper in Russia than in Finland.

The largest currently ongoing power plant project is Finland's fifth nuclear power plant being built by Teollisuuden Voima. Sweden has decided to restrict the construction of additional nuclear power, but the existing nuclear reactors will be up-rated.

Since the deregulation of the electricity markets, there has been little investment in new capacity. In Sweden, the capacity that is in use has even decreased as unprofitable power plants have been moved to long-term reserves. One of the aims of the deregulation was to make the use of existing capacity more efficient. In the common Nordic market area, the need for reserve power is lower and, on the other hand, efficient trading between the countries reduces the need for new capacity.

The area has, however, moved from overcapacity to a situation of scarcity in capacity. It is justified to ask whether the market structure encourages new investment. For instance, in Sweden, the national system operator Svenska Kraftnät has taken production that was moved to long-term reserve back into stand-by condition.

Profitability of power plant investments

VTT's electricity market price model has been used to roughly estimate the profitability of different power plant investments in relation to different precipitation years until 2012. The profitability criteria were that the price of the electricity produced at the plant must, in addition to variable costs, cover capital costs (OECD/IEA 2005) and other costs. The results are only indicative because the cost parameters used do not fully correspond with the costs of any actual power plant project. In reality, each investment decision is considered carefully with case-by-case boundary conditions.

The annual amount of precipitation has a heavy impact on the annual profitability of power plants. In a good precipitation year, new capacity is hardly needed and no power plant type can cover all costs. When there is less hydropower available, thermal power is needed to cover the lack in hydropower production. In this case, CHP plants that use natural gas or biomass fuel are profitable. Because the occurrence of good and poor precipitation years is stochastic and they occur nearly as often, initial conclusions can only be drawn based on the results from a normal precipitation year.

The profitability of conventional condensing power plant and gas turbine investments seems weak based on the calculations. In terms of condensing power the result is alarming, because condensing power is needed as a slow reserve for dry precipitation years. So far there is condensing capacity, but once it is removed from use, no replacing market-based capacity will be generated. The profitability of gas turbines is affected by other factors apart from the electricity market price because gas turbines are used as reserve power in the electricity system.

The profitability of nuclear power is among the best electricity production forms in the comparison. The benefit of nuclear power is its long service life. On the other hand, investment costs are high and the profitability of the investment depends on the financing markets. One risk is also future fuel price development.

The Nordic countries already utilise nearly all of the available hydropower resources permitted by legislation. The profitability of new hydropower investments varies heavily case-by-case. The profitability of hydropower production is not heavily dependent on precipitation because during a dry year, hydropower production decreases but the price of electricity increases.

Combined heat and power production is, according to the calculation, among the most profitable forms of electricity production. The precondition for building CHP production is the need for produced heat. There is still unutilised CHP production potential, particularly in Sweden. Natural gas is the most profitable fuel for combined production at current price levels. Biomass fuels do not, for the time being, measure up to natural gas due to specific investments, but national subsidies improve the profitability preconditions.

The construction of wind power is also not yet profitable without subsidies according to the calculations.

Responsibility for sufficient electricity production capacity

The European Transmission Systems Operators ETSO has defined the roles and responsibilities between system operators, market players and authorities (ETSO 2005a). According to ETSO:

- Transmission system operators are responsible for maintaining instantaneous balance and operational safety. Reserves are primarily used. If these are not sufficient to maintain power balance, the system operator uses load shedding as a last resort. In practice, this means circulating power outages.
- The market players are responsible for meeting their commercial commitments and power deliveries. The market structure and mechanisms should encourage them to invest in new generation capacity if necessary.
- The authorities have the responsibility for the overall market design and the legislative framework for security of supply with a duty to react if needed.

The responsibility for the electricity system having enough capacity is ultimately the authorities' responsibility.

2.2 Electricity transmission

The Finnish national transmission system operator is Fingrid Oyj. Fingrid's task is to transfer electricity in the grid, maintain instantaneous balance between electricity consumption and production, settle power deliveries between parties at the national level, develop the main grid and promote the functioning of the electricity markets. Fingrid is jointly owned by the Finnish State (12%), Fortum Power and Heat Oy (25%), Pohjolan Voima Oy (25%) and institutional investors (total 38%). Voting rights are centralised to three first mentioned: the state has 16.44 per cent, Fortum Power and Heat Oy and Pohjolan Voima Oy both have 33.4 per cent. In Sweden and Norway, the national system operators are fully state owned.

This chapter studies the Nordic electrical power network from a technical viewpoint. The chapter reviews the reasons behind the scarcity of transmission capacity in the network. The price differences caused by a lack of transmission capacity are reviewed in section 4.1.3.

2.2.1 The Nordic electrical power network

The Nordic synchronous electrical power network consists of Finland's, Sweden's, Norway's and east Denmark's power networks. These, together with west Denmark's electrical power network, form the Nordic electricity system and electricity market area. There are several AC and DC transmission links between the countries. The transmission links between countries within the Nordic area are, today, fully available to the electricity markets without any separate fees. The costs are covered by the grid tariffs for each country.

The Nordic electricity system has transmission links to Germany, Poland and Russia. The Baltic Cable between Sweden and Germany and the SwePol Link between Sweden and Poland are commercial transmission links and the owners of the links decide upon their commercial use. Other links are controlled by national system operators and their use is open to everyone under similar conditions against compensation.

Of the Nordic countries, Sweden has the greatest transmission network, a total of 30,700 km of high voltage network. In Sweden, approximately half of the network has a nominal voltage of 110–150 kV and half 220–400 kV. Finland has 21,700 km of transmission network of which approximately 70 per cent is 110 kV cable. Denmark naturally has the least transmission network, due to the size of the country, but measured in percentage, it has built the most new network in past ten years, the total addition of some 7 per cent. In Finland, the net kilometre volume of transmission networks, including all voltage levels from 110 kV upwards has increased by approximately 2 per cent since 1996. The Finnish national system operator, Fingrid, which owns approximately half of Finland's 110 kV network and the majority of the 220–400 kV network, invests approximately 40 million euros annually in its network according to Eurelectric's report. In Sweden, the net kilometre volume of transmission networks has grown by approximately 1 per cent and Norway only by approximately 0.3 per cent since 1996. The transmission links between the countries are included in the figures as is the high voltage cables classified as supply service (Nordel 1995–2004, Eurelectric 2004).

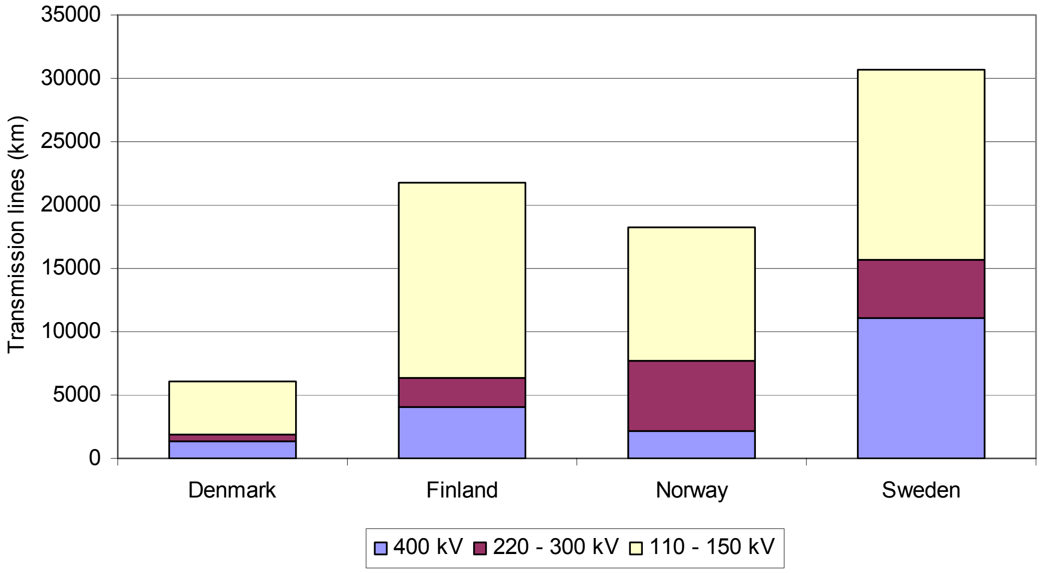

Figure 6. The kilometre volume of transmission network by voltage level 31 December 2004. Transmission links between countries are included in the volume (data Nordel).

New transmission capacity investments

Nordic system operators have agreed on five transmission link investments, so-called Priority Cross-sections, which will reduce the bottlenecks in electricity transmission, enable larger transmissions between countries and improve the reliability of electricity transmission. These transmission link investments will cost a total of 940 million euros and they will be partly financed with bottleneck income accumulated from market parties (Nordel 2005b, Nordel 2005d). These links should be completed during 2008–2012. The transmission links are:

- Nea–Järpströmmen connection between Norway and Sweden at the same level as Trondheim.
- Fennoskan 2 connection between Sweden and Finland.

- The connection of southern and middle Sweden, Södra länken (so-called cut 4).
- Skagerak connection between Jutland and Norway.
- A new link within Denmark between Fyn and Själland (Storebelt connection).

The Storebelt is the only new investment that will be built in a place where there is no previous electrical power network connection. The other new investments strengthen existing connections.

The deeper integration of the European electricity markets advocated by the European Union increase the need for transmission links between market areas. The transmission capacity of the NorNed connection to be built between Norway and the Netherlands is 700 MW and it will be in use during 2007. There have also been plans in Norway for new links to Great Britain and Germany, but they have probably been frozen at least for the time being. A 350 MW commercial transmission link called Estlink is being built between Finland and Estonia and should be completed in late 2006. The aim of Estlink is to bring electricity produced in the Baltic region to the Nordic electricity markets. An estimated 2 TWh of electricity will be transferred through the cable annually. United Power Oy has, in the spring of 2004, filed an application with the Ministry of Trade and Industry for building a 1,000 MW submarine cable between Russia and Kotka (Nordel 2004a, Helsingin Energia 2005, KTM 2004e).

2.2.2 Sufficiency of transmission capacity

National electrical power networks were originally built to correspond with the country's internal transmission needs. As the electricity markets were deregulated and integrated, the pressure on transmission links has grown both within and between countries.

There are occasional situations in the electrical power network where the transmission need in a certain part of the network exceeds the existing capacity. The maximal transmission capacity of the links varies depending on the load and production situation and it is restricted either by the link's physical transmission capacity or the system's stability. Occurrence of moderate bottlenecks from time to time in electricity transmission is usually, as a whole, the most economical and appropriate option. If there were no bottlenecks in the system the network would be oversized from a financial viewpoint. If there is a lack of transmission capacity repeatedly in a certain part of the network or the bottleneck is significant in size, it should be removed by strengthening the network.

Most significant cuts

There are also so-called cuts in the electrical power network, sort of tight spots, which in certain situations become bottlenecks for electricity transmission. The following cuts exist between the Nordic countries where the transmission may have to be restricted and that affect the Nordic electricity market (Nordel 2004c, STEM 2004)

- The Fennoskan DC power link between Finland and Sweden, RDC cut, and the AC link in the North, RAC cut.
- The links from west Denmark to Norway, Sweden and Germany.
- The Öresund cut between east Denmark and southern Sweden.
- There are several cuts between Norway and Sweden. In addition, the Hasle cut in southern Norway restricts transmission between Norway and Sweden.

There are also many cuts within the countries. The most significant ones are:

- Four cuts in Sweden: cut 1 in Northern Sweden, cut 2 north of Fennoskan, cut 4 at the same height as Gotland and the Västkustsnittet cut on the west coast of Sweden.
- Denmark's cut A in Northern Jutland.
- Finland's cut P1 that divides Finland in two, the north and south.
- Norway's five cuts in addition to the Hasle cut.

Clearing a bottleneck

The system operators estimate in the mornings how large transfers are possible in the electrical power network during each hour in the following 24 hours based on joint reliability criteria. Nord Pool publishes the transmission capacities available to the markets compiled from the system operators' data before the players assign their sell and buy bids to the spot markets. The system managers ensure the transmission capacity to the markets that they have notified to Nord Pool. If the transmission capacity proves insufficient, the system manager is responsible for settling the bottleneck situation by either clearing the bottleneck with counter purchases or giving Nord Pool the assignment to divide the market into price areas.

In a counter purchase situation, the necessary power is acquired from the Nordic regulating power markets if possible. If there is not enough capacity in the regulating power markets, the system operator asks the different parties at the opposite ends of the bottleneck based on the bids to increase or decrease the consumption or production of electricity. The producers and consumers that partake in the regulation will receive compensation from the system operator. The system operator pays for the counter purchases and the bottleneck is not visible in the electricity market price. The costs are collected from all system operators' customers as part of other fees.

When the bottleneck is cleared using a price area, Nord Pool calculates the area price for a price area that deviates from the system price so that the system price is lower in an area of overproduction and higher in an area of underproduction. The area price consists of the electricity sell and buy bids of the area's players. The costs of the bottleneck are in this situation thus, in practice, paid by the parties that trade on the spot markets and the players that trade on OTC markets whose agreements have tied the price to the area price. A bottleneck that is cleared using area prices generates profit that corresponds with the difference in the area price and the system price multiplied by the transmission capacity between the price areas. Nord Pool collects the profits from bottlenecks and credits them to the system operators once a week.

The basic principle is that the price areas are used when the bottleneck is structural and appears between pre-determined areas, i.e., in practice to clear bottlenecks between countries and internally in Norway between certain areas. Counter purchase is used to clear bottlenecks within a price area and when the bottleneck is generated within an operating hour. Bottlenecks between countries could also be cleared with counter purchases in the planning stage but it would increase the system manager's costs instead of gaining bottleneck profits. The price areas lead to more transfers of costs and profits than counter purchases as they are directed towards a more efficient use of the system. If there are clear deficit of surplus areas in the system, the price differences should, at least in theory, affect the decisions on where new capacity is built.

Bottleneck profits and costs

Bottleneck profit is generated every time a bottleneck between price areas is cleared by creating an area price or prices. Annual bottleneck profit depends on how often there is a lack of transmission capacity between price areas and on how large the price differences are during these times.

The bottleneck profit fluctuates considerably from one year to another and they are difficult to predict. According to Nordel's report (Nordel 2005c), the annual bottleneck profits in the Nordel area have, in the past four years, been between 33 million and 95 million euros. Between Finland and Sweden, the annual bottleneck profit varied between half a million euros to approximately 10 million euros. Divided evenly with total consumption, the Nordel area bottleneck profits are in a magnitude of approximately 0.1–0.25 €/MWh.

Annual counter purchase costs have been clearly lower than the bottleneck profits. Counter purchase costs in the Nordic countries in 2001–2003 amounted to approximately 7–15 million euros per year. Norway's system operator Statnett had clearly the highest counter purchase costs: 4–10 million euros/year (STEM 2004). A majority of the counter purchases are carried out within the price areas.

The Nordic system managers have used their bottleneck profits mainly to lower network tariffs and for counter purchases. In the next few years, bottleneck profits will be increasingly used to strengthen the network, particularly since part of the income will be directed towards the five so-called Priority Cross Sections investments.

In its decision of 18 December 2001, the Energy Market Authority found that Fingrid should use its bottleneck profits primarily for transmission capacity increase investments and, if the transmission capacity is considered sufficient in view of average transfer volumes, the profits should be used to lower the main grid tariff (EMV 2000). In terms of market functionality, it is desirable that the same principle would be followed in all Nordic countries.

Transferring bottlenecks to country borders

Transferring bottlenecks to the border refers to a situation where the system operator restricts electricity transmission to or from a neighbouring country in order to not exceed the transmission capacity within the country. This practice may lead to the generation of area prices even if the transmission capacity between the countries does not restrict the transmission. The Nordic system operators do not agree on to which extent it would be acceptable to transfer internal bottlenecks to the country borders. By transferring internal bottlenecks to the border of the price area, the system operator reduces the amount of counter purchases and therefore also it's costs.

Finnish and Danish players, in particular, have criticised Svenska Kraftnät's practices to transfer bottlenecks to the border. The Danish have complained about Svenska Kraftnät's methods to the EU Commission and demanded that Sweden terminates the transmission restrictions on the Öresund link. According to a report by the Swedish energy authority, Statens Energimydighet (STEM 2004), Svenska Kraftnät restricts the capacity of cross-border links it has assigned to the market, when it suspects that the grid's transmission capacity within Sweden will be insufficient. According to the report the Swedish grid is, by the decision of Svenska Kraftnät, mainly used to transfer electricity for the country's internal needs and only secondarily for export and import. Figure 7 shows an example of how Svenska Kraftnät restricted exports in the Baltic Cable link, due to internal Swedish bottlenecks in November 2005.

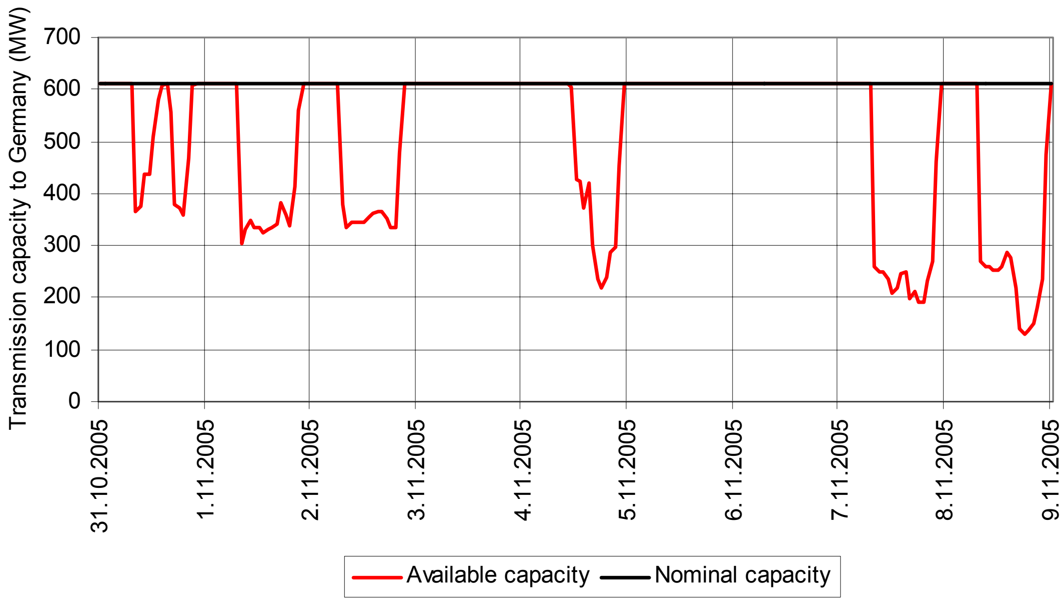

Figure 7. An example of cross-border transmission capacity restrictions caused by internal bottlenecks in Sweden. Transmission capacity from Sweden to Germany 31 October 2005 to 8 November 2005 (data Nord Pool).

On Thursday 8 December 2005, Svenska Kraftnät restricted the transmission capacity in the cross-border cable between Finland and Sweden when Sweden's internal transmission capacity was estimated to be too low. Svenska Kraftnät predicted a large transmission due to a deficit in southern Sweden's production and restricted exports to neighbouring countries in order for its internal transmission system to not become overloaded. The Finnish area price hit an all time high at 1147 €/MWh. At the same time, the Swedish price was a couple of euros below the system price, at 35.60 €/MWh. The Finnish area price consisted at the time mainly of Finnish players' electricity bids.

STEM has reviewed the transmissions and transmission restrictions issued during 2001 – June 2004 within Sweden and with international links Hasle, Nothern Finland, Fennoskan, Kontiskan 1 and 2 and Öresund. Because it is not possible to accurately analyse the restrictions of border capacity and its reasons in retrospect, STEM has estimated over how many hours each country's system operator has probably restricted border capacity. A maximum energy amount has been calculated for these hours which, theoretically has not been transferred due to the transmission restrictions, and compared this to the area price differences during the bottleneck hours. The following presents the results of the STEM study.

STEM has divided the hours during which the capacity of a cross-border link has been decreased or there has been a bottleneck into three categories: the hours when 1) Svenska Kraftnät has probably restricted border capacity, 2) the counterparty has probably restricted border capacity, and 3) there have been no transmission restrictions due to the underlying network. The third category includes the hours when the border capacity has been normal but also the hours when it has been lower than normal if the reason is the maintenance of the transmission link or a failure in the link. STEM does not differentiate between whether the transmission restriction has been made due to an internal bottleneck or for stability reasons.

According to STEM's report, the border capacity given to the spot markets between Sweden and one of its neighbouring countries has, during the review period, been restricted for approximately 40% of the time for reasons not related to the border link itself. The transmission capacity restriction did, however, for the most part not result in a bottleneck, i.e., a situation where the market's demand for transmission capacity is higher than the announced capacity. The majority of the bottleneck situations occurred in circumstances where the transmission capacity was restricted due to the underlying network.

According to the report, Svenska Kraftnät and Fingrid restricted imports from Sweden to Finland roughly to the same extent, however, at most by approximately 750 hours per year during the review period. These restrictions did not, however, cause any bottlenecks. In total there were bottlenecks in other times during only some 1% of the review period.

In exports to Sweden there were clearly more restrictions. In 2003 and 2004 particularly, there were thousands of hours of export restrictions from both system operators, in nearly a third of these situations there were also bottlenecks between the countries. According to STEM's report, Fingrid has restricted exports to Sweden clearly more often and at higher volumes than Svenska Kraftnät. In export situations from Finland to Sweden, there was bottleneck during 15% of the review period. Two-thirds of the bottlenecks occurred when the transmission capacity was restricted by Fingrid.

According to a report given by Fingrid to the Energy Market Authority, it has not transferred internal bottlenecks to the borders since 2000 (EMV 2000). According to Fingrid, the export restrictions to Sweden have been made for stability reasons and not for internal Finnish reasons (STEM 2004).

In order for inter-Nordic and transmission link investments outside the Nordic area to be in efficient use, the system operators should agree on the principles and compensation for exports, imports and transit transmission so that the country's internal bottlenecks are cleared where they occur and not transferred to the border. Nordic system operators joined the European Inter-TSO compensation mechanism (ITC mechanism) in 2004, which compensates system operators for through transmission that passes through their network to another grid. The ITC mechanism and its calculation methods are still being developed but in principal each system operator should receive compensation for transit from this mechanism. (ETSO 2005b)

If the Swedish bottlenecks increase, dividing Sweden into two price areas should be considered, which would mean that the transmission restrictions in foreign links caused by internal bottlenecks would decrease. STEM's report compares the benefits and drawbacks if the new price area border runs at cut 2 or correspondingly at cut 4. STEM considers the former as being better, however, because the division should be as fair as possible and also functional for the neighbouring countries and the entire electricity markets, there is bound to be some heated discussions on the topic if the division becomes topical.

Increasing transmission links

New transmission links will also be needed in the future due to the deregulated markets, increasing consumption and increased regional production deficits. Traditionally, the system operators to whom an investment applies directly have agreed on investments and cost division together. Due to increased transmissions and particularly transit transmission, the investments within a country or between two countries usually also benefit other countries. Therefore, new models for financing investments and investment division are sought. Nordel's report (Nordel 2005c) presents the following financing options: the system operators finance the investments themselves just like so far, a new Nordic market fee is introduced, part of the bottleneck profits are directed towards investments or the income generated from the European ITC mechanism are used.

Money could be collected for new investments with joint Nordic network or market fees paid on top of national tariffs. The problem with introducing such a fee is to reach a consensus between the countries and inside the countries from who the fees are collected and on which basis.

Bottleneck profits should be used for network investments that strengthen the transmission links between countries. Countries' internal transmission network investments should be financed nationally and/or with income from transit transmission using, e.g., the ITC mechanism.

In addition to new links required by the functionality of the electricity system and markets, there are also transmission links that are built purely for commercial reasons. The players that use commercial links usually pay for the investment and operating costs of the link and they are not paid by other players in form of, e.g., main grid tariffs. From the viewpoint of other market players, a commercial international link is like a production plant or electricity consumer that increases competition. International links affect the country's internal electricity transmission and may cause the need to strengthen the grid just like a large power plant. The builder of a commercial link must partake in the costs arising from strengthening the network based on the same principle as other customers that join the grid.

Constructing a cross-border link is subject to licence. According to the Electricity Market Act, the precondition for granting the licence is that the construction is necessary to secure electricity transmission and that it is purposeful in view of electricity market development and reciprocity. In order for the player to not be able to exploit the situation and try to raise the market price by not utilising the commercial link, it must be provided at the licence stage that any unused capacity will be given to other players against compensation with equal and non-discriminatory terms. North European energy regulators suggest in their seminar implementation of this *Use it or lose it* principle (Nordic Mini-Forum on Congestion Management, Conclusions 19 January 2005).

2.3 Electricity import and export

In terms of the electricity network and markets, electricity imports correspond to the production plant and exports to a large electricity consumer. Because not enough new production capacity is being constructed, Finland and other Nordic countries as a whole are increasingly dependent on imports. There are both electricity imports and exports to the Nordic countries from Poland and Germany; there are only imports from Russia. Figure 8 clearly shows the capacity increase in the Russian transmission link and the lower Russian imports during the summer months. In the years 2003 and 2004, with low precipitation, Finland was a net exporter to other Nordic countries. In 2005, imports to Finland have been higher than ever. At the end of the last millennium, as much electricity measured by volume was exported from the Nordic countries as was imported. In the past few years, exports have remained roughly at the same level but imports have grown considerably (Figure 9).

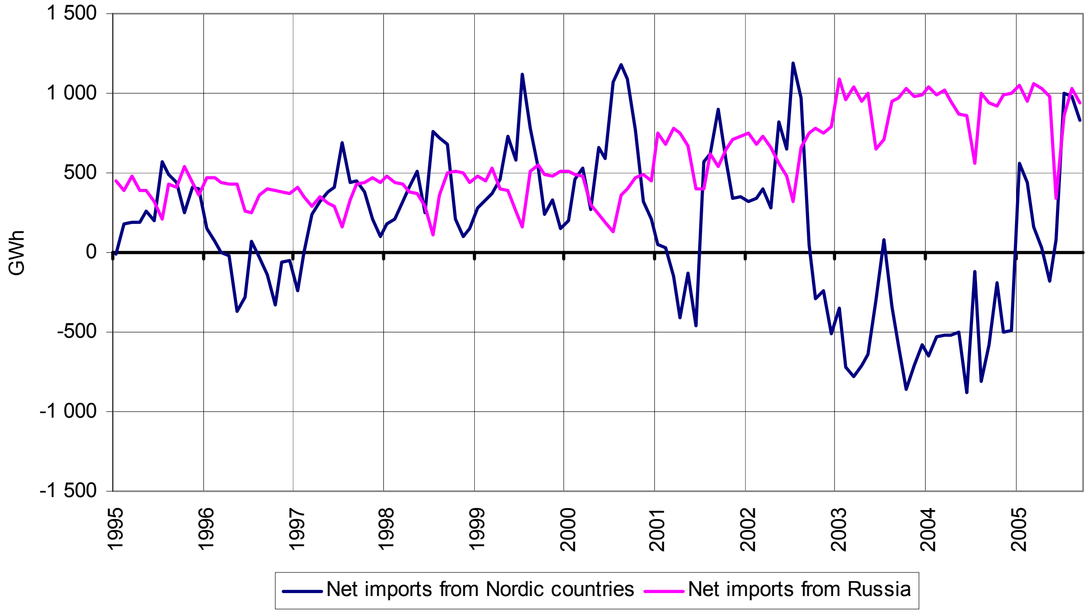

Figure 8. Monthly development of Finnish electricity imports 1995–2005 (data www.energia.fi).

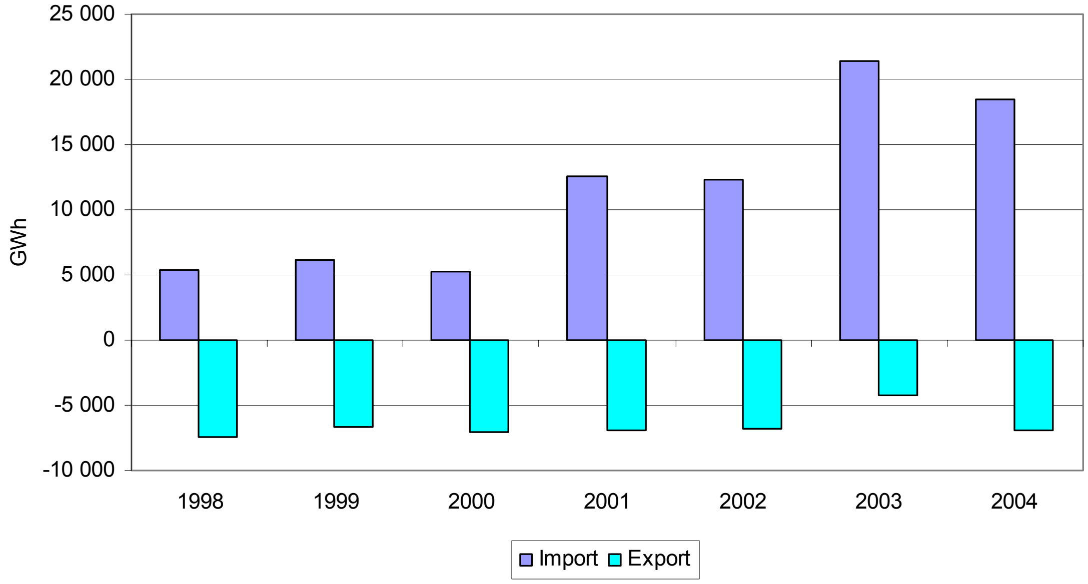

Figure 9. Development of electricity imports and exports in Nordel countries 1998–2004. The countries have transmission links to Russia, Poland and Germany (data Nordel 1995–2004).

Cross border trading between the Nordic countries and the rest of the world has previously only been possible if players are neighbours from an electrical point of view, i.e., Finns only with Russia, Swedes only with Poland, etc. Nord Pool has, since 5 October 2005, quoted the Kontek price area which enables trading from any Nordic country in the Vattenfall Transmission's Europe market area in Germany. Nord Pool settles Kontek trades in cooperation with the German EEX exchange. The aim is that the electricity in the Kontek would thus flow in the right direction from a market viewpoint, i.e., from cheaper price area towards a more expensive one. Previously, the transmission capacity of the Kontek link was traded in annual, monthly and daily auctions. The Kontek price area replaces the two latter from October onwards and players no longer have to separately reserve transmission capacity for a Kontek bid. (Nord Pool 2005b)

The commercial Swe-Pol cable connects Sweden and Poland. The commercial terms for using the cable is decided by the owner SwePol Link AB. SwePol Link is owned by Svenska Kraftnät (51%), Vattenfall (48%) and the Polish PSE (1%). Any possible free transmission capacity is sold by annual agreement. A fixed fee of approximately 1.5 million euros entitles a 50 MW capacity reservation and a 75 GWh transmission. A small additional fee is charged for any excess energy volumes. If the player transfers 75 GWh per year, the fee for using the link is approximately 20 €/MWh. Continuous transfers of 50 MW throughout the year (8760 h/a) costs approximately 4 €/MWh. The fee covers the use of the SwePol link and any subsequent losses, however, not the main grid fees or taxes. (http://www.swepollink.se/ 7.11.2005)

Sweden has a commercial transmission link to Germany through the Baltic Cable. The link is owned by E.ON Sverige AB and the Norwegian Statkraft Energi AS' company Baltic Cable AB. The former owns a third of the shares and the latter two-thirds. If there is free transmission capacity, it is sold through daily and hourly agreements. The reservation fee for a daily agreement is approximately 110 €/MWh and for an hourly agreement 11 €/MWh. In addition to the reservation fee, Baltic Cable charges an energy fee depending on the transmission direction and time, which covers the losses and Swedish main grid fee. The energy fee for exports is 3.5–4.2 €/MWh and 0.5–1.2 €/MWh for imports. (http://www.balticcable.com/ 7.11.2005)

The transmission capacity between Jutland and Germany is available to all western Denmark players and it is auctioned through annual, monthly and daily auctions. The annual and monthly auctions offer a continuous channel for a fixed energy volume throughout the period. Annual and monthly agreements can be transferred to another market player in weekly periods. If the player does not use the capacity it acquires, it will lose it so the link applies the so-called *Use it or lose it* principle. In daily auctions, the transmission capacity is sold on an hourly basis. Nord Pool announced that it has also launched a new service to this link in October 2005, which ensures a more market-based transmission of electricity in the link (Nord Pool 2005c, http://www.eonnetz-eltra-auctions.org 25.8.2005).

The transmission link between Finland and Russia is a one-way link and only enables electricity imports to Finland. The capacity of the transmission link can be reserved by all players on similar terms. The transmission capacity is agreed upon with a fixed agreement that is made with Fingrid for 1–5 years. The minimum capacity that can be reserved is 50 MW. The customer pays a reservation fee of 500 €/MW p.a. for the transmission service, a transmission fee of 6,000 €/MW p.a. and a total of 2.3 €/MWh in grid service fees. (Fingrid 2005)

The capacity division of transmission links between Nordic countries and other countries is implemented in extremely different ways and time-scales. The pricing is also varied. The use of commercial links is expensive for outsiders and capacity is not always available, which is understandable because the links have mainly been constructed for the owners' own use.

New links outside the Nordic countries would increase competition in the Nordic markets. Increased imports from countries with lower production costs like Russia and the Baltic countries lower the electricity price. Increasing connections to Germany probably enables higher income for producers due to a higher price level in Continental Europe. This would also raise the price level in the Nordic countries.

3. State subsidy and taxation systems in the Nordic countries

The methods used by the states' energy policies are energy taxes and subsidies. The energy policy has both national and international targets. The focal point for the Nordic countries' energy policies has been to support its own domestic production and maintain a competitive price for industrial customers' electricity. The use of renewable energy sources is supported. In several countries, the income from energy taxation is a considerable source of state income.

Traditionally, states have practiced their energy policy independently. The environmental effects of energy production stretch beyond country borders, however, and energy policy is becoming increasingly international. The EU's internal emissions trading that began in 2005 is a new energy policy control method that applies to all member states. Emissions trading is discussed in Section 4.2 of this study.

European Union membership also affects energy policy in other ways. Article 90 of the EC Treaty denies tax discrimination based on indirect taxation and article 87 denies state subsidies. The member states have, however, wide jurisdiction to promote targets approved by the EC with taxation and subsidies, and any planned measures of support must be reported to the Commission in advance. The measures of support can only be implemented after approval from the Commission. Norway is not an EU member so these injunctions do not apply to Norway.

Energy production is highly capital-intensive and the service life of investments is several decades. A long-term approach is essential in energy policy. Changes in energy taxation and subsidies may change the profitability of existing investments considerably. New investments require a stable political environment.

3.1 Finland

3.1.1 Taxes

The central basis for energy taxation has been the reduction of carbon dioxide emissions and ensuring the competitiveness of indigenous energy sources. Energy taxation also has a considerable effect on the national economy; the state collects nearly 3 billion euros per year as national tax from energy, which constitutes approximately 9% of all tax income.

Energy taxes are excise tax and they are collected on traffic and heating fuels as well as electricity. In addition, precautionary stock fee is paid. The excise tax is divided into a basic tax and an additional tax, that is determined based on the carbon content (since the beginning of 2003 18.05 €/tCO_2). The exception is natural gas which has received a 50% tax reduction and peat which received exemption from tax on 1 July 2005. The use of peat for energy has an important position in the Finnish energy system in maintaining the security of supply. In addition, it also has a significant regional employment effect.

In Finland, electricity consumption is taxed and the fuels used in electricity production are tax-free. The tax is scaled into two classes so that the electricity tax is lower for industry (Table 1). The industrial electricity tax will be cut in the near future according to the new Energy and climate strategy (KTM 2005b).

The use of light fuel oil is taxed clearly less in Finland than in Sweden, Norway and Denmark (Kara 2005). In Finland, the consumer price of fuel oil is approximately 40% of that in these countries due to lower tax.

Table 1. Energy taxes 1 July 2005.

Product	Basic tax	Additional tax	Precautionary stock fee
Motor petrol c/l			
– reformulated sulphur-free	53.85	4.23	0.68
– other grade	56.50	4.23	0.68
Diesel oil c/l			
– sulphur-free	26.83	4.76	0.35
– other grade	29.48	4.76	0.35
Light fuel oil c/l	1.93	4.78	0.35
Heavy fuel oil c/kg	-	5.68	0.28
Coal €/t	-	43.52	1.18
Natural gas c/m3 (n)	-	1.82	0.084
Fuel peat	-	-	-
Electricity tax c/kWh			
Taxation class I	-	0.73	0.013
Taxation class II	-	0.44	0.013

In addition to actual energy taxes, the players pay normal corporate tax (28% of pre-tax profit) and real estate tax to the city in which the power plant is located (0.5–1.0% of the property's taxation value and on the power plant construction max. 1.4%, on nuclear power plant constructions max. 2.20% of the taxation value).

3.1.2 Support systems

In Finland, power production receives tax support and energy intensive industry receives tax rebates. Since the beginning of 2003, wind power, less than 1 MW hydropower, electricity produced from wood and wood-based fuels, recycled fuels and biogas, as well as electricity produced from peat in less than 40 MWA thermal power plants, have been included in the electricity production support system. The subsidies are scaled into three groups, and wind power and forest chips receive 0.69 c/kWh, electricity produced from recycled fuels receive 0.25 c/kWh and other 0.42 c/kWh. In 2005, the energy tax and subsidy for peat was abolished. An industrial company is entitled to support if the amount of excise tax included in its energy product subject to excise tax, apart from traffic fuels, exceeds 3.7% of the company's value added. These companies receive 85% of the energy tax for the share that exceeds the limit in rebates. A total of approximately 15 million euros is annually paid in rebates.

The total amount of support for renewable energy forms will, according to the government's newest energy report (KTM 2005b), remain at the same level as before, at approximately 30 million euros per year. Investment subsidies are considered on a case-by-case basis and it has been 30–35% of investments (max. 40%) for wind power. The share of wind power projects in the allocation has been 10–22% in previous years and the share of wood energy use in new projects has decreased from 80% to 53%.

The Finnish energy taxation system currently has three parts that the Commission considers to be state subsidies and that would require approval by the EU Commission. These are a scaled electricity tax for industrial and other users, tax support paid to electricity production and an electricity tax rebate system for energy intensive industries. The subsidies are valid until the end 2006. The electricity tax rebate system for energy intensive industries is valid until the end of 2011.

3.1.3 Changes to the energy taxation system in the near future

The start of EU emissions trading at the beginning of 2005 has created the need for change in the energy taxation system. Energy taxation is no longer needed in the emissions trading sector to control emission reductions but for other energy policy reasons, as well as national economy reasons, the tax cannot be removed in full.

As a result of emissions trading, the following needs for the development of energy taxation has arisen: the rise in electricity price and the competitiveness requirements it sets, decreased used of indigenous fuels due to weakened competitiveness of peat and the regional and employment problems it causes, as well as the wood supply problems for industries that use wood remains as raw material caused by increased use of wood in energy (KTM 2005c).

The increase in electricity prices decreases the competitiveness of energy intensive industry considerably. The cost effects of the price increase must, according to the energy and climate strategy, be compensated by lowering the electricity tax paid by industry. The size of the tax cut has not been decided but the strategy uses a 50% tax cut in its calculation examples. The tax subsidies paid to certain industries for electricity produced from by-products and waste from production will be removed because the subsidy no longer has an effect on using the products in electricity production.

The taxation of fuel peat was changed in July 2005.

3.2 Sweden

The basis for Swedish energy policy is to create preconditions for efficient energy use that is based on sustainable development and for cost efficient and a secure energy supply.

3.2.1 Taxes

In Sweden, the fuel for heat production and motor use is taxed under energy and carbon dioxide tax. Electricity production is not taxed as taxation focuses on electricity consumption. The exception is nuclear power as electricity produced from nuclear power is taxed. The source material explains Sweden's energy taxation and subsidies (STEM 2005).

The use of fossil fuel is taxed under a sulphur tax and a nitrogen oxide fee is paid for their use. Of biomass fuel, only the use of tall oil is taxed due to industrial policy reasons.

When fossil fuel is used in CHP plants, the fuel used for heat production is taxed under energy, carbon dioxide, sulphur dioxide and nitrogen oxide taxes. Since the beginning of 2004, thermal power producers have been able to deduct the entire energy tax and 79% of the carbon dioxide tax for fuel used in heat production.

In addition to actual energy taxes, the players pay normal corporate tax (28% of pre-tax-profit) and real estate tax (0.5% of a property's taxation value).

Nuclear power plants pay 5,514 SEK, i.e., approximately 584 € (according to Bank of Finland's exchange rate on 15 December 2005, one euros equals 9.440 SEK) per the plant's thermal power megawatt in power tax, this corresponds with approximately 2.7 öre/kWh (0.29 c/kWh). This tax is paid despite the energy amount produced. In addition, electricity produced from nuclear power is taxed 0.15 öre/kWh (0.014 c/kWh) and approximately 0.6 öre/kWh (0.064 c/kWh) for the disposal of spent nuclear fuel. The aim of taxation on nuclear power is to encourage the market-based development of nuclear power. A decision has been made in Sweden to give up nuclear power.

Electricity consumption outside industry and professional greenhouse growing is taxed heavily. Northern Sweden has a slightly lower energy tax than other parts of the country.

3.2.2 Support systems

The aim of the Swedish parliament is to raise the amount of electricity produced from renewable energy sources by 10 TWh by the year 2010. Because electricity production with renewable energy sources is not currently profitable without subsidies, a green certificate system has been created to support renewable power production. In the system, the subsidies for renewables are generated from the market, i.e., the state does not have to finance the subsidies. The price of the certificate is also determined on the market. The certificate system includes wind power, CHP plants that use biomass fuel, small-scale hydropower and solar power.

A producer that produces electricity with renewable energy sources receives a certificate from the state for each produced megawatt hour. The player sells the electricity it has produced and the certificate. In order for there to be demand for the certificates, it has been regulated that the electricity user must have a certain share of certificates compared to the amount of electricity it consumes. The parliament decides the size of the quota, the quota in 2003 was 7.4% of the consumer's electricity consumption. The quota increases annually and in 2010 it will be 16.9%. Electricity consumers do not have to acquire the certificates as the electricity supplier can be responsible for them. Electricity consumers' certificates are checked once a year.

The certificates were distributed to electricity producers in May 2003 for the first time so the first check was in 2004. During 2004, the producers received approximately 23 öre/kWh (2.4 c/kWh) from certificate sales. If the electricity consumer or producer has not acquired enough certificates, the player must pay a fine to the state. The fine was set as 150% of the average price of the certificate. In 2004 and 2005, maximum limits were, however, set for the fine as 175 and 240 SEK (18.50 and 25.40 €). The certificates are traded at Nord Pool.

In addition to the certificate system, the construction of wind power is supported with a miljöbonus system. The system is intended to be temporary. The subsidy is 9 öre/kWh (approximately 1 c/kWh) for wind power constructed on land and 16 öre/kWh (1.7 c/kWh) for wind power constructed at sea. In addition, there is pilot project funding available from the state for offshore and arctic wind park projects. From the first instalment of approximately 37 million euros, a few offshore wind parks received funding. The second instalment is coming up for application.

3.3 Denmark

Danish energy policy targets well-functioning energy markets that ensure cost efficiency, security of supply, environmental friendliness and energy efficiency. The markets should be transparent and competition effective. Well-functioning markets ensure the cheapest possible energy price.

Denmark has good indigenous energy resources. The country has abundant oil and natural gas reserves in the North Sea and, thanks to these, Denmark has been self-sufficient in energy since 1997 (Danish Energy Authority 2005). Thanks to technical development, an increasing share of Danish oil reserves can be used and new oil and gas fields may also be found. The country prepares for exhaustion of the oil and gas reserves by supporting indigenous electricity production based on renewable energy sources.

The main renewable energy sources in Denmark are wind and biomass. In 2002, 20% of Danish electricity production was based on renewable energy sources. The share is increasing.

Denmark taxes fuels used for electricity production under sulphur and carbon dioxide taxes.

Electricity produced from renewable energy sources is subsidised with a feed-in tariff, i.e., a prioritised electricity system. Renewable resources include wind power and decentralised CHP power produced from waste or natural gas. Prioritised electricity is more expensive than conventionally produced electricity and its price is regulated. Electricity consumers must buy a certain share of prioritised electricity.

Denmark is abolishing the wind power feed-in tariff. No new agreements have been made in recent years. After the abolition of the feed-in tariff, wind power construction focuses on separately competed offshore wind park projects and replacement construction. Plants smaller than 450 kW are currently being replaced. These projects receive a feed-in tariff so that a maximum of 48 DKK/MWh is received for produced electricity (with the Bank of Finland's exchange rate on 15 December 2005, of DKK 7.4502 this equals 6.4 €/MWh).

In Denmark, the reconstruction of coal condensing plants into CHP plants that run on natural gas is supported with investment subsidies. The subsidy can at best be close to half of the total investment.

3.4 Norway

In Norway, the energy policy targets increasing energy efficiency, the promotion of diversity in energy supply, a decrease in the share of direct electric heating and an increase in the share of renewable energy sources (large-scale hydropower is not included in these).

Nearly all of the electricity production in Norway is based on hydropower. Several taxes, in addition to normal corporate taxes, have been imposed on hydropower producers, these taxes are based on the market value of the electricity that the company produces. The taxes are justified by hydropower being a limited natural resource and its yields being higher than normal yields. The taxes are presented for 2005 (Finansdepartementet 2005). The taxes have been announced based on the Bank of Finland's currency rate of 15 December 2005 (EUR/NOK 7.9510).

The basis for the natural resource tax (*naturresursskatt*) is the average electricity production of the plant over the past 7 years and the tax in 2004 was 13 NOK/MWh (1.6 €/MWh). The tax is deductible in income taxation. 11 NOK/MWh of the tax is paid to the municipality and 2 NOK/MWh to the province.

The *grunnrente* tax is paid to the state and it is 27% of the calculated grunnrente of each power plant, i.e., of the income that exceeds calculated normal income. The income is estimated by multiplying the power plant's hourly production with the electricity spot price of each hour. For *konsesjonskraft* electricity (sold at regulated price) and electricity sold with contracts valid for more than 7 years, the tax is paid based on the actual contract price. The actual operating costs, depreciation and tax free allowance is deducted from this income. The tax free allowance is calculated annually and it depends on the plant's taxation value.

The basis for property tax (*eiendomsskatt*) is the plant’s average income for the past five years, which is calculated in the same way as in the grunnrente tax. For instance, the paid grunnrent tax is deducted from income. The tax is paid to the municipality.

The owner of the plant must pay licence payments (*konsesjonsavgift*) to the state and municipality. The municipality must direct these funds to support the industrial life of the community. In addition, the municipality in which the plant is located is entitled to buy so-called konsesjonskraft electricity. The electricity amount can at most be 10% of the plant’s production. The price of konsesjonskraft is regulated and in 2005 it was 8.76 öre/kWh (1.1 c/kWh).

The state also taxes electricity consumers. In 2005, electricity consumers paid 9.88 öre/kWh (1.2 c/kWh) in tax and for industrial consumers the reduced electricity tax was 0.45 öre/kWh (0.06 c/kWh). Certain energy intensive industrial processes (metal, cement and chemical industry) have been exempt from the tax. Household electricity consumption and public consumption in the Finnmark province and North Troms have been exempt from electricity tax. In practice, businesses in this region do not pay electricity tax either. In total, some 30% of electricity consumption is exempt from tax.

The state’s energy subsidies have been organised through a separate public company in Norway, ENOVA SF. ENOVA is owned by the Norwegian Oil and Energy Ministry and started operating in 2002. ENOVA’s goal is to promote environmentally friendly and sound electricity production by distributing financial subsidies to market players. ENOVA has been granted a 650 million euros grant for ten years. Offshore wind power is not part of ENOVA’s line of business nor does it finance research projects.

Norway is introducing a green certificate system. The aim is to join the same system as Sweden within the near future. A temporary solution from which investment subsidies can be applied is in use for wind power.

4. Electricity and emission allowance markets

The Norwegian system operator Statnett founded an electricity exchange, Statnett Marked AS, in 1993. Sweden joined the exchange in 1996 when Nord Pool ASA, jointly owned by the Swedish and Norwegian system operators, was founded.

Trading in electricity futures in Finland began in 1996 when Suomen Optiomeklarit Oy founded El-Ex Sähköpörssi Oy for trading. In 1998, Fingrid acquired the El-Ex Sähköpörssi and sold half of it to the Swedish system operator Svenska Kraftnät. In the same year, cooperation with Nord Pool began. The Finnish El-Ex Sähköpörssi became responsible for Finland's and Sweden's joint Elbas market and derivative trading centralised on Nord Pool ASA. A separate company, Nord Pool AS, was founded for physical electricity trading. The western parts of Denmark were linked to the exchange in July 1999 and the eastern parts in October 2000.

Companies that operate in a competed market have a higher incentive to make operations more efficient than in a monopoly situation, and the dissolution of the monopolies aimed at encouraging electricity companies to lower their costs. In the 1990s there was too much electricity production capacity compared to consumption. On the other hand, the electricity market has been conceived as a mature market that does not require much investment from the state. Thus resources could be moved elsewhere.

Within a common market area, electricity is always produced where it is cheapest at that time. There was naturally active electricity trading between countries already before the markets merged. The joint electricity exchange manages production more efficiently, however. The structures of the countries' electricity production vary a lot (Figure 10). The annual amount of electricity produced from hydropower may vary by as much as 60 TWh depending on the precipitation situation.

On the other hand, each country only had one state-owned large power company that dominated the national market. There was no desire to divide the companies into smaller companies as the markets were expected to integrate to other European markets. In these large future markets, the Nordic power companies would be the smaller players.

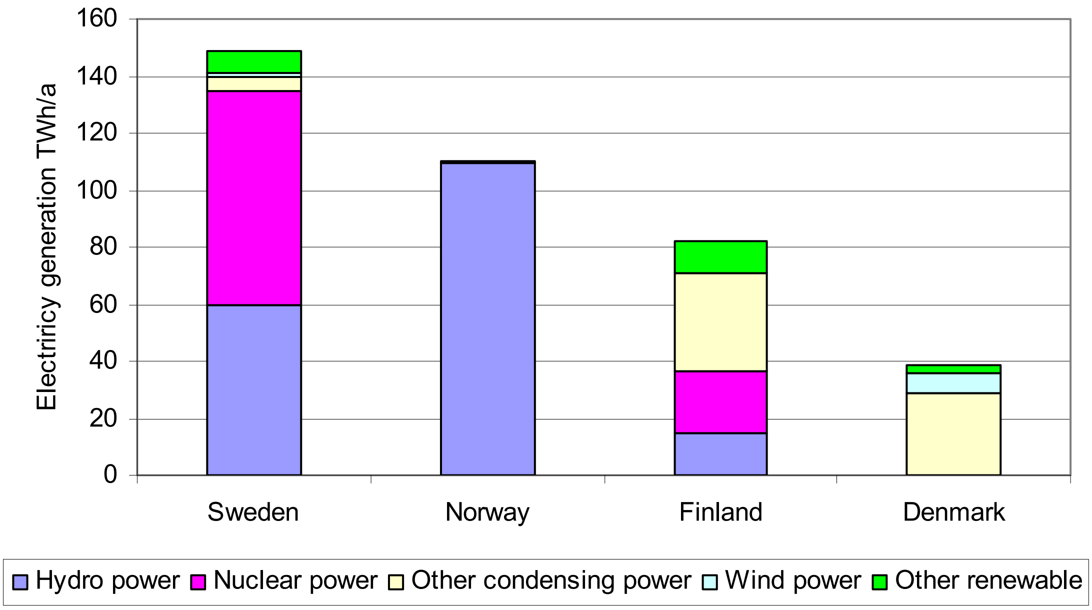

Figure 10. Structures of Nordic electricity production in 2004 (data Nordel 1995–2004).

Figure 11 shows the diversity of energy supply of industrial countries through the Stirling index. The illustration shows that Finland's energy production structure is extremely versatile even by international comparison. The available hydropower resources have been built and additional nuclear power is being built. In Finland, a lot of electricity is produced through the CHP production of power and heat which is favourable in terms of power-to-heat ratio and environmental emissions.

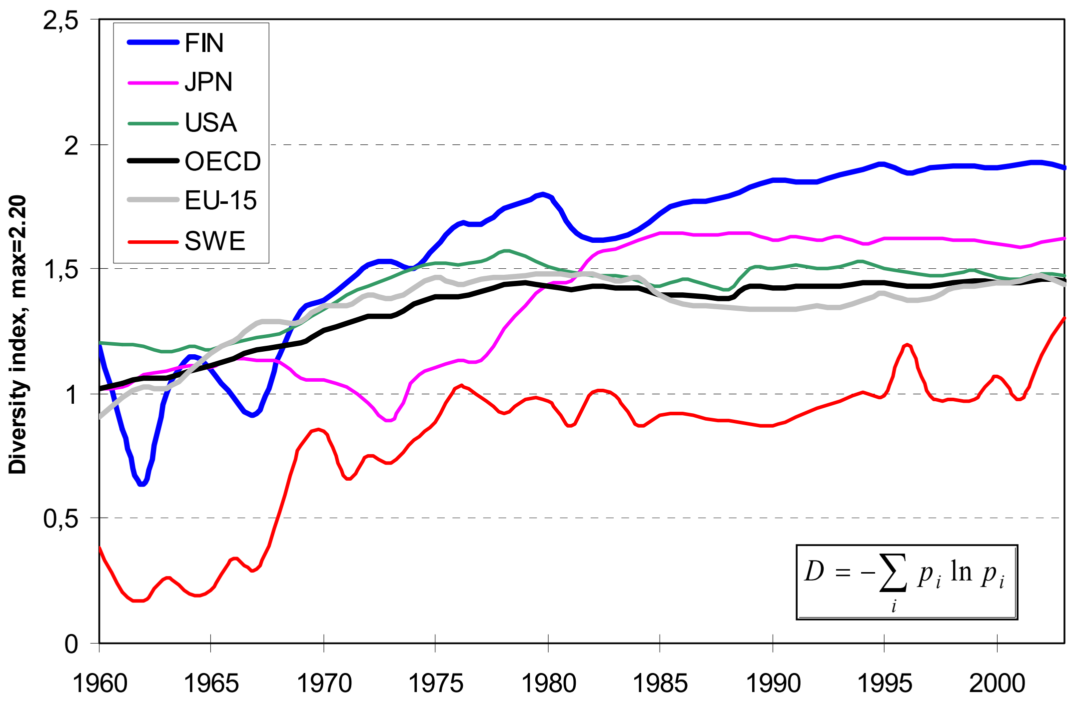

Figure 11. The Stirling index that depicts the versatility of energy production in different countries (VTT Energia 2001).

4.1 Electricity market

Figure 12 shows the time span for the operations in different markets. Financial contracts are traded in Nord Pool and in OTC markets (over the counter). In Nord Pool, standardised financial electricity contracts can be traded up to four years from the delivery, in the OTC markets trades are also made with agreements that stretch further into the future.

Elspot is Nord Pool's market for physical electricity where the following day's hourly electricity deliveries are traded. 43 per cent of the electricity used in the Nordic countries in 2004 was traded through Elspot and the spot price is widely used as a price reference for electricity sold outside the exchange. The prices of the financial contracts traded in the exchange are tied to the spot market price.

After the Elspot market is closed, there is still 12–36 hours until the electricity is delivered. The need for electricity deliveries may change over this period, for instance, due to a malfunction in a large power plant or unexpected change in temperature. The Elbas after market operates in Finland, Sweden and eastern Denmark, where physical electricity deliveries can be traded for up to one hour before the actual delivery hour. This market is used for balance control. The Elbas market is maintained by Nord Pool Finland Oy.

During the actual hour of operation, trading is carried out in the regulating power market maintained by the system operators. The purpose is to balance the production and consumption. The players partake by giving their bids to the regulating power markets. Momentarily, the power balance is maintained with frequency-controlled reserves that are automatically activated according to frequency changes in the network.

The actual electricity deliveries of the parties are cleared after the operation hour in the balance settlement. The settlement uses measured and actual hourly energies and load diagrams for small consumers. The result is the power balance for all market participants. In Finland, Sweden and Denmark, balancing power pricing is based on a double price system, i.e., a separate hourly price is determined for both buying and selling of balancing power. Norway uses a single price system.

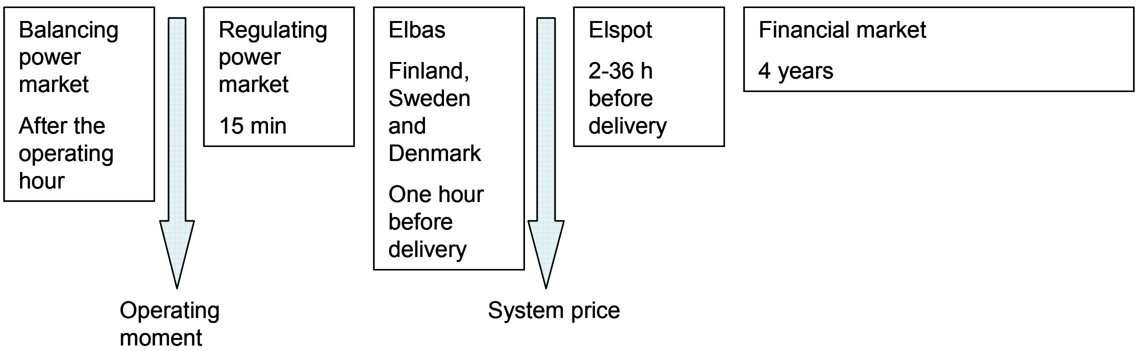

Figure 12. Electricity market places.

4.1.1 Players in the electricity market

Figure 13 shows a simplification of the structure of the Finnish electricity trade in 2004. The biggest electricity producer was Fortum that produced 24 TWh of electricity in power plants located in Finland. The second largest electricity producer was Pohjolan Voima (PVO) whose electricity production in its own and partly owned plants was nearly 18 TWh in 2004. PVO operates on the Mankala principle, i.e., it acquires electricity for its shareholders against production costs. Among other power companies that operate on the same principle are Etelä-Pohjanmaan Voima, Kemijoki and Teollisuuden Voima.

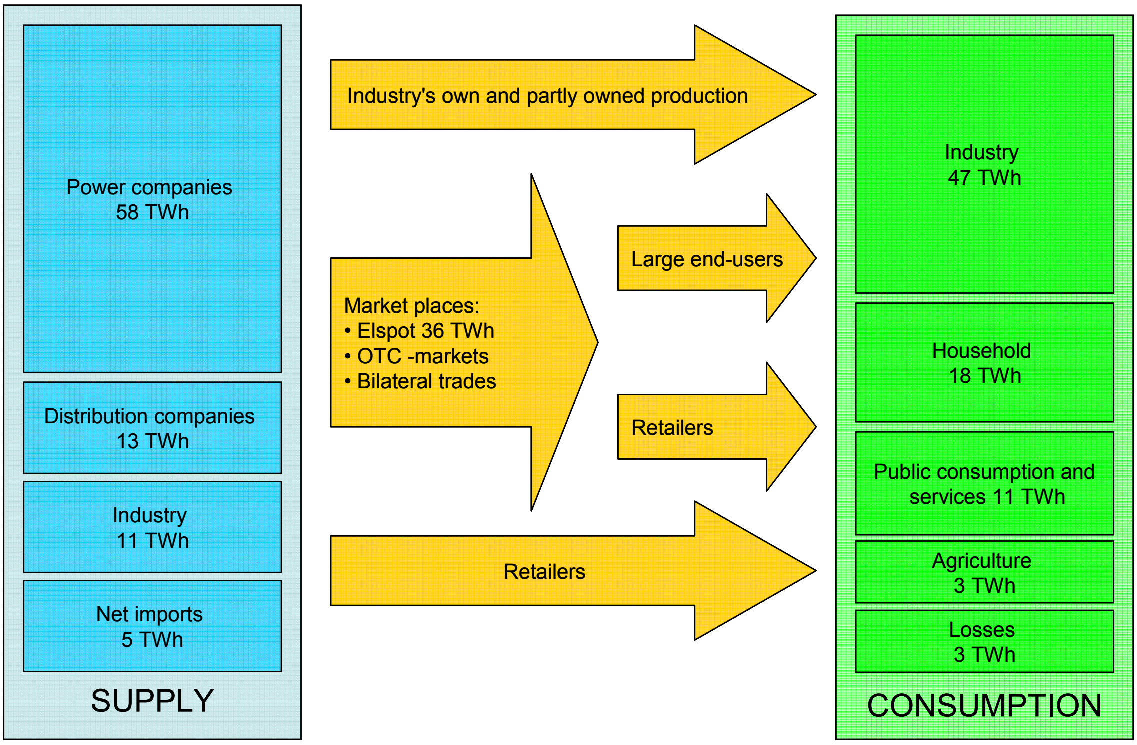

Figure 13. Structure of Finnish electricity markets in 2004.

On the Nordic level the four largest power companies' share in production is, in total, over half of the entire electricity production (Figure 14). The three largest companies are former national power companies, i.e., Fortum, Vattenfall and Statkraft. The fourth largest power company is E.ON whose share in Nordic electricity production is approximately 9%. The companies' electricity production structures differ considerably from each other. Statkraft produces electricity nearly solely from hydropower, E.ON and Vattenfall from hydro and nuclear power and, in addition to these, Fortum also has some other electricity production, i.e., thermal power.

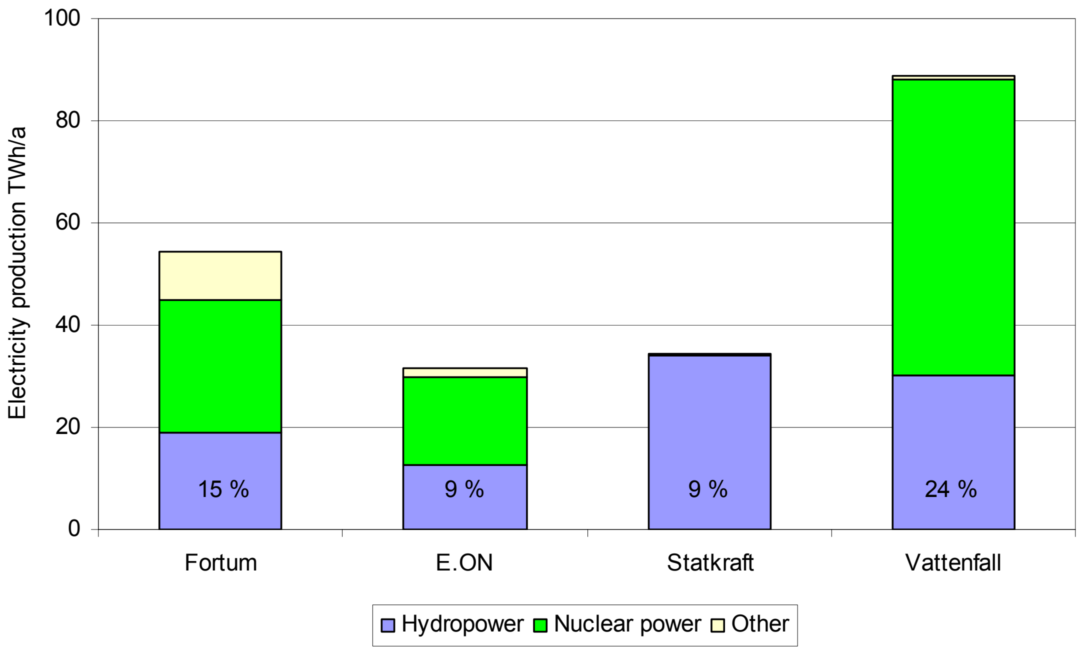

Figure 14. Production structures of large power companies and their share of Nordic electricity production in 2004.

The ownership base of the large power companies differ somewhat from each other. The Swedish and Norwegian states have chosen to keep the national power companies fully in the states' ownership. The Finnish state only owns a little over half of Fortum and Fortum is the only Nordic former national power company that is a listed company. The ownerships and market areas of the large companies operating in the Nordic market are presented in Table 2.

The Finnish state had holdings in 50 companies, of which 12 were listed, at the end of 2004. The biggest measured by value was Fortum in which the state's holding was worth approximately 7 billion euros at the end of 2004. Fortum shares have been sold

- in November-December 1998, mainly in the domestic markets, the state's income 420.5 million euros, the change in the state's holding -19.9 percentage points (21 million euros per percentage point)
- in June 2002, international sales, the state's income 444.3 million euros, the change in the state's holding -9.9 percentage points (45 million euros per percentage point)
- in June 2005, international sales, the state's income 770 million euros, the change in the state's holding -7.2 percentage points (107 million euros per percentage point)

In total, the state has made approximately 1,600 million euros from selling Fortum shares. For instance in 2004, Fortum's net profit amounted to 1,200 million euros.

France is only now gradually privatising its national power company EdF. 15% of the company will be divested and the earnings are to be used for investments in the energy system.

Table 2. Data on the large power companies operating in the Nordic markets.

Company	**Ownership**	**Main market area**	**Electricity production TWh**
E.ON	Public company	Central Europe, the UK, USA, the Nordic countries, Eastern Europe	403.7
Fortum	Public company 51.7% held by the Finnish state	The Nordic countries, the Baltic countries	55.5
Statkraft	100% held by the Norwegian state	The Nordic countries, Germany, the Netherlands	34.3
Vattenfall	100% held by the Swedish state	The Nordic countries, Germany, Poland	167.1

According to the Energy Market Authority, approximately 74 electricity retailers operated in Finland in 2005. Of these, 70 were incumbent electric utilities (EMV 2005). The net sales of the companies vary from some 60,000 euros to nearly 400 million euros. The average electricity sales of 62 selling companies that responded to the Energy Market Authority's questioner was approximately 1 TWh per year. In the electricity supply of said companies, approximately one-third has been indigenous production, one-third has been bought on the exchange and the rest based on bilateral agreements.

In Finland, the pulp and paper industry is the single largest electricity consumption group. Pulp and paper industry companies have a lot of internal electricity production and holdings in power companies.

4.1.2 The Nordic power exchange

A well-operating electricity exchange is a precondition for well-functioning electricity markets. The Nordic power exchange, Nord Pool, is considered perhaps the best functioning electricity exchange in the world. Nord Pool's system price is also used as a price reference for trading outside the exchange.

The parent company for the exchange and the maintainer of the financial markets is Nord Pool ASA that is half-owned by the Norwegian and Swedish system operators Statnett SF and Svenska Krafnät. Nord Pool ASA still owns 20% of the trade centre for physical electricity, Nord Pool Spot AS. The rest is evenly divided between the Nordic system operators. The holdings of system operators are presented in Table 3. Nord Pool operates under Norwegian law.

In theory, the electricity exchange implements the demand of the Nordic electricity markets excellently. System price directs the power plants to run in optimal merit order. Reservoir hydropower should be offered to the markets so that long-term occupation efficiency is maximised both for the consumer and the producer. Because a power producer can always sell produced electricity to the exchange, the exchange's electricity price is used as a reference price in over the counter-markets as well.

Table 3. Nord Pool Spot AS holdings 2004.

	%
Svenska Kraftnät	30
Fingrid	20
Statnett	30
Energinet.dk	20

Physical power market Elspot

The Elspot market trades in the hourly physical electricity deliveries of the following day. This physical market is central to all trading as the price of electricity is determined on the Elspot market. The price of the derivatives is tied to the Elspot price, and the price is used as a reference on markets outside the exchange as well. Elspot's volume in 2004 was 167 TWh, i.e. 43% of the area's electricity consumption. The share has increased continuously apart from 2003, when the exchange prices were extremely high due to the weak precipitation situation and demand decreased (Figure 15).

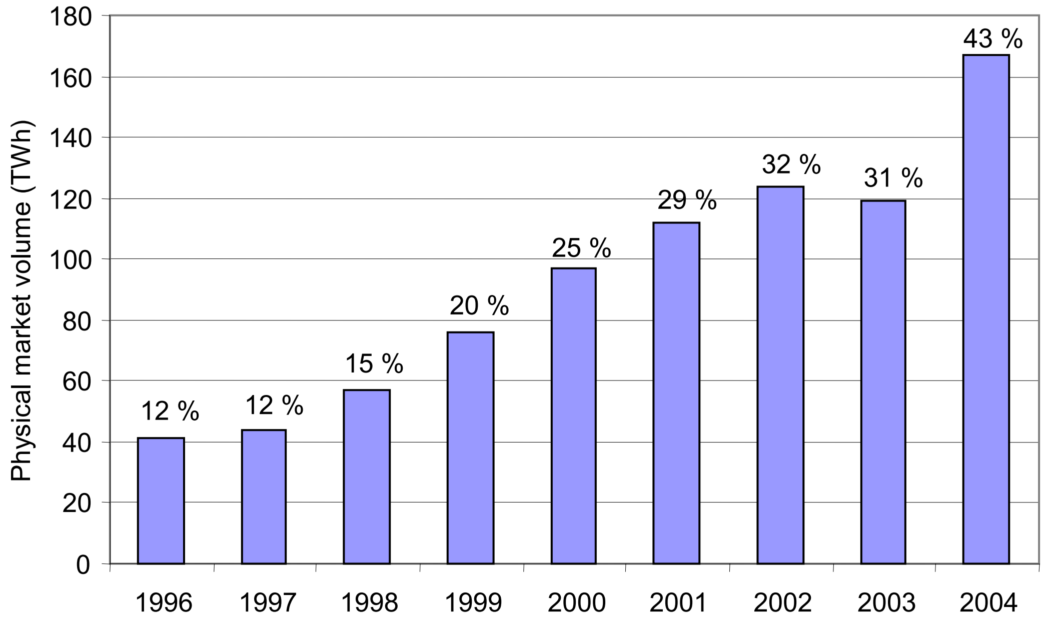

Figure 15. Development of Nord Pool's physical electricity trade volume 1996–2004. The share of Nord Pool's trades compared to the electricity consumed in the area is shown above each column (data Nord Pool 2005a).

In 2005 there were some 100 players on the spot markets of which 22 were Finnish. There were the most Norwegian players, i.e., almost half. The share of trading in Finland in Elspot in 2004 was 35.7 TWh which corresponds with approximately 21% of the exchange volume (Figure 16). Finland consumed approximately 87 TWh of electricity so approximately 41% of electricity consumed was purchased through the exchange.

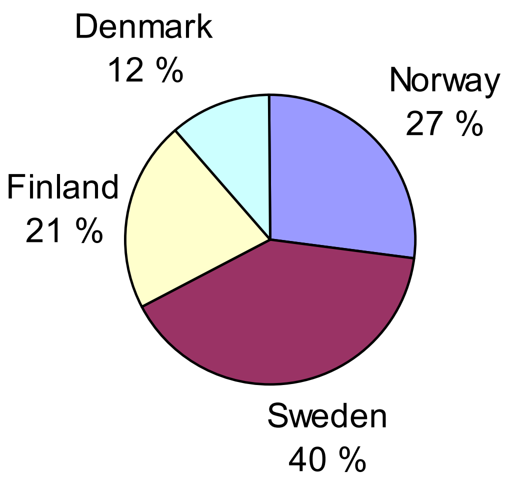

Figure 16. Distribution of Nord Pool's spot trade volume in 2004. The total volume was 167 TWh (data Nord Pool 2005a).

Product structure and price formation of the Elspot market

Different bids can be made on the Elspot market, the most common being the hourly bid; in addition, block bids and flexible hourly bids can also be made. A flexible hourly bid means a bid for the most expensive hour of the day.

The exchange operates as a closed auction. The market players give their bids once a day for the hourly purchases and sales of electricity for the next day. The exchange sums all the bids for each hour by price to form a curve for purchase and a curve for sale. The intersection point of the curves determines the system price and volume. Thus, in order of the variable costs, the last player to enter the market, i.e., the marginal producer's bid determines the electricity price for everyone. The price formation principle is presented in Figure 17.

The marginal producer of each hour only receives coverage for its variable costs. Players that produce electricity at a cheaper price than this receive coverage for their capital costs as well in that hour. For instance, nuclear power is an extremely capital intensive form of electricity production where the variable costs are relatively low. A nuclear power producer gets coverage for their investments to the amount of the difference between the electricity market price and the power plant's variable costs within each hour.

During a majority of the hours in the year, the spot price in the Nordic countries is close to the variable costs of a coal condensing plant.

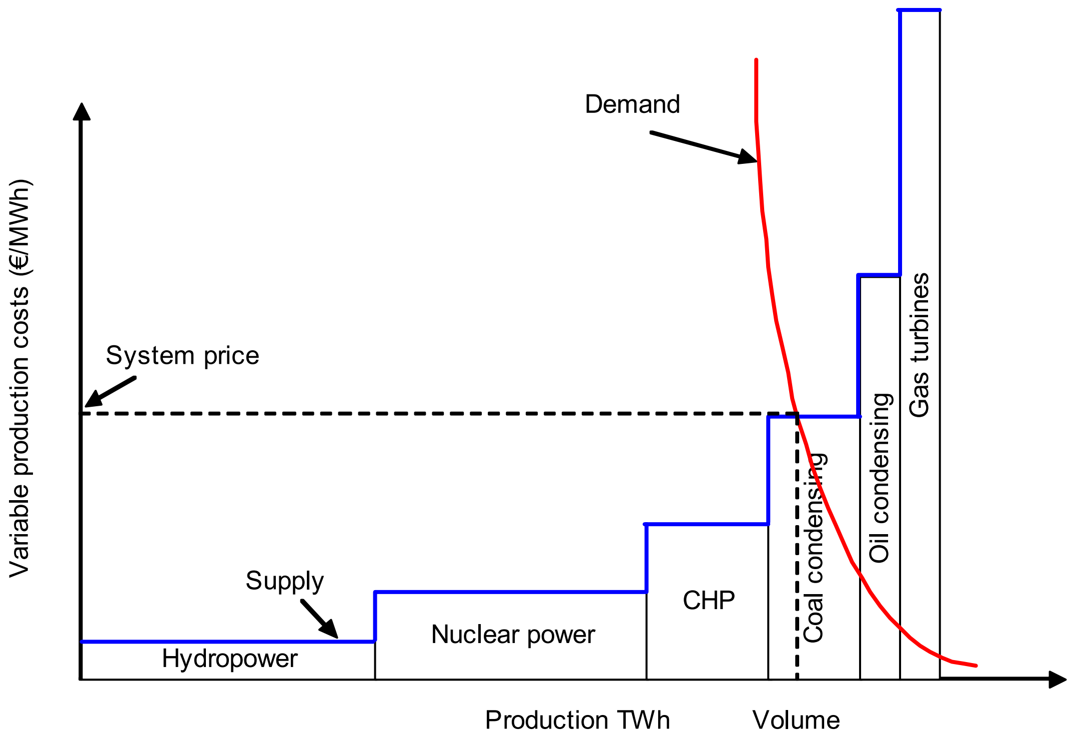

Figure 17. Price formation, principle illustration.

Financial markets

Nord Pool's financial market trades in electricity derivatives, emission allowances and green certificates. Derivative products include futures, forwards, options and CdF product (Contract for Difference), which can be used to hedge against the price risk caused by differences in area prices. In 2005 there was 117 players trading on the financial markets of which 16 were Finnish (www.nordpool.com 15.12.2005). In 2004 Nord Pool's financial market volume was 590.2 TWh. The share of Finnish parties in the entire volume was only approximately 5% (Figure 18). Reasons for the low volume could be trading on markets outside the exchange, the use of international brokers or a trading strategy that deviates from other players.

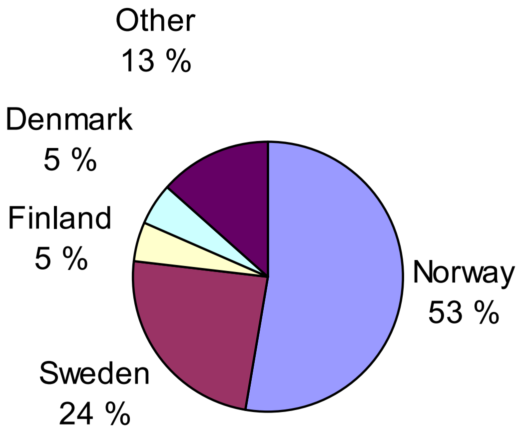

Figure 18. Distribution of Nord Pool's financial market volume in 2004. Total volume was 590.2 TWh (data Nord Pool 2005a).

No physical delivery is related to the financial market electricity products. Thus the trade does not apply to actual physical electricity delivery but the payment that depends on the actualised electricity spot price. The electricity producers, sellers and consumers use the financial contracts for risk management and there is also exchange brokers on the market that try to benefit from the price fluctuations. The brokers improve market liquidity so they are useful for other players as well.

Futures and forwards differ from another in terms of the timing of the payment traffic. Nord Pool only trades in daily and weekly futures which are on offer for the following 8–9 weeks. After making a future agreement the development of the future price for the delivery period is monitored daily. The agreement is changed for a new one every day at the price corresponding to that day so there is a lot of monetary transactions. During the delivery period compensation is paid in relation to the actualised spot price.

According to the current product structure of forwards the trading is carried out with monthly, quarterly and annual contracts. The monthly contracts are listed for the next six months. The quarterly contracts are altered into monthly contracts when the delivery period approaches. Annual contracts are divided into quarterly contracts. There are no daily monetary transactions related to forwards before the delivery period, the average price of each day during the period is compared to the contract price on the Elspot market and compensation is paid.

Contracts for Difference (CdF) were launched in 2000. The aim of the product is to help players hedge against differencies in area prices.

The well-functioning derivative market on Nord Pool has decreased the need for bilateral agreements. Electricity sellers and consumers may hedge the electricity price on the derivative market and purchase the physical electricity on the spot market.

4.1.3 Finland's area prices

The system price is formed from all sell and buys bids given in the Nordic electricity market area. The capacity of the transmission interconnectors is not always sufficient to create these deals required by the system price. If the grid congestion is within a predetermined price area (e.g. Finland), the system operator should handle the situation with counter purchases. These are explained in Section 2.2.

When the transmission interconnectors from Finland to the Nordic countries are not sufficient for trades required to create a system price, Finland forms its own market area. The situation is different, for instance, in Sweden as Sweden is usually in the same price area either with Finland or part of Norway. There are relatively few Finnish parties that trade on the exchange so a large electricity buyer or seller can affect the price of electricity if it so wishes in a situation when the transmission capacity is restricted.

Average prices of price areas

Table 4 shows the average system price in 2000–2005 and both the Finnish and Swedish area prices. The biggest factor that affects the price level and the need for electricity transmission is the precipitation situation. The table also shows percentage shares of the hours in the year during which Finland's price has been as high as the system price or Sweden's price. These shares also reflect the changes in precipitation conditions and temperature.

The year 2000 was an exceptionally good precipitation year and the average system price was lower than the Swedish and Finnish area price. The biggest difference in prices is between Norway and Sweden. More cheap Norwegian hydropower was available than could be transferred to the southern consumption areas. The transmission capacity is not, however, dimensioned and should not be dimensioned based on extremes.

In the autumn of 2003, the precipitation conditions clearly weakened and the price level started rising. Towards the end of the year, the temperature dropped and at the turn of 2002–2003, the exchange price was at a high level for a long time. The precipitation conditions did not return to normal until the end of 2004. In 2003 and 2004, the Finnish area price has been, on average, lower than the Swedish price or the system price. The restricted transmission capacity has limited electricity sales from Finland to other Nordic countries.

For 2005, price information is only available for January-November. The precipitation conditions have been relatively good. The average area price for Finland has been higher than in Sweden and Finland has formed its own price area approximately 10 per cent of the time.

Table 4. Area prices 2000–2005. For 2005, data available until end of November (data Nord Pool).

	2000	2001	2002	2003	2004	2005*
Average system price €/MWh	12.75	23.15	26.92	36.69	28.92	28.92
Average Finnish area price €/MWh	14.88	22.84	27.28	35.31	27.68	29.98
Average Swedish area price €/MWh	14.24	22.86	27.62	36.49	28.08	29.31
Finnish price equals system price	35%	62%	56%	38%	30%	55%
Finland and Sweden in the same price area	84%	99%	95%	71%	76%	90%

Temporal occurrence of insufficient transmission capacity

The temporal division of area price differences is reviewed with average daily prices. Figures 19–21 show the daily average area price differences for 2000, 2003 and 2005. The years have been selected so that 2000 represents a good precipitation year, 2003 a poor precipitation year and 2005 an average precipitation year and emissions trading situation.

In 2000, the difference in Finnish and Swedish daily area price averages was approximately 10 €/MWh at the highest and anytime a price difference occurred, the Finnish price was higher than the Swedish price. The majority of the price difference hours occurred in July–October. In 2003, the Finnish price was, on average, lower than the Swedish price and there was a rather even amount of price difference days throughout the year. The average daily price difference was approximately -9 €/MWh at most.

In 2005, there were price differences in both directions and by the end of November differences had occurred approximately 10% of the time. The daily average of the price differences have been higher than in the previous years and they often exceeded 10 €/MWh and at the end of October even 20 €/MWh was exceeded.

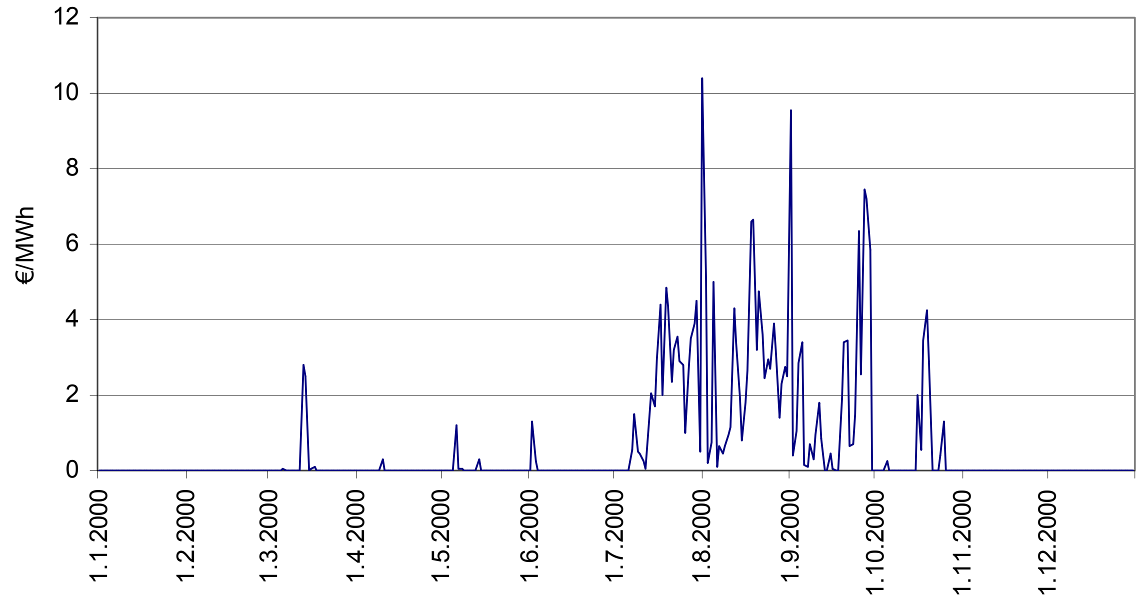

Figure 19. Differences in daily area price averages in Finland and Sweden in 2000. The year 2000 was a good precipitation year (data Nord Pool).

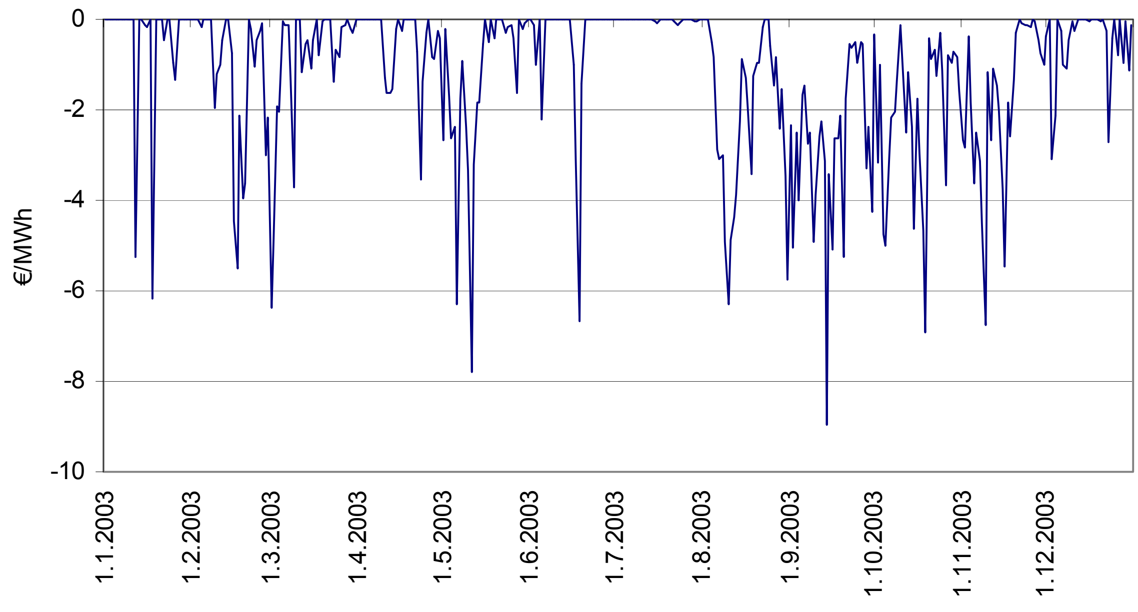

Figure 20. Differences in daily area price averages in Finland and Sweden in 2003. The year 2003 was a poor precipitation year (data Nord Pool).

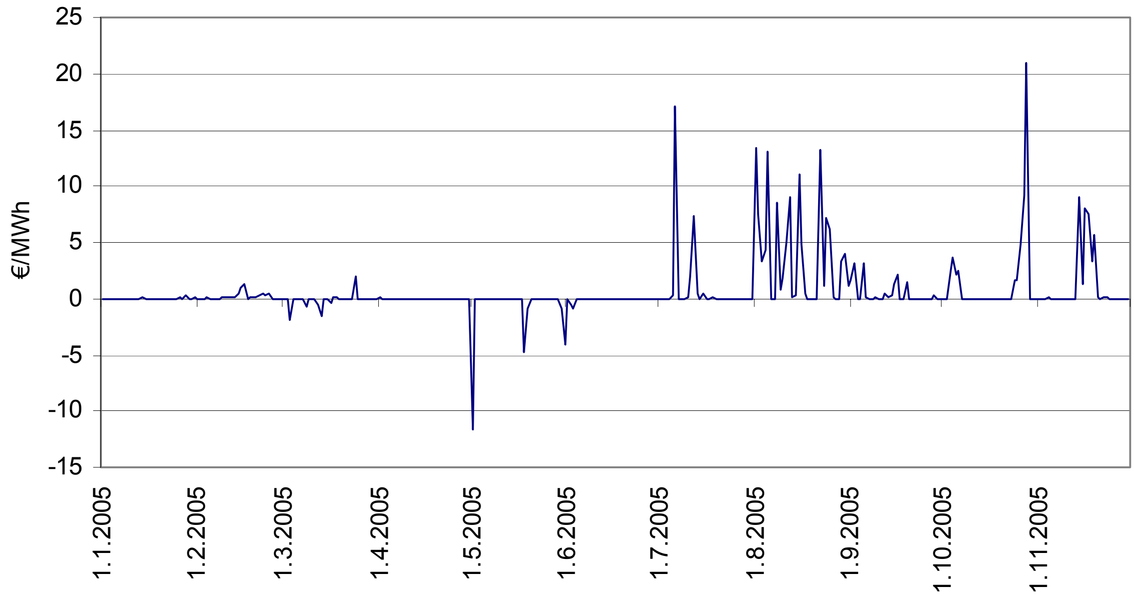

Figure 21. Differences in daily area price averages in Finland and Sweden in January–November 2005. Emissions trading began at the beginning of 2005. The year was an average precipitation year (data Nord Pool).

Hourly analysis

Figure 22 shows a summary of the hourly fluctuations in the difference between Finnish and Swedish area prices in 2000–2005. The bar depicts the occurrence of hourly price differences, for instance, in 2001 there were only 81 hours of price differences, i.e., 0.9% of the annual hours. The right axis shows the difference between the Finnish and Swedish area price. The black square is the median of the difference in area price, which is thus the median of the area price differences for the hours when the area price difference has occurred. In addition, the illustration shows the 95% confidence interval of the price difference. Table 5 shows the same data as the figures.

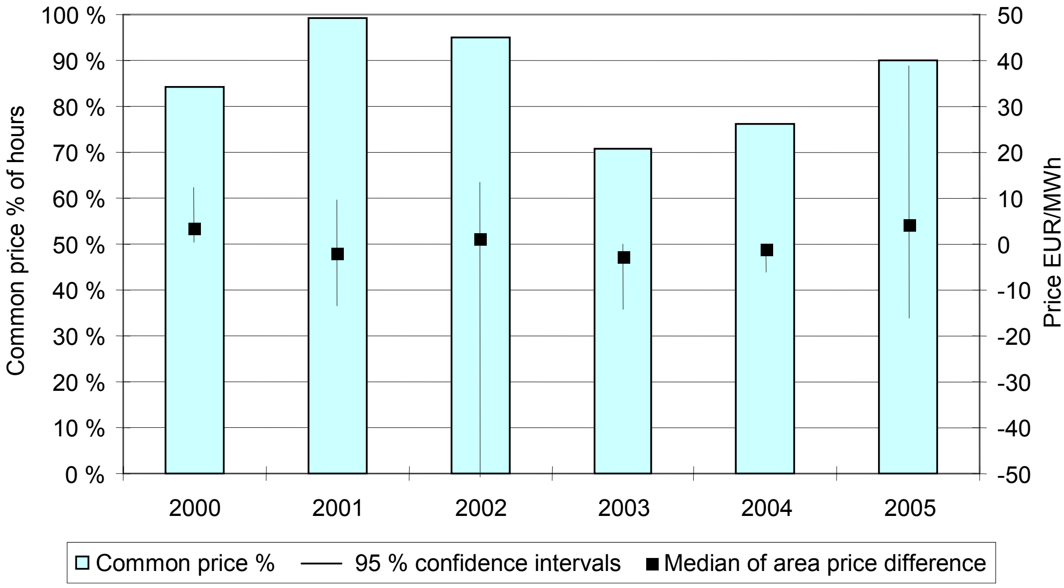

Figure 22. Differences in Finnish and Swedish area prices in 2000–2005, for 2005 data available only until the end of November (data Nord Pool).

Table 5. Finnish and Swedish area price differences 2000–2005. The table data has been calculated for the hours in which area price differences have occurred. For 2005, data available only until the end of November (data Nord Pool).

	2000	**2001**	**2002**	**2003**	**2004**	**2005***
Area price difference hours	1383	76	439	2561	2092	808
Median (€/MWh)	3.59	-1.95	1.24	-2.74	-1.11	4.22
Minimum (€/MWh)	-2.85	-13.95	-68.06	-13.13	-11.86	-28.58
Maximum (€/MWh)	35.19	13.08	18.30	-0.01	-0.01	158.53
Lower 95% confidence interval (€/MWh)	0.20	-13.32	-52.14	-14.33	-6.33	-16.25
Upper 95% confidence interval (€/MWh)	12.12	9.63	13.50	-0.14	-0.05	38.98

Finland's area price was considerably lower than the Swedish area price in December 2002 (Figure 23). The electricity price rose heavily when the amount of electricity produced by hydropower decreased, however, the consumption of electricity grew due to the cold weather. Finnish condensing power plants were started up. The transmission capacity between the countries restricted electricity transfer to Sweden and Norway.

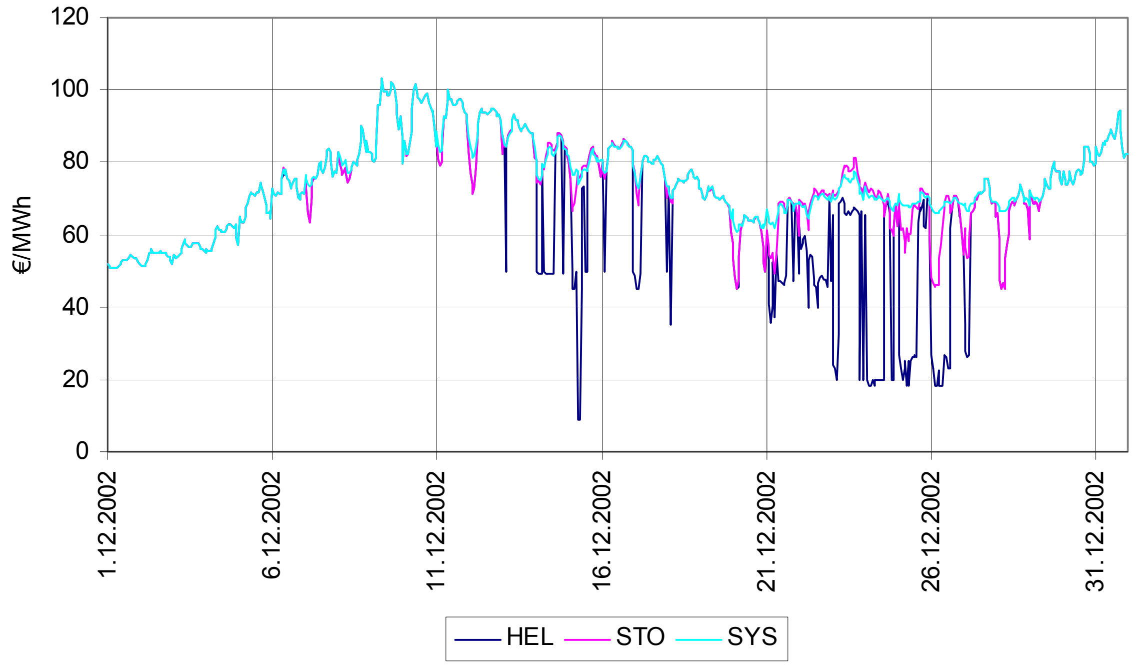

Figure 23. The system price and Finnish and Swedish area prices in December 2002 (data Nord Pool).

There were extremes in 2005 (the illustrations in the report lack data for December). There were a lot of price differences in August (Figure 24). The Finnish area price was, for several days and for a longer period, tens of euros higher than the Swedish area price.

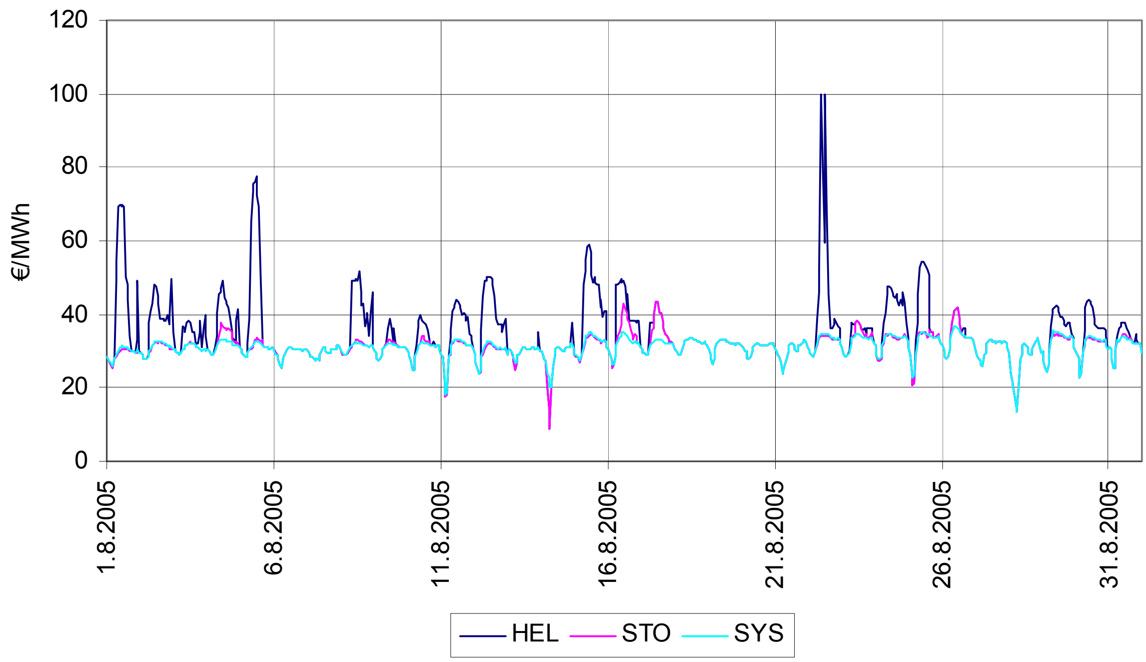

Figure 24. The system price and Finnish and Swedish area prices in August 2005 (data Nord Pool).

All in all, there has been a normal amount of fair price differences in 2005, however, when Finland has been as its own price area, the price has deviated strongly from Sweden's area price. When the transmission capacity is restricted, Elspot's Finnish area price is formed only based on Finnish players' bids. Large electricity sellers and buyers then have the chance to affect the electricity price.

One can hedge against the area price on Nord Pool's financial market with the CdF product (Contracts for Difference). So far trading with CdF products has been rather limited so its use for hedging against price risk is difficult.

Based on a questioner by the EU Commission, it is regarded as a wider problem in the EU that there are not enough incentives for national system operators to construct new cross-border cables. National system operators actually gain income from bottlenecks cleared with area prices. Based on the Commission's questions, e.g., German system operators invest only approximately 5% of the bottleneck income of hundreds of millions into cross-border transmission capacity investments.

4.1.4 Retail markets

The real competition in retail electricity markets began in 1998 when the Electricity Market Act were changed so that small consumers no longer needed an hourly meter in order for them to ask for competing offers from electricity companies. By 2000, approximately only 2% of electricity consumers had changed their electricity provider. In 2002, the figure was merely 4% and in 2004 it was 11% (EMV 2005).

One factor that depicts the efficiency of the market is how well the electricity retail price reflects the electricity procurement cost of the electricity seller. The exchange price for electricity forms the minimum level for small consumers' price. An efficiently operating electricity seller values its own production according to the exchange price as there is always the option to sell the produced electricity to the electricity exchange. There should not be big differences in the retail and wholesale price levels and the electricity price for small consumers should follow the wholesale prices when prices both rise and fall. The electricity price for small consumers consists of the wholesale price and the seller's margin.

The electricity price for small consumers does not follow the fluctuations in the exchange price immediately but in the longer term. In Finland, the retail electricity prices follow the changes in the exchange prices rather slowly (Figure 25). Figure 26 compares the end-user electricity prices in the Nordic countries. In Sweden and Norway, the electricity price for small consumers follows the changes in the exchange price clearly faster than in Finland (KTM 2004b).

One reason for the slow price changes is that the retail sales tariff prices in Finland are very rarely tied to the exchange prices. In the majority of tariffs, the payment components are of a fixed price, which means that the electricity seller must, according to §26 paragraph 4 of the Electricity Market Act, announce a price change to the customer in writing at least a month before the change becomes effective.

Figure 25 shows that the electricity prices for end-users have raised evenly in 2000–2005 as the electricity exchange price has increased. When the exchange price has decreased, the end-user prices have only decreased a little. Figure 27 shows the retail electricity seller's margin in 2000–2005. The seller's margin is derived by subtracting the exchange price from the retail electricity price. The illustration shows that electricity sellers have not, on average, raised their margin which would be a sign of ineffective pricing. During 2005, a majority of electricity sellers have announced that they will raise the price for small consumers even by as much as one-fifth due to the price increase in electricity caused by emissions trading.

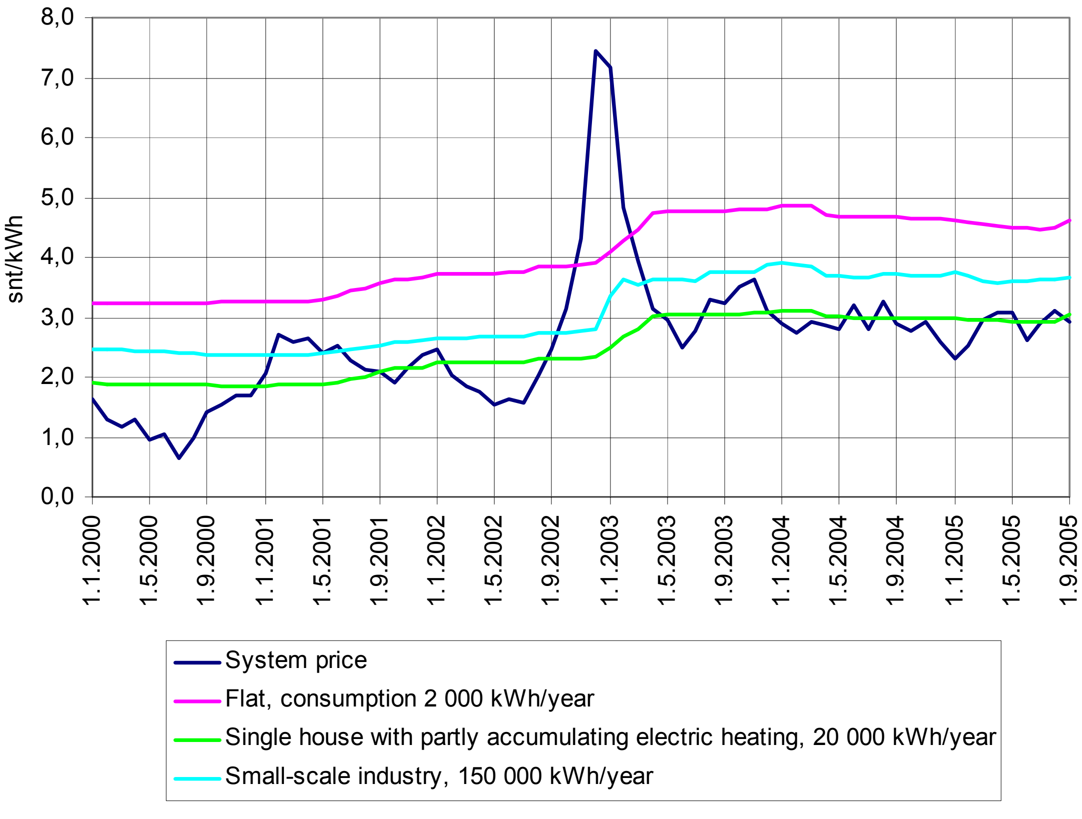

Figure 25. Monthly average of Nord Pool system prices and a typical consumer's average tax-free electricity energy price. The customer prices are incumbent prices. The typical consumer L2 has electric storage heating and a double tariff, i.e., the consumption is focused on cheaper night-rate electricity (data Nord Pool and the Energy Market Authority).

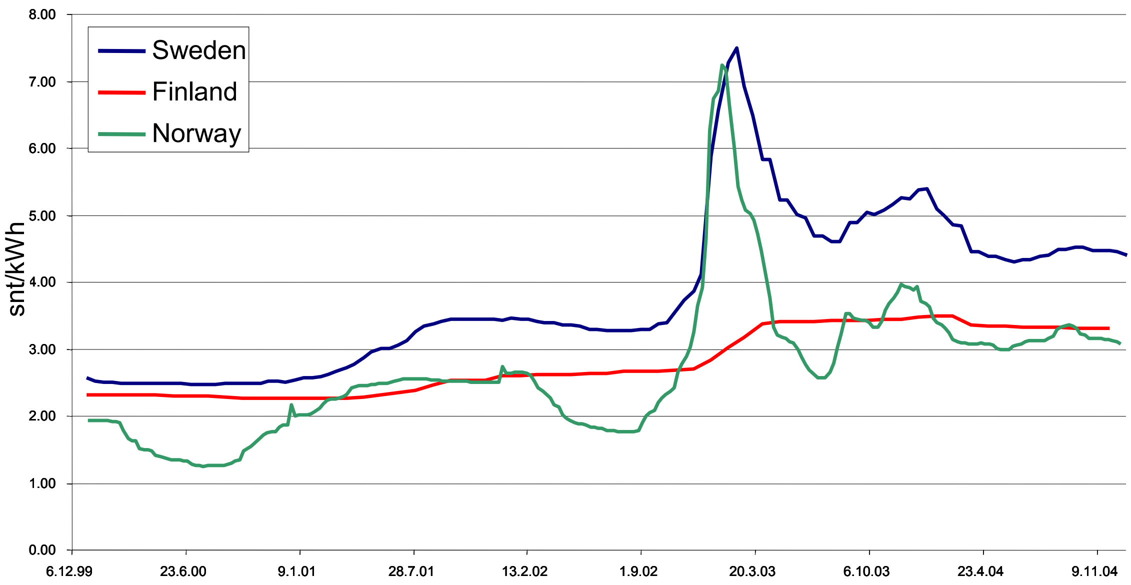

*Figure 26. Small consumer prices in Sweden, Finland and Norway. Single house with electric heating, exchange rate EUR/SEK 9.0035, EUR/NOK 8.222 (*www.energia.*fi).*

In Finland, small consumers are extremely loyal to their electricity companies and only a small number of customers have changed their suppliers since the market deregulation. There are several reasons for low customer activity: customers who consume little electricity do not benefit much financially from changing their electricity supplier, asking for competing offers is regarded to be complicated and information is not easily accessible.

Customer passiveness has partly resulted in competition in retail electricity markets not working properly. The electricity seller can announce that it is raising its retail sales prices by several dozens of per cent and possibly only a few per cent of customers change their supplier due to the higher prices.

In its report, the Ministry of Trade and Industry (KTM 2004b) has reviewed the effects of unrestricted competition on small customers. Deregulation has not lead to heavy price competition between electricity sellers and thus has not affected the price paid by the customer for electricity.

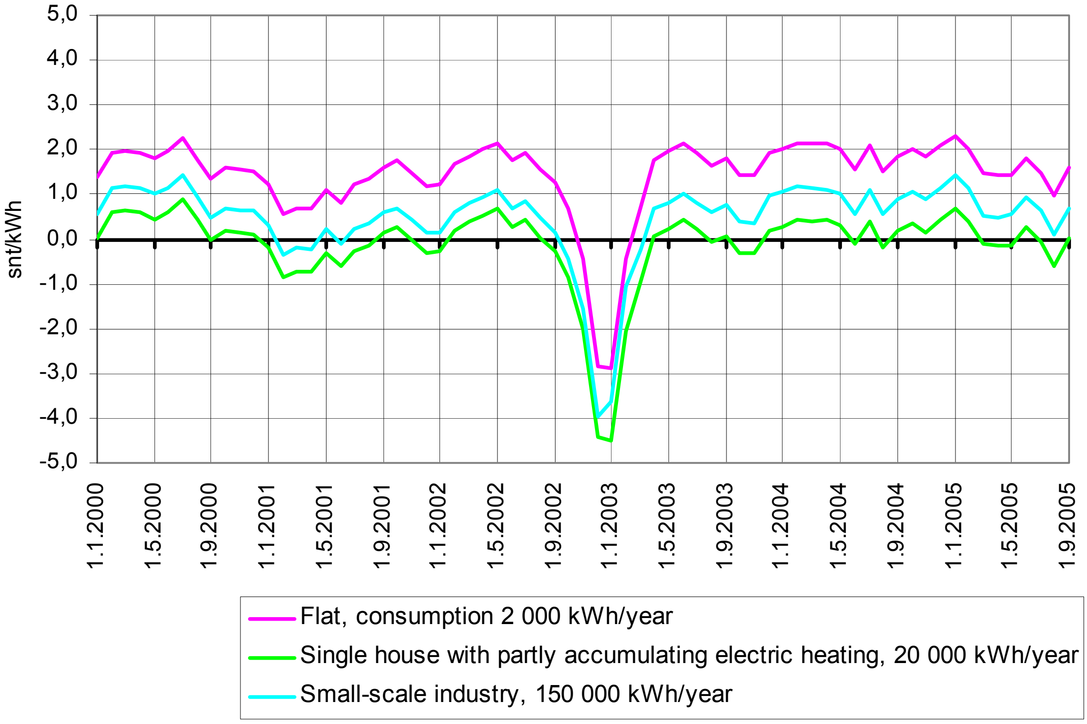

Figure 27. Retail seller's margin, excluding tax, in 2000–2005. The illustration shows incumbent companies average retail price, from which Nord Pool's Finnish area price has been subtracted. For electric heating, electricity is sold at cheaper price during night-time (data Nord Pool and the Energy Market Authority).

4.1.5 Functionality of the electricity markets

Generation concentration

One of the biggest problems in Nord Pool is concentration. A few large electricity producers dominate the markets. These players may affect the electricity exchange price, for instance, by refusing to produce electricity so that the scarcity leads to higher prices. In a concentrated market, investments into new production may be too low as it is not worthwhile for the dominant players to invest. Scarcity maintains high electricity prices.

Concentration is emphasised in situations where the capacity in cross-border cables restrict the deals necessary to form the Elspot market price. In such times, Finland's area price is formed only by sell and buy bids given by Finnish players on Elspot. There are not many Finnish players and only a few large electricity consumers buy electricity directly from the exchange.

In well-functioning markets, a high price level often leads to new entrants entering the market. New entrants entering electricity production is, however, difficult for several reasons. In Finland and other Nordic countries, more extensive construction of the most profitable production form, i.e., hydropower is impossible within current legislation as the remaining large water resources are conserved. Several electricity production forms are extremely capital intensive, which means that large projects, like the construction of a nuclear power plant, require a consortium of several companies. It may be difficult for new players to become part of such joint ventures. A large risk is connected to the construction of electricity production that emits greenhouse gases, as no decision has been made on how greenhouse gas emissions will be treated after the Kyoto period.

Generation concentration on a few players is also a problem in other European electricity markets, for instance, in France EdF dominates the market almost alone and only some four per cent of consumed electricity is traded in the exchange (European Commission 2005).

Power exchange surveillance

Nord Pool operates under Norwegian law and surveillance is the responsibility of Norwegian authorities. Finnish authorities have no authority to supervise an international electricity exchange or Finnish players that trade there.

The electricity and derivative trading on Nord Pool is monitored by the Norwegian competition authority Konkurrenstillsynet, energy market authority Norges vassdrags- og energidirektorat (NVE) and the financial supervision authority Kredittilsynet. Supervision is largely based on malpractice suspicion detected by Nord Pool's own market surveillance.

In the spring of 2002, the Swedish financial supervision authority Finansinspektionen contacted the corresponding Norwegian authority and announced suspicion of possible price manipulation during the Easter of 2002. The reason for suspicion was exceptionally high volumes on the Norwegian and Swedish regulating power markets. Nord Pool ASA's market surveillance unit launched an investigation and asked the Nordic system managers for more information on regulating power market trades.

The outcome of the investigation was that the large volumes on the regulating power markets were mainly caused by the difficulty to predict electricity consumption. According to the investigation, there was no reason to suspect market manipulation.

Nord Pool ASA also asked Finnish authorities for information on the trades carried out on the market. It became evident that Finnish authorities are not authorised to ask for or deliver information to the Norwegian authorities. In February 2003, the Ministry of Trade and Industry appointed a work group in order to make suggestions on how to organise the authority tasks related to the surveillance of the electricity exchange in Finland and arrange the necessary exchange of information with Nordic authorities. The conclusion of the workgroup report (KTM 2004c) was that Finland does not require a separate supervision system for physical electricity trading and the surveillance should continue to be based on general competition legislation. The workgroup also found that the regulation concerning the Energy Market Authority's data acquisition rights and rights to render said that the information does not have to be changed. In order to ensure data acquisition, Nord Pool AS' regulations were changed so that the market players commit to the Nordic system operators having the right to handover information to the exchange's market surveillance unit.

The workgroup that studied the surveillance of the electricity exchange feels that the Nordic authorities should cooperate tightly in issues related to the surveillance of the electricity exchange.

Availability of information

Nord Pool has been criticised for, among other things, unfair availability of information (Finansinspektionen 2005). Large electricity producers that partake in exchange trading use active spot trading. This enables them to gain information on the faults in their own power plants before other parties and utilise this information. The use of this information should be prevented by stopping trading or by the so-called Chinese wall procedure. Large producers can also predict each other's actions better than others. On the other hand, some players may benefit from affecting the spot price and collect the profits on the financial market. In concentrated markets, large players are not price takers, which should be the case on perfectly operating markets.

Nord Pool has tightened its internal surveillance, e.g., due to criticism from the Swedish Finansinspektionen. The exchange's fines have been raised and internal surveillance unit monitors completed trades.

Demand response and development of Elbas markets

The functionality of the spot markets could be improved considerably if there was more price elastic consumption in the market. This would improve market functionality in extreme situations where the price can be extremely high. Nordel suggests, in its report (Nordel 2004b), the introduction of a new financial product. This product would improve the players' ability to prepare for price peaks caused by peak load situations. The product is being tested in Jutland.

The volume on the Elbas markets is extremely low in proportion to the spot market. Currently, Norwegian players do not partake in the Elbas markets at all. Getting the electricity intensive Norwegian industry to join trading would alleviate handling the extreme situations.

Development of the Elbas markets would also alleviate wind power becoming part of the electricity markets. The production of wind power depends on momentary wind conditions and the time span for the Elspot market, 12–36 hours, is often too long for predicting winds and thus the production of a wind power plant.

Free market for smaller players

The target set by the European Union is an open European electricity market. Currently, not even the Nordel area operates as a uniform market all the way to the consumer. An electricity consumer that does not buy electricity directly from the exchange can select his/her supplier freely only among domestic sellers. Nordel is hoping for measures, mainly from authorities, in order to create a joint Nordic market for small customers as well (Nordel 2005b). There is a similar restriction for electricity sellers, i.e., electricity can be sold either within your own country or directly to the electricity exchange. Nord Pool's trading fees are, in principle, hindering exchange trading for smaller electricity sellers and consumers. Thus, the electricity market for small and medium-sized electricity producers, sellers and users is basically restricted to their home country.

Therefore, it is not purposeful for electricity consumers, like industrial companies, to build a production plant in another Nordic country.

4.2 Emissions trading

4.2.1 Emission allowance markets

EC's emissions trading directive (2003/8/EC) obliges member countries to make a national allocation plan (NAP) for trading with emission allowances. In the allocation plan, member countries must, for instance, present the total amount for emission allowances during the commitment period and the division of emission allowances to different installations. The first allocation plan has been made for 2005–2007 and it only applies to carbon dioxide emissions originating from energy production and certain industrial processes. The EU Commission approved Finland's 1st allocation plan in October 2004 and all EU25 countries' allocation plans had been approved by June 2005. The second NAP applies to the commitment period for the Kyoto protocol, 2008–2012. The Commission has published additional guidelines for preparation of the second allocation plan in the beginning of 2006 concerning, e.g., small combustion plants, new entrants and the shut-down of plants. The second plan must be submitted to the European Commission and other member states no later than 30 June 2006 when the Commission will also publish a more detailed directive proposal and make a new legislation proposal if necessary. Due to the EU's schedule, emissions trading for the second period will have the same legal basis as the first.

According to the directive, at least 95% of the emission allowances must be given to plants and processes for free in the first NAP of 2005–2007 and in the second plan at least 90% should be given for free. Based on 15§ of the Emissions Trading Act, all Finnish emission allowances are distributed free of charge.

In the national allocation plans of the EU25 states, emission allowances have been distributed in excess or below the estimated need based on whether the EU states must decrease its greenhouse gas emissions to achieve its Kyoto target within the so-called EU bubble or if the member state has the possibility to increase its greenhouse gas emissions from the current level during the Kyoto period. New EU states, in particular, are estimated to have excess emission allowances. A total of approximately 6,500 million tonnes of emission allowances have been distributed in the first period, i.e., more than 2,000 million tonnes per year. Approximately 12,000 installations are covered by the emissions trading and they must monitor their CO_2 emissions and return an amount of emission allowances corresponding to their CO_2 emission. All EU member states have national emission allowance registers that must be operating before the member country may start trading. In Finland, the emissions trading register is managed by the Energy Market Authority and Finland was among the first, alongside other Nordic countries, to have its register working. In December 2005, there were 16 working registers and over 70% of emission allowances had been distributed to companies. Table 6 shows the emission allowance volumes of the EU countries, the number of installations and the position on the EU wide emission markets.

Table 6. National allocation plans for 2005–2007 and the position in EU emissions trading. Situation 15 December 2005 (short: deficit of emission allowances; long: surplus of emission allowances) (data www.climatecorp.com).

Member state	Emission allowances, million tonnes	Share of EU's total emission allowances, %	Number of installations[2]	Register working	Position[3]
Germany	1497.0	22.8	1849	Yes	Short
Spain	523.3	8.0	819	Yes	Short
The Netherlands	285.9	4.3	333	Yes	Short
Belgium	188.8	2.9	363	Yes	Short
Finland	136.5	2.1	550	Yes	Short
Portugal	114.5	1.7	239	Yes	Short
Denmark	100.5	1.5	378	Yes	Short
Austria	99.0	1.5	205	Yes	Short
Ireland	67.0	1.0	143	Yes	Short
Slovenia	26.3	0.4	98	Yes	Short
Total	**3038.8**	**46.2**	**4977**	**Yes**	**Short**
France	469.5	7.1	1172	Yes	Long
Great Britain	736.0	11.2	1078	Yes	Long
The Czech Republic	292.8	4.4	435	Yes	Long
Sweden	68.7	1.1	710	Yes	Long
Estonia	56.9	0.9	43	Yes	Long
Lithuania	36.8	0.6	93	Yes	Long
Latvia	13.7	0.2	95	Yes	Long
Total	**1674.4**	**25.5**	**3626**	**Yes**	**Long**
Italy	697.5	10.6	1240	No	Short
Luxembourg	10.1	0.2	19	No	Short
Poland	717.3	10.9	1166	No	Long
Greece	223.2	3.4	141	No	Long
Hungary	93.8	1.4	261	No	Long
Slovakia	91.5	1.4	209	No	Long
Total	**1833.4**	**27.9**	**3036**		
Cyprus	17.0	0.3	13	No	n.a.[1)]
Malta	8.8	0.1	2	No	n.a.[1)]
EU 25	**6572.4**	**100.0**	**11 428**		**Short**

1) Cyprus and Malta have not ratified the Kyoto agreement.
2) There may be inaccuracy in the number of installations.
3) Different sources have presented different estimates on the position of the EU states (e.g. Portugal).

The first market place for trading in emission allowances was launched in February in Nord Pool. OTC trading has been made available before the actual launch of the emission allowance markets and the majority of the trading still takes place on the OTC markets (Figure 28). There were seven market places in December 2005 that traded future and/or spot trades with emission allowances. Measured by traded volume, the European Climate Exchange (ECX/ICE) is the clear market leader in EU's emissions trading. Secondly most trades have been made in Nord Pool (Table 7). EXC's members are mainly financial institutions that trade speculatively, while Nord Pool's members are mainly companies that are operators in the emissions trading scheme. A majority of the trades have been completed with December -05 futures but trades have even been made with futures of the Kyoto period. The 2005–2007 future prices have been close to the same level, but the future prices for the Kyoto period have been a few euros lower. Spot trading is modest so far and the trading volume has only been a few thousand tonnes. At the end of November 2005, a total of approximately 190 million tonnes of emission allowances had been traded (Fortis Bank 2005, Point Carbon 2005a, ECX 2005).

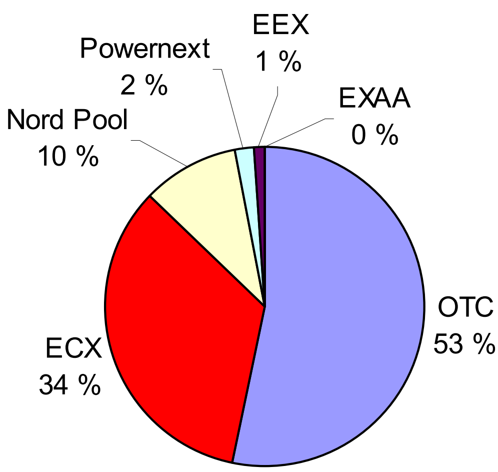

Figure 28. EU emissions trading market shares for January–October 2005.

Table 7. Market places in the EU area and trading volumes in November–December 2005.

Market place[1]	Starting date	Products	Members	Volume cleared, Mt	Volume traded, Mt	Open interest, Mt
Nord Pool, Norway	14.2.2005 24.102005	Forward Spot	62	13.6[2)]	12.5[2)]	12.8[2)]
ECX, the Netherlands	22.4.2005	Forward	50	62[3)]	24.8[3)]	15[3)]
EEX, Germany	20.5.2005 9.3.2005	Forward Spot	9	1.7[3)]	1.7[3)]	n.a.
Powernext, France	24.6.2005	Spot	27	2.3[3)]	2.3[3)]	n.a.
EXAA, Austria	28.6.2005	Spot	11			
Climex, the Netherlands	17.7.2005	Spot	6			

[1)] In addition, Sendeco/New Values, Spain-the Netherlands; Ipex, Italy (spot trading) started in January 2006.
[2)] Situation 14 December 2005, source data Nord Pool.
[3)] Situation November 2005, source Fortis 2005.

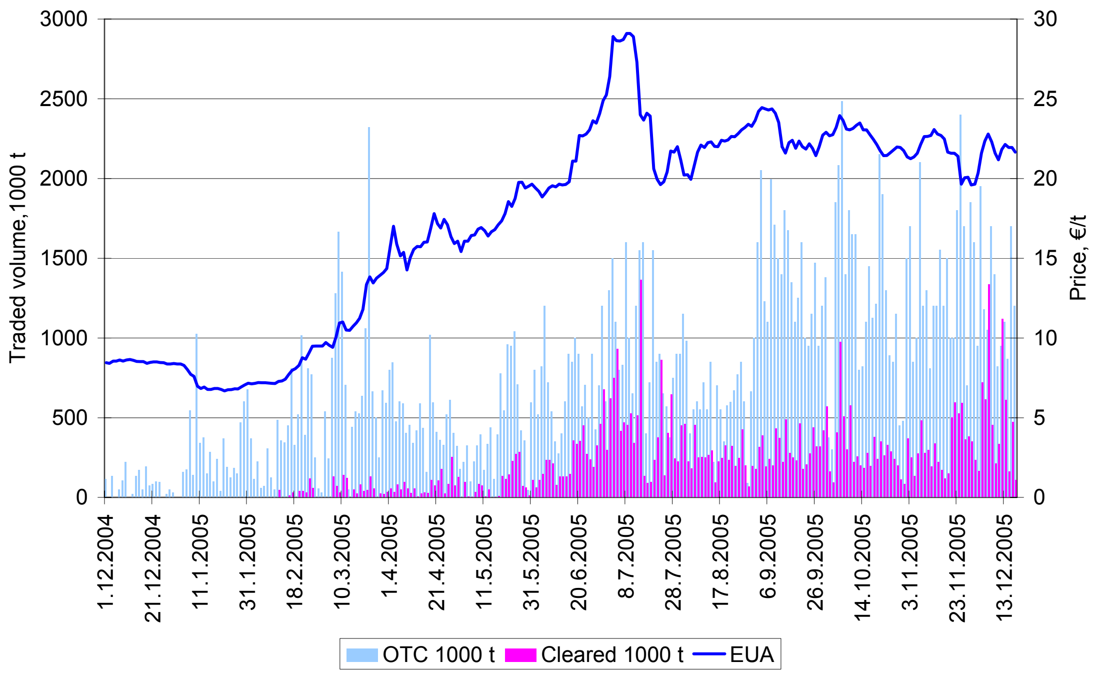

Figure 29. Development of emission allowances' price and trading volume (data www.pointcarbon.com).

The price of the emission allowances is determined on the international markets. During 2005–2007 the emission allowances market is EU-wide but during the Kyoto period other emissions trading systems may be linked to EU emissions trading. EC's linking directive (2004/101/EC) also permits trading carried out with credits from Kyoto mechanisms (Joint Implementation (JI), Clean Development Mechanism (CDM), Emissions Trading (ET)) to be linked to EU's emissions trading system. Drivers that affect the emission allowances' market price in the short-term include the relation between demand and supply of emission allowances, marginal costs for emission reductions in the market area and the functionality of the emission markets. In the long-term, the demand and supply of emission allowances will be directed by political decision-making, especially regulations related to greenhouse gas emissions. The demand for energy and thus also emission allowances is, on the other hand, also affected by economic growth and its structure as well as decisions related to energy supply and political steering. Linking other emissions trading systems and Kyoto mechanisms, especially JI and CDM, to the EU's emissions trading will probably also affect the market price of emission allowances.

The credits from the CDM projects, called certified emission reductions (CER), may be utilised already during the first trading period. The price of CER depends on the volume and the conditions of the sales agreement related to the delivery time of the CER. In December 2005, the CER price level was 6–10 €/t in agreements where no sales volume was included. A similar price level in an agreement where the CER seller commits to a certain sales volume at a certain time was 12–15 €/t CO_2. An increasing share of CER trading takes place within the higher price category (Point Carbon 2005b).

The price development of emission allowances in 2005 is presented in Figure 29 and the factors that affect the price are presented in Table 8. Figure 29 shows that the market price of the emission allowance has fluctuated heavily in 2005 hitting its highest level in early July and, on average, being 20 €/tCO_2 (during 14 February 2005–13 December 2005). The market price of emission allowances started rising in March-June after the EU Commission published cuts in the national allocation plans of Poland, the Czech Republic, Great Britain and Italy. The spring was colder than average and the summer was exceptionally dry in Central Europe. Energy consumption and the need for emission allowances grew and, on the other hand, low precipitation in Spain, for instance, decreased the production of emission free hydropower. The market price of oil and gas in Central Europe fluctuated but the price of coal remained relatively stable. With high gas price levels, energy production plants shifted to using more coal, which meant that energy producers needed more emission allowances. The emission allowances' market price reached its peak almost at 30 €/tCO_2 in July even though the price of oil and gas continued rising until October. The decrease in the price of emission allowances was, for instance, affected by the price of natural gas making a downturn.

Table 8. Factors affecting the price of emission allowances (+ refers to a small effect, +++++ refers to a significant effect).

Factor	Long term	Year 2005
Political decision-making	+++++	++++
Economic growth	++++	+
Price ratio between gas and coal	++++	+++
Oil price	++++	++
Outside temperature	+++	++
Rainfall and wind conditions	++	+
Market speculation	++	+++
CER entering the market	++++	

In the Kyoto protocol period, 2008–2012, Finland has an average of 70.5 million tonnes of allowed emissions. According to estimates, Finland's greenhouse gas emissions exceed the level of the Kyoto obligation by a total of 56 million tonnes, i.e., some 15%. As an annual average, the estimated emissions are approximately 11 million tonnes higher than Finland's commitment. According to the new energy and climate strategy, the Finnish state is prepared to finance approximately 10 million tonnes of credits acquired through Kyoto project mechanisms. The state also has an estimated 2.2 million tonnes of emission reduction units through the JI/CDM test programme during the Kyoto period. The reduction need for greenhouse gas emissions is thus approximately 9 million tonnes annually (KTM 2005b).

The Ministry of Trade and Industry has estimated the reduction need of emissions trading sector to be approximately 8 million tonnes p.a. so that the total amount of emission allowances distributed to the emissions trading sector is this much lower on an annual level than the estimated need. For industrial processes where the emissions originate from raw material or fossil fuel used in the process, the emission allowances are distributed based on the estimated need. The power plant's overall thermal efficiency is taken into account in the distribution of emission allowances, which promotes the combined heat and power production (CHP). The biggest reduction in emission allowances would thus be directed at condensing power production with a low thermal efficiency. The Finnish Emissions Trading Act is being revised in terms of the distribution principles of emission allowances and implementation of the linking directive. Within the framework of the linking directive, companies can also utilise JI and CDM projects in acquiring emission allowances. The Council of State makes the final decision on Finland's emission allowances allocation plan proposal, which must also include the maximum share of JI and CDM emission reductions in the total volume of emission allowances granted to installations (KTM 2005b, 2005c).

There are no international emission reduction commitments for the period following the Kyoto obligation period. The EU has, however, reviewed emission reduction paths in the magnitude of 15–30% until 2020 compared to the emissions of 1990. According to estimates, a 30% cut would mean that there would be 35 million tonnes less of emission allowances than the estimated need (KTM 2005b).

Emission allowance market is immature and the effect of the factors that affect the price of carbon is difficult to analyse within such a short timeframe. The number of players on the market in 2005 was relatively small and daily trading volume on the forwards markets varied between a few thousand tonnes to over one million tonne. In November 2005, the forward volume was approximately seven million tonnes and the volume on the OTC markets was nearly 30 million tonnes (Point Carbon 2005a). Because the trading volumes have been low, individual deals might have affected the price level easily.

According to the Emissions Trading Act, the Energy Market Authority acts as the national emissions trading authority in Finland. The tasks of the emissions trading authority include the granting of emission permissions and supervising them, maintaining the emission trade register and supervising the fulfilment of obligations arising from EU's emissions trading. Accounts are opened by the Energy Market Authority in the emissions trading registry for each installation that is issued an emission permit. The operators must annually submit an emission report on the carbon dioxide emissions for the previous year by the end of March. The amount of emission allowances purchased on the markets must also be reported. Plant-specific annual emission balance is public, but the data concerning purchased emission allowances are confidential for five years.

The supervision of EU's emissions trading should be further developed and transparency increased in order to minimise the possibilities of emission allowances price manipulation. A closer analysis of the effects of emissions trading would also require more extensive research.

4.2.2 Effect on electricity and fuel prices

The effect of emissions trading on electricity price can be described by three major factors: the market price of emission allowances, the specific emissions of electricity production and the emission allowance's passing through to electricity price. Emission allowances passing through to electricity price refers to the percentage share of the emission allowances market price that is transferred to the electricity price. Emissions trading also affects the demand for certain fuels and their price development, which in turn affects the production costs of electricity.

The emission allowance is a so-called opportunity cost for the company regardless of whether the emission allowances have been distributed for free or purchased for instance in an emission allowance auction or on the emission allowances market. Opportunity costs refer to the company being able to either use the emission allowance itself or sell it at market price. A company that operates financially sensible adds the total emission allowances' price to production costs when making (short-term) decisions, for instance, in terms of production or trading. If the emission allowances are distributed for free, to both old and new production plants, the free emission allowances can be considered to work as a subsidy, with which the company can compensate some of the fixed costs that would otherwise be covered solely by the income from electricity sales. Free emission allowances should, in theory, lead to investments and if there is a lack of capacity in the electricity markets the market price of electricity would decrease due to the investment. Distributing emission allowances for free does not, in theory, lower or neutralise the affect that the emission allowances' price has on the electricity price. If there is a lack of capacity in the electricity markets, free emission allowances act like investment support by lowering the fixed costs and the price of electricity may decrease through new power plant investments.

The passing through of emission allowances' market price to the electricity price is dependent on many factors of which the most significant are listed below (ECN 2005):

- electricity production structure in the market area
- structure and functionality of the electricity markets
- effect of outside electricity markets or competition
- market regulation and "voluntary" measures
- demand price elasticity
- initial allocation of emission allowances in later emissions trading periods.

Some estimates on the emissions allowances passing through to electricity prices have been made, they vary between 50–70% (ECN 2005, ECON 2005). The lowest estimates have been made for the Nordic electricity market area and the highest for the Central European electricity market area. In the Nordic markets, some 70% of production is CO_2 emission free hydro and nuclear power, and thus the effects of emissions trading on electricity prices is lower than, for instance, in Germany or the Netherlands, where the share of fossil fuels in electricity production is higher. In the Nordic markets, condensing coal power is a marginal producer for most of the year and the specific emissions of coal condensing power are high. So we can assume for this part that the effect of emissions trading on electricity prices is high, particularly in years with low precipitation when the share of coal condensing power production increases.

The structure and functionality of the electricity market also affects the passing through of the emission allowances' price. The number of market players (incl. horizontal and vertical integration), the capacity situation, how easy/difficult it is for new entrants to enter the market and market transparency are factors that should be taken into account when assessing the effects of emissions trading on electricity price. The effect of the electricity market's structure and functionality of the passing through of the emission allowances' price is most significant within the Nordic electricity market area but the structure and the level of competition of outside electricity markets in the EU and in Russia should also be considered when assessing the effects of emissions trading. The better the market functions the better the market price reflects the variable costs of the marginal producer. In this situation, the emission allowances' market price is added in total to the variable costs.

Figure 30 shows the prices of power derivatives on different European exchanges. The illustration shows that the derivative prices of all electricity exchanges follow the market price of emission allowances. In addition, one can see that the market price level of Nordic power exchange is significantly lower than in other European electricity exchanges. Figure 31 shows the electricity spot price and forwards price in the Nordic markets. At the estimated approximately 35 €/MWh price level, the additional price brought by emissions trading could be 10–15 €/MWh (KTM 2005b). In 2005, the level of water reservoirs has still been the factor to affect electricity prices most, since the electricity price was at its lowest in summer 2005, despite the record price level of emission allowances.

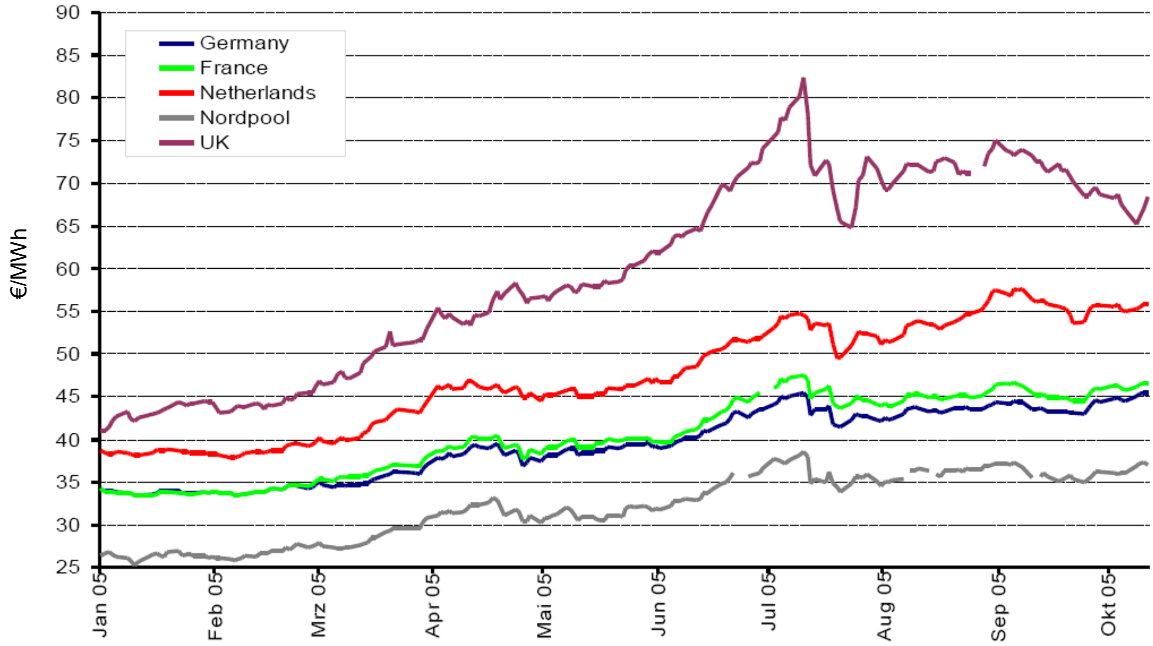

Figure 30. Price of power derivatives on European electricity exchanges (RWE 2005).

As explained above, the fossil fuels market prices affected the market price of emission allowances in 2005. Figure 32 shows the development of the emission allowance market price, fossil fuel and electricity market price in Central Europe in 2005. The illustration shows that the price fluctuation in emission allowances is clearly bigger than for fuels or electricity. Essential is the price ratio between natural gas and coal, which affects the fuel switch and therefore the demand as well as price level of the emission allowance.

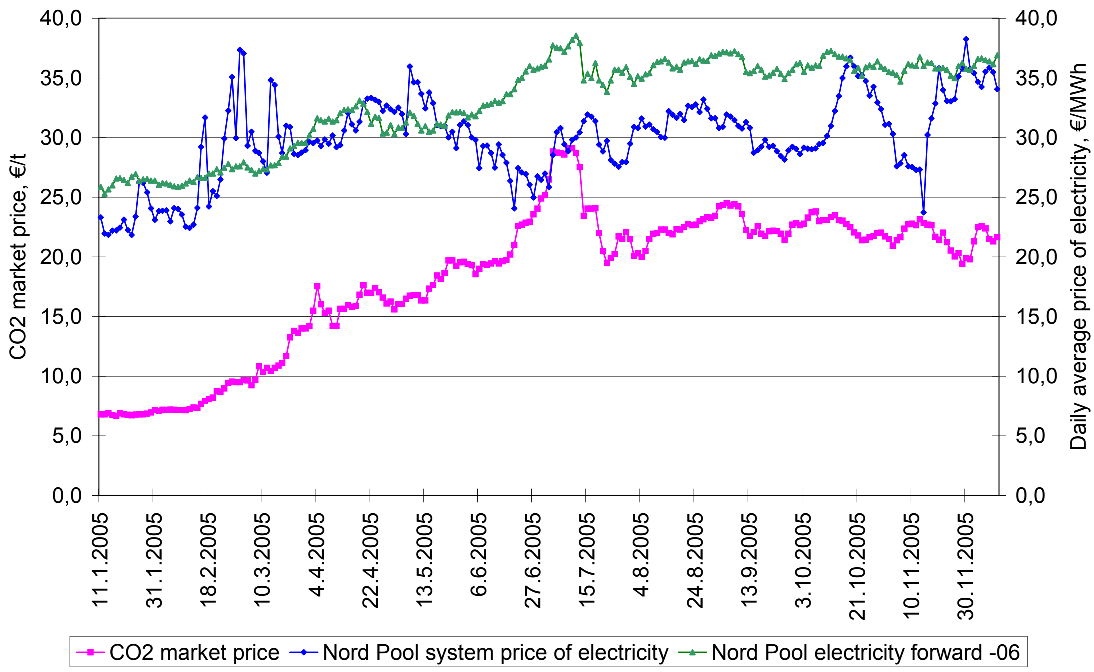

Figure 31. Emission allowance market price, electricity spot and forwards prices on Nord Pool.

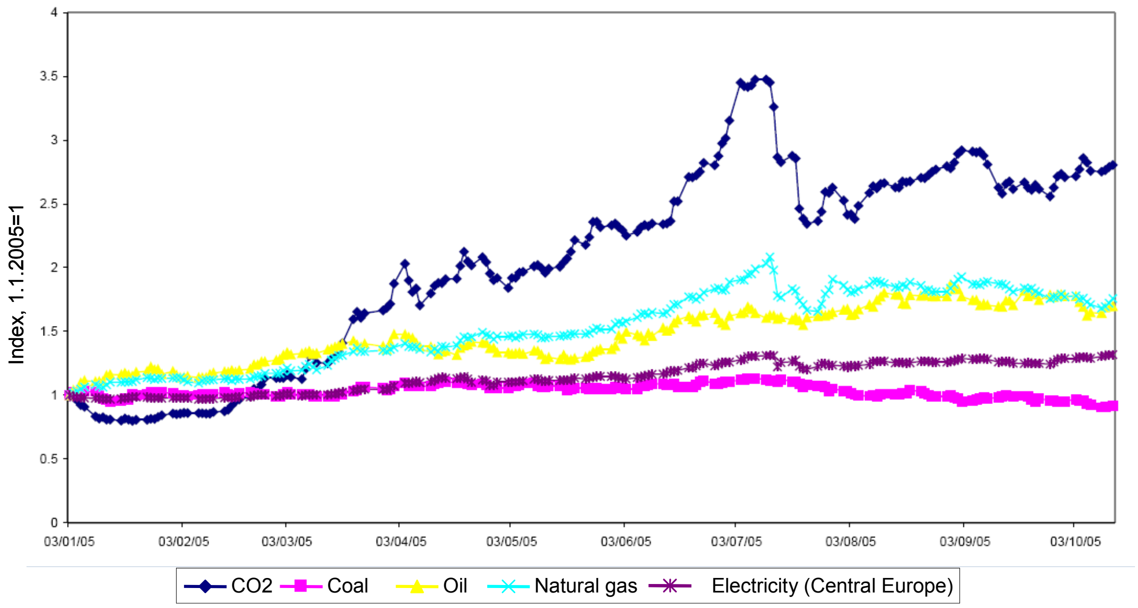

Figure 32. Market price development of fuels and emission allowances on the European markets in 2005 (Shell 2005).

On the other hand, the price level of the emission allowance also affects the demand of different fuels in electricity production. At high emission allowance prices, the share of more expensive fuels with lower specific emission rates increases in electricity production, which in turn increases the electricity price. Earlier studies have found (Koljonen et al. 2004) that in the Nordic electricity market area, the production of natural gas condensing power becomes more profitable than coal condensing power production at an emission right market price of higher than 30 €/t if the natural gas price level compared to coal is moderate (e.g., the situation in 2003–2004). Because the specific emission rate of natural gas is lower than that of coal, the passing through of the emission allowance price to the electricity price is lower so the effect of emissions trading on electricity prices is also lower.

Emissions trading has weakened the competitiveness of fossil fuels and thus raised the willingness to pay for renewable fuels. In Finland, this has been visible as a price rise in wood fuels and their increased use. In this sense, emissions trading has worked as intended. In Finland, high emission allowance prices may lead to a situation where wood raw material is directed towards the energy sector in great volumes. The first production cuts in the forest industry due to wood raw material price rising too much occurred at board mills, in the production of chemical pulp from sawdust from sawmills and the use of tall oil. If emission allowances remains close to the 20 €/t level, part of fibre wood is also directed towards energy production. Subsidies and taxes can be used to prevent unwanted development in view of business economics and the national economy.

In Finland, peat has lost most of its competitiveness, which, with current emission allowance prices, is a cheaper option in CHP production than coal, especially inland. In terms of the regional and national economy, it would be justified to maintain peat's competitiveness as more attractive than coal also in condensing electricity production.

4.2.3 View on windfall profits

In this context, a situation in emissions trading where the producer, based on emissions trading at the authority decision, receives a higher price for its product without any of its own actions, is called windfall profit. Allocation of free allowances to operators may be considered as a subsidy for the producer and therefore called windfall profit as well. Similarly, combining emission allowances trading and electricity markets with other markets outside the Nordic countries makes some completed investments unprofitable. Such costs are called stranded costs. In the Finnish energy system, condensing power plants are ending up in this situation.

The term windfall profit has been used in many connections. When the United Kingdom privatised its state-owned companies, an extraordinary windfall tax was ordained on the value increase experienced by the companies (Chenells 1997). In 2005, windfall profits were fervently debated both in the EU in connection with carbon dioxide emissions trading and in the US in terms of the additional profits gained by oil companies partly due to the hurricane damages in the autumn of 2005 (Financial Times 2005, The Economist 2005). In the US, exceptionally high oil company profits have already been taxed during the 1980s.

Confusion is caused by the fact that the free allocation of emission allowances is considered to cause windfall profits. In functioning electricity markets, the price of the emission right is an opportunity cost that is transferred to the electricity price in full regardless of the emission allowances being free or paid for. The EU emissions trading was originally assumed to raise electricity prices and this price rise was assumed to act as an incentive for less emission rich solutions. Only later have some parties suggested windfall taxation as a fiscal measure for the state.

Due to EU emissions trading, several countries have suggested that windfall profits should be cut, for instance, through taxation. Sweden is raising its property tax for hydro and nuclear power plants as well as its power tax for nuclear power. Ireland has earlier suggested legislative measures to direct electricity companies' windfall profits towards decreasing the retail price of electricity and, to some extent, towards energy research.

In the electricity markets, windfall profits can be seen as a structural joint effect of two systems, the emission markets and the electricity markets. The effect is hard to prove and even harder to measure or direct the generated windfall advantage to different players (Määttä 2005).

The conclusion of this study is that a windfall tax should not be implemented. Emissions trading has created an investment incentive in the electricity price and taxation of this incentive would decrease the desired effect by further decreasing investment willingness. It is difficult to implement the taxation so that the collected funds would be returned to development of the energy sector in accordance with the climate targets.

The study (Kara 2005) mentions a windfall incentive. The idea is that the state should invest in technology that reduces emissions and, with reservation, it was stated that the funds for the investments could come from windfall taxation. It has been stated (Honkatukia 2004) that additional taxation of the energy sector for fiscal purposes cannot be justified through the realisation of energy and climate policy targets.

If windfall profits are to be cut, the income should be directed towards covering the main stranded costs of the energy system. In Finland, this would mean an obligation to keep condensing power plants in the system. Maintaining condensing plants in a ready-for-use state is important for ensuring the security of supply of our energy system. This also benefits the consumer because electricity price levels and price fluctuations would increase without the condensing plants.

5. Self-sufficiency

In the past ten years, the energy markets have become deregulated. This has partly lead to a decrease in self-sufficiency and security of energy supply. On the deregulated markets, companies are no longer able to voluntarily maintain a higher capacity than what is required by the market and its customers. Part of the constructed production capacity has even become a financial burden for companies and maintaining this capacity in the system can no longer continue from business economical viewpoints.

Emissions trading has, for its part, raised the electricity price and changed the competitiveness of different forms of electricity production. Finnish condensing power production is in an increasingly poor position. Several players are considering removing the plants from constant production readiness.

CHP production is based on the heat load. In Finland, the heat loads in both industry and communities have been gathered in an exemplary fashion. For instance in Sweden, combined electricity and district heat production is relatively smaller than in Finland. There is good reason to say that the heat loads of CHP production in Finland are sort of an extra indigenous energy source of electricity production. The preconditions for CHP production must be cared for. The possibility of a CHP production power plant to produce segregated electricity offers a lucrative opportunity to build reserve capacity for electricity production.

5.1 Effects on the competitiveness of indigenous energy

Finland’s dependency on natural gas and electricity imports has increased constantly. The share of imported energy in Finland’s total energy balance in 2002 was 76%. More than half of Finnish energy imports come from Russia. Figure 33 shows that the Finnish electricity balance has constantly shown deficit. Due to emissions trading, higher fuel prices and shutdown in the Finnish paper industry and the share of import in electricity used in Finland has increased.

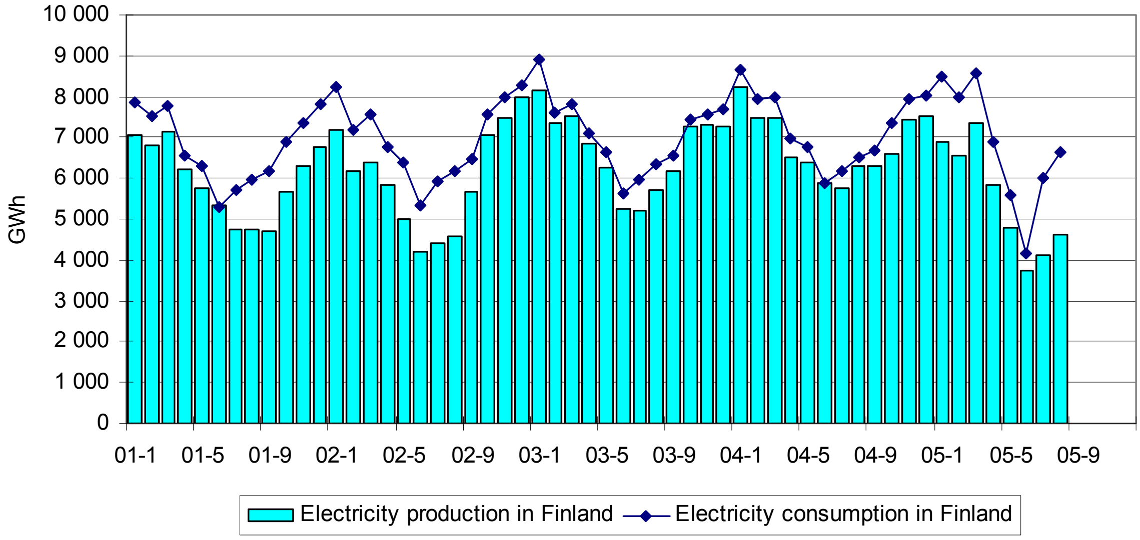

Figure 33. Electricity production and Finnish electricity consumption on a monthly level 2001–2005.

The competitiveness of condensing electricity produced with peat compared to coal has depended on coal prices, which has fluctuated between 4–9 €/MWh_{pa} during the past ten years. The varying production cost for peat condensing has been lower than that of coal condensing, when the price of coal has exceeded 6 €/MWh_{pa} (KTM 2005a). In 2005, the price for coal was approximately 7.5 €/MWh_{pa} in electricity production (average coal price at coastal plants). Emissions trading has weakened the competitiveness of peat compared to coal because the specific emission rate of peat is higher than that of coal. Figure 34 shows the competitive situation of fuel at an emission allowance price of 20 €/tCO2. As the price of the emission allowance rises the competitiveness of peat weakens if the price ratio between coal and peat does not change dramatically.

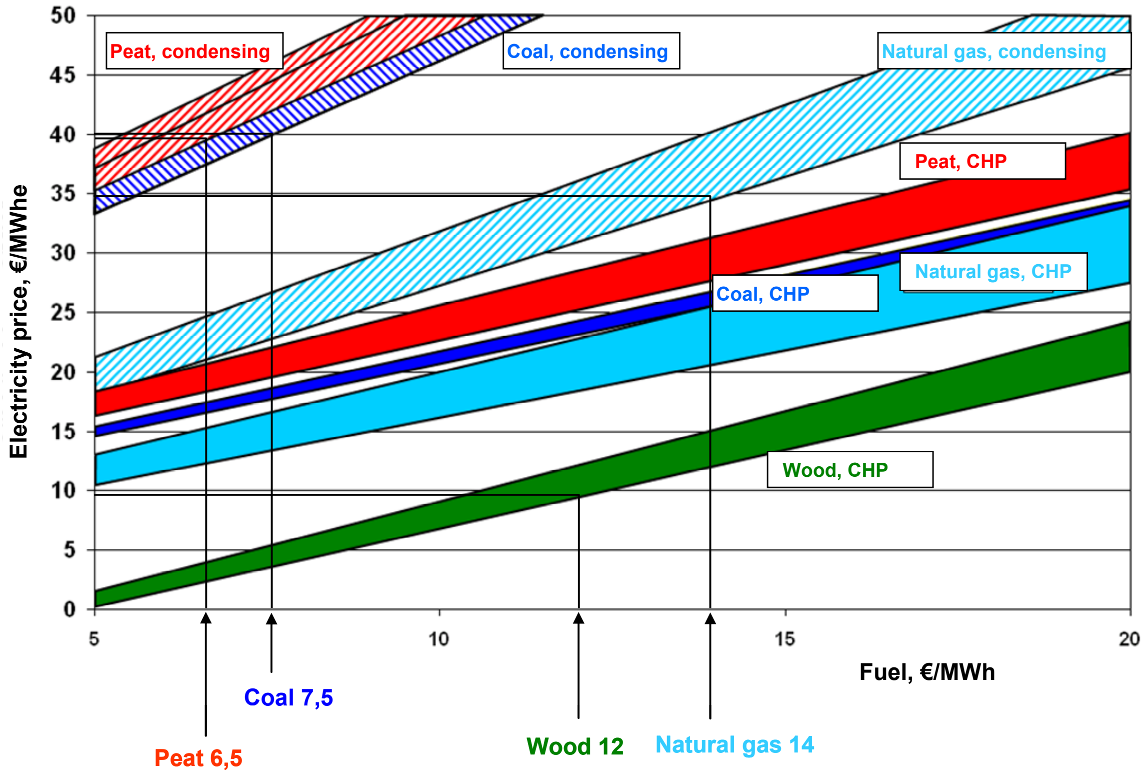

Figure 34. Competitiveness of electricity production forms with different fuel prices. Price of emission allowance 20 €/tCO_2.

In 1995–2004, an annual 4.0–6.9 TWh of electricity was produced from peat. In 2004, 6.2 TWh of electricity was produced from peat. The amount of condensing electricity produced from peat in 1998–2004 has fluctuated between 1.0–3.7 TWh (KTM 2005a). The amount of electricity produced from peat has depended on the precipitation situation. In the longer term, the competitiveness of indigenous renewable energy sources will improve due to emissions trading.

There is only one condensing power plant in use for peat condensing production, Haapavesi, and three large plants that also produce heat, as well as several small CHP plants with the option to produce condensing. Haapavesi cannot, in practice, use any fuel other than peat, while the other plants can compensate some of the peat with wood or coal. If coal becomes cheaper fuel for condensing production than peat due to the price of emission allowances, then some of the peat condensing capacity will be removed from use and part will use mainly imported fuel. Supporting peat condensing production so that peat condensing comes before coal in the merit order would be enough to maintain capacity and to maintain the production, storage and transportation chain of peat. The users of peat should, in addition to the producers, partake in the costs caused by large fluctuations in production and use through, for instance, the price structure of peat that would include a share consisting of fixed and variable costs. Maintaining peat condensing in the electricity production structure replacing import fuel and electricity can be justified through self-sufficiency, security of supply and regional economy aspects.

Emissions trading is not a big enough incentive for investments of small plants that produce electricity and heat based on renewable energy sources. Most other countries use fixed price feed-in tariffs or green certificates, however, in Finland, investment subsidies have proven an effective incentive that do not disturb the markets, which have also proven highly cost effective.

5.2 Risks related to energy imports

Finland is fully dependent on the international availability and price development of oil, coal, natural gas and nuclear fuel. The share of these energy sources in Finnish energy supply is 60% (KTM 2005c). For instance, traffic fuels and nuclear fuel are fully imported from other countries and they cannot be quickly replaced with other sources. Part of the imported fuels, like coal, natural gas and oil, can, for the most part, be replaced with another imported fuel, and in the longer term partially with indigenous fuels.

Nuclear fuel is extremely low in emissions throughout its lifespan and its demand on the international markets has started growing clearly. The price of nuclear fuel reached its minimum at the turn of the century and will continue increasing in the future. The speed of the change cannot be predicted but no actual threat is visible.

Emissions trading has a huge effect on coal use. Emissions trading has already restricted the demand for coal in Europe. On a global scale, the use of coal is, however, increasing quickly and coal will be the main fuel for centuries to come due to its sufficiency. In Finland, the position of coal will be significant in the future as it cannot be fully replaced by, e.g., security of supply stockpiles. Technology development will make coal use more efficient in the long-term. Separating the carbon dioxide that is generated when burning coal from flue gas and storing it may create the possibility to reduce the carbon dioxide emissions related to coal burning considerably.

The price of oil and natural gas develop similarly in the global markets. Oil demand grows considerably. The marginal costs for increasing oil production rise because new production areas are increasingly difficult to utilise. Refinery capacity also restricts the ability to satisfy increased demand. Oil prices will rise in the long-term. In Finland the share of oil in total energy consumption has, since the 1970s' oil crisis, decreased and is currently approximately one quarter. Oil is necessary for Finland as a traffic fuel, but the share of oil as a heat source should decrease clearly. The retail price of light fuel in Finland is approximately 40% lower than in Sweden, Norway and Denmark due to lower taxation (Kara 2005). The taxation of light fuel should be raised to restrict the choice of heating options that are based only on oil.

In traffic, bio fuels that could be used to replace oil are still expensive. The product development of such products should be supported. The production costs of bio fuels are being lowered by, for instance, finding operating models where production would be combined with industrial and power plants and by utilising wood- and waste-based raw materials.

The price of natural gas fluctuates regionally because it is more difficult to transfer natural gas than oil. The transporting of liquefied natural gas by ships is turning natural gas into a fuel comparable to oil in the global markets. In Europe, emissions trading further increases the demand for natural gas. Increasing the production of gas used in Europe is mainly only possible in Russia but even there with considerably high border costs, the construction of transmission links is also increasingly expensive. Finnish natural gas supply is purely dependent on Russia.

All Nordic countries expect electricity imports to grow, which is, however, an impossible equation. Increasing electricity imports requires the strengthening of transmission links and this certainly has a positive effect on security of supply of electricity – but securing reserves are still needed. Slow reserves are a bigger problem in Finland than in Sweden and Norway, which have large reservoirs and Denmark that has relatively more CHP power plants in production system. The growth in electricity imports is restricted by the integration with the Central European electricity markets, which raises electricity prices and electricity exports from Finland as well.

Electricity imports from Russia have been cheap. It is presumable that in the future the price will approach the general market price. Russia also offers several cooperation possibilities as a country that is not part of emissions trading scheme. Hydropower and other production capacity may be built across the eastern border if the network investments remain moderate. In the future, a larger proportion of the price rise caused by emissions trading in electricity and natural gas is likely to slip to Russia because our import dependency on Russia is so large.

The buying of emission allowances seems necessary and it weakens the foreign trade balance. The use of Kyoto mechanisms is justified as the costs for reducing emissions in Finland are clearly more expensive than the emission allowances to be acquired.

Finland is extremely dependent on energy imports. In accordance with the Government Decree (350/2002), indigenous energy production and the use of indigenous fuels must be developed to ensure energy supply.

In the short-term, emissions trading decreases and has already decreased self-sufficiency and the security of energy supply as the competitiveness of peat has weakened. In order to prevent an increased dependency on imports, a mechanism must be developed that makes peat condensing power more profitable than coal. The use of indigenous renewable energy source must be increased. In the long-term, emissions trading is assumed to improve energy security of supply because its raises the electricity market price, which in turn improves the competitiveness of renewable energy.

5.3 Effects on security of supply

Due to the deregulated energy markets and partly to the emissions trading, the security of supply produced by the energy markets and the ability to handle temporary disturbances has constantly weakened.

Supply problems in imported fuels (coal, natural and different oil products) are being prepared for by storing fuel in security stockpiles. It is important, in terms of security of supply, that the necessary or replacement fuel can be stored in Finland. Currently, 80% of security stockpile fuel is oil and 20% is coal (KTM 2004d). Storing natural gas is not economically viable so plants that use natural gas are constructed so that the fuel can be replaced. The use of peat as stockpile fuel is restricted as peat has low energy density, storage loss and the production of peat depends on weather conditions.

Most worrying in terms of security of supply has been the considerable decrease in commercial fuel storages. The average storage level of crude oil and oil products halved during the late 1990s. Coal was, in the early 2000s, still in a better position but already then the increased electricity imports lowered the use of coal heavily.

The Government Decree on the security of supply targets requires that our country has an average import fuel storage that suffices for five months of normal consumption. In the current system, coal obligation stockpile is based on the assumption that coal is used for energy production in normal conditions. Due to increased fuel prices and carbon dioxide emissions trading, the use of coal is, however, clearly decreasing and coal obligation storage will dissolve as the use of coal decreases.

The final report of the workgroup set by the Ministry of Trade and Industry in October 2002 to study the restriction of using coal also discusses security of supply (KTM 2004d). According to the workgroup, it should be monitored whether coal remains a securing stockpile fuel in Finland in an emissions trading situation in order to ensure security of supply. If the use of coal is replaced with natural gas, the security stockpile of its reserve fuel must be ensured.

According to the National Emergency Supply Agency's target report (Huoltovarmuus-keskus 2001), when the use of natural gas increases from 4 billion to approximately 8 billion cubic metres, we must focus on security of supply. The security of fuel supply can, in such a decision, be based only on indigenous fuels, nuclear fuels and the security stockpile of oil products.

According to the workgroup that studied the restriction of coal use, coal can also be used on the so-called principle of similar storage. In this case, the heat production of a CHP power plant that runs on natural gas is handled locally, for instance, by power plants and heating plants that run on other fuels. Electricity produced from natural gas can be produced elsewhere with coal in condensing plant (KTM 2004d).

6. Conclusions

The long-term targets of the energy and climate policy have been a diversified and secure energy system and to maintain the generated environmental emissions within the limits of our international commitments. The energy policy aims at promoting the use of indigenous energy sources and renewable energy as well as increasing self-sufficiency. In addition, new energy technologies should be promoted and taken into use and energy markets should be made more efficient especially from the viewpoint of competition. The energy policy measures include energy subsidies and taxes. These control measures have been used to spur the use of, for instance, building additional power production capacity based on renewable energy and the industry is ensured a competitive electricity price by maintaining a lower electricity tax for the industry than for other consumers and returning some of the paid taxes. Energy taxes form a considerable share of the state income.

The Finnish electricity market was deregulated in 1995. The objective was to improve the functioning of the electricity market so as to secure sound and well-functioning economic competition in electricity generation, transmission and distribution systems in Finland also in the future. Simultaneously, the electricity markets were integrated with the Nordic electricity markets. Opening the market naturally reduced the state's direct steering possibilities in electricity production, sales and international trading.

The national power company Imatran Voima merged with Neste in 1998 and the new company, Fortum, was listed on the stock exchange. In 2005, the Finnish state only owned slightly over half of Fortum. The income from selling Fortum shares has been transferred outside the energy system. France is only now privatising its national energy company EdF. The income from selling a 15% share will be returned to the energy system in investments. The Swedish and Norwegian states have decided to keep ownership of their national power companies and Vattenfall and Statkraft are fully state owned.

The European Union's emissions trading that began at the beginning of 2005 is a change comparable to the deregulation in the operating environment. The aim of the Emissions Trading Act is to promote the reduction of greenhouse gas emissions cost effectively and economically. Emissions trading in itself ensures that the carbon dioxide emissions of the emissions trading sector remain within the targets of the international agreements. The prices of emission allowances have been higher than anticipated and, in the summer of 2005, the price hit 30 €/tCO_2. The price of emission allowances is passed through to the electricity price and certain electricity producers have gained large profits. Similarly, the price of electricity has increased for most electricity consumers. The electricity price rise caused by emissions trading will, in Finland, be partly compensated by decreasing the electricity tax paid by industry.

The income transfer caused by emissions trading is only one of the problems seen on the market. Electricity production capacity has not been built much in Finland or other Nordic markets since the market was deregulated. Finland's dependency on electricity imports, particularly from Russia, has increased. Coal and peat condensing power that was used as basic power production before the electricity market was deregulated has not been run much in the past year due to higher fuel prices, emissions trading and the good precipitation situation in Norway. In the short-term, emissions trading decreases self-sufficiency, and electricity imports have increased and the competitiveness of peat has decreased. One might ask whether the energy policy targets are being realised.

The power exchange drives the use of power plants effectively

The Nordic power exchange, Nord Pool, is generally considered well functioning. In 2004, 43% of the electricity used in the Nordic countries was sold through the exchange and the price of electricity on the Elspot markets is generally considered a price reference also for trades outside the exchange. The Nordic electricity exchange, Nord Pool, controls the operation of the existing power plant capacity based on the order of the plants' variable costs well. The exchange is also used to effectively control the use of water reservoirs. The exchange's price formation mechanism is correct and working in the short-term.

Hydropower produces a considerable share of the electricity used in the Nordic countries. The precipitation situation thus affects the Nordic electricity price considerably. In good precipitation years, electricity is cheap. During poorer precipitation years, more electricity must be produced with more expensive production forms such as condensing power. In this situation, the electricity price rises. It is important that the electricity price rise caused by the precipitation situation is not interfered with as the high price level in poor precipitation years brings balance to the more expensive power production capacity used at this time.

One of the biggest problems in the Nordic electricity market is the concentration of electricity production to a few companies. Large national power companies dominate the markets and it is difficult for new players to enter the market especially by building new capacity. On the other hand, it does not make sense to split the companies into smaller ones as this would weaken Fortum's, Statkraft's and Vattenfall's competitive preconditions in the integrating European electricity markets. An oligopoly situation demands special interest from authorities that supervise competition.

Nord Pool operates under Norwegian law and supervision is the responsibility of Norwegian authorities. The ownership of Nord Pool AS, the exchange for physical electricity trading, is not divided evenly between the national system operators that trade on the exchange, as Sweden's and Norway's national system operators have larger shares than Finland and Denmark.

The executor finds that:

- The cooperation between Nordic authorities in supervising the exchange must be developed.
- The transparency of exchange trading must be promoted. The announcement of power plant disturbances must be expanded to smaller players in view of equal treatment. The limit could be, for instance, 100 MW instead of the current 200 MW.
- Increasing demand price elasticity would decrease the possibility of large electricity producers to use their dominating market position to manipulate prices and improve the possibility to manage peak load situations.
- The market functions could also be improved by alleviating new players' entrance to the market. This requires further study.
- Economic theory based instruments that depict oligopoly electricity markets should be developed to help market surveillance.
- In order to ensure equality, Nord Pool AS' ownership should be divided equally between the Nordic system operators.
- The exchange must offer products based on demand.

Electricity transmission and the effects of transmission capacity on Finnish electricity prices

In Finland, electricity transmission is the responsibility of Fingrid Oyj. Fingrid's owners are the large electricity producers Fortum Power and Heat Oy and Pohjolan Voima Oy both with quarter shares. Of the voting power, these two companies have a total of 66.88%. In Sweden and Norway, the national system operators are fully state owned. The interests of electricity producers may sometimes deviate from the interests of the system operators.

There are occasional situations in the electrical power network where the transmission need in a certain part of the network exceeds the existing capacity. The maximal transmission capacity of the connections varies depending on the load and production situation and it is restricted either by the connection's physical transmission capacity or the system's stability. When the transmission capacity proves insufficient, the bottleneck is cleared either by counter purchases or by dividing the different sides of the bottleneck into different price areas. The basic principle is that the price areas are used when the bottleneck is structural and appears between pre-determined areas, i.e., to clear bottlenecks between countries and internally in Norway between certain areas, in practice. Counter purchase is used to clear bottlenecks within a price area and when the bottleneck is generated within an operating hour. The system operator pays for the counter purchases and the bottleneck is not visible in the electricity market price.

When Finland forms its own price area, the Finnish area price is nearly purely formed by sell and buy bids made by Finnish players. The Finnish area price has, in the past years, often deviated from the Swedish area price: in 2003, 29% of the time and in 2004, 24% of the time. Sweden very seldom forms its own price area due to its central location and several cross-border links.

In the autumn of 2005 there were several extremely high price spikes. Previously, bottlenecks mainly occurred in an export situation from Finland to Sweden, but now they have also occurred in import situations due to heavily increased imports. The Finnish area price climbed to an all-time high at 1147 euros/MWh on Thursday 8 December 2005. The Swedish price at that time was slightly lower than the system price at 35.60 euros/MWh. The difference between the Finnish and Swedish area prices was affected by the Swedish system operator's, Svenska Kraftnät's, operating method to transfer internal bottlenecks to the country's borders.

When Finland is separated into its own price area, the domestic electricity market becomes highly concentrated and the large players can affect the area price, particularly predictable bottlenecks may affect the bidding by the players. The concentration of the markets is increased by the fact that it is not worthwhile for small- and medium-sized electricity producers and consumers to trade on the exchange because the exchange's trading fees are high.

Limited transmission capacity between price areas restricts the export and import and the strengths of different price areas in terms of production forms cannot be fully utilised. During export restrictions, producers are not always able to sell the desired amount of cheap electricity to neighbouring areas which means the price in the own price area decreases. Similarly, in an import situation, consumers have to buy electricity at a higher price within their own price area as they cannot get the cheaper electricity from the neighbouring area.

New transmission connections will also be needed in the future due to the free markets, increasing consumption and increased regional production deficits. Traditionally, the system operators to whom an investment applies directly have together agreed on investment and cost division. The Nordic system operators have, for the first time, agreed on five transmission link investments (Priority Cross-sections), which will partially be financed by bottleneck profits accumulated from the market players. This is extremely positive in the current, contradictory situation where new transmission links reduce the profit accumulated from bottlenecks to system operators. In its decision of 18 December 2001, the Energy Market Authority found that Fingrid should use its bottleneck profits primarily for transmission capacity increase investments and if the transmission capacity is considered sufficient in view of average transfer volumes, the profits should be used to lower the main grid tariff. In terms of market functionality, it is desirable that the same principle be followed in all Nordic countries.

The executor finds that:

- The owners of the national system operator, Fingrid, should not be large electricity producers in order to ensure equality in operations.
- The system operators must agree on the principles for exports, imports and transit transmission and compensations between system operators so that the internal bottlenecks are cleared where they occur and not transferred to the borders. The transmission link investments between countries must be used to the full.
- The bottleneck profits accumulated from area prices must be used in full to strengthen the transmission links between the countries.

New market-based capacity is not really generated

One of the targets of the deregulation of the electricity market was to make the use of existing plant capacity more efficient. The over-capacity that prevailed in the 1990s has now, however, turned into a situation of scarcity in capacity. In 1995–2004, the electricity consumption of the entire market area has grown by an average of 1.3% p.a., the maximum system load by 3.1% p.a., but the installed capacity has only grown by 0.4% p.a.

There is only relatively short experience of the operation of deregulated electricity markets. It seems, however, that hardly any new power plant investments are on the way. One could say that the market structure and the subsequent electricity prices do not encourage the building of new capacity. The responsibility for the electricity system having enough capacity is ultimately the authorities' responsibility.

The electricity price rise caused by emissions trading and free emission allowances partially act as an investment incentive. Power plant investments are, however, so long-lived that a better return in the short-term does not have much effect on the willingness to invest. Uncertainty about how greenhouse gas emissions will be restricted in the future is a huge risk for anyone who builds a power plant.

The executor's view is that:

- Political decision-making that applies to the energy market supervision methods must become more persistent.
- Investments that increase electricity production capacity (especially CHP production plants and their auxiliary condensers and auxiliary coolers) should be encouraged, for instance, with the initial allocation of emission allowances.
- In Finland, energy production subsidiaries, for instance, in renewable energy are at a moderate level in European comparison. This should be the case on the free markets but this leads to investments being directed outside Finland.

Competitiveness of condensing power plants

The competitiveness of Finnish condensing power production is not sufficient in normal or high precipitation years. Emissions trading and high fuel prices have weakened the competitiveness of these plants.

The market price of electricity on the Nordic power exchange decides the profitability of running the plants and the merit order and plants have to be started up and shutdown more often. Before the market was deregulated, one party decided how plants were run. In this way, condensing power plants that were designed for stable running were kept running throughout the winter season. The current running of condensing power plants deviates from the plans considerably. The plants are only started up when the market price of electricity is estimated to stay above the plant's variable costs and the fixed costs related to the starting up of the plant for long enough. In previous years, the amount of electricity produced in Finnish condensing plants has varied by as much as 15 TWh from one year to another.

The cold start-up of the condensing plant takes approximately one day depending on the plant and each start-up corresponds with hundreds of hours of operation at constant capacity in terms of the service life of the plant's boiler house and turbine installation. Start ups and capacity changes increase emissions.

In the Nordic hydropower dominated system, reserve capacity, like condensing power plants are needed and they are run throughout the winter season only in poor precipitation years. During dry yeas, the electricity price must rise to a high level in order for the running of these plants to be profitable. A majority of condensing plants are reaching the end of their service life and it is not worthwhile to build new similar plants in the current system.

There is reason to seriously doubt that the deregulated electricity market will lead to an unsatisfactory situation in terms of the functionality of the electricity systems and electricity prices due to a reduced share of condensing power capacity.

If the Finnish condensing power capacity is removed, the security of supply of Finnish electricity during dry precipitation years becomes threatened. For instance in Sweden, the national system operator Svenska Kraftnät has taken production that was moved to long-term reserve back into stand-by conditions.

The executor's view is that:

- The state must react if condensing power plants are removed from use. The plants must be kept in readiness for security of supply reasons.

Emissions trading is a severe control method

Emissions trading and the electricity market operate correctly together: the price of the emission allowance must be transferred to the electricity price, which is already the case. The prices of emission allowances are now clearly higher than anticipated, which means that the effect of emissions trading on, e.g., electricity prices has been higher than expected. A majority of the company profits generated from the higher electricity price is directed towards Norway and Russia, and they are not increasing the investments in lowering emissions in Finland.

The emission allowances market is only now developing. The volume has been low, volatility high and prices high. In 2005, there were only a few players on the market as several EU states were not yet part of the market. The emission allowances market is not transparent enough, and the markets offer the possibility of manipulating the price level of emission allowances and thus also electricity. The functionality of the emission allowances market should be made more efficient.

The precipitation situation still has the biggest effect on the Nordic electricity price. In a dry year, the price level could have risen even more due to emissions trading.

The electricity price that is rising thanks to emissions trading accelerates the transfer of energy intensive industries to countries outside emissions trading agreements. This may result in an increase in total emissions if industrial production is transferred to countries with slacker emission and energy efficiency norms.

The executor finds that:

- The effect mechanisms of the emission allowances market is not yet known well enough. The emission allowances market is immature and market operations should be developed.

Electricity producers' windfall profits

The electricity price rise caused by emissions trading benefits electricity producers. The idea behind the emissions trading system is that the higher electricity price encourages a reduction in emissions. In the Nordic markets, the problem is that it is impossible to build new hydropower that is emission-free on a larger scale. More nuclear power could be built in Finland but not in Sweden. The additional profits gained by producers are not large enough to make the construction of power plants based on renewable energy sources profitable without subsidies. The electricity producers' profits are also partially affected by the free initial allocation of emission allowances.

Similarly, combining emission allowances trading and electricity markets to other markets outside the Nordic countries is making some completed investments unprofitable. Such costs are called stranded costs. In the Finnish energy system, condensing power plants are ending up in this situation.

This study does not recommend that the electricity producers' profits be taxed with a windfall tax. Taxing the profits would further reduce investment willingness and it is likely that such taxation would also further increase electricity prices. The additional taxation of energy sector profits cannot be justified by the realisation of the energy and climate policy targets. Fiscal taxation alone would not benefit the national economy considerably.

Electricity producers transfer a possible tax to the electricity price, which means the price paid by consumers would rise further. In addition, the investment incentive brought by the profits would disappear and it would be extremely difficult to carry out the taxation so that the funds would be returned to energy sector development in line with the climate policy targets.

The executor finds that:

- The electricity producers' windfall profits should not be taxed.
- If windfall profits are to be cut, the income should be directed to cover the main stranded costs of the energy system. In Finland, this would mean an obligation to keep condensing plants in the system.

Retail markets

In efficient markets, retail prices follow the changes in wholesale prices efficiently. In Finland, the changes in the electricity exchange price are transferred to small customers slowly and the price level does not necessary decrease much if the wholesale price falls. In Sweden and Norway, the electricity price of small customers follows the exchange price clearly more efficiently. On the other hand, the sellers' margin has not risen much in Finland so the inefficiency has not at least increased.

Small consumers have not benefited much from the open market. The biggest reason lies in low activity among customers; in 2004, only approximately 11% of small customers had changed their electricity supplier in Finland.

Smaller electricity producers, sellers and users cannot buy or sell electricity outside their own country as the cross-border cables are reserved for electricity transmissions required by exchange trades. The competition for small customers would become more efficient if electricity could be bought outside one's own country.

The executor suggests that:

- The possibility for small customers to buy electricity outside their own country should be studied.

Nordic energy taxation and subsidiary systems differ from each other

Nordic energy taxation and subsidiary systems differ from each other considerably. Sweden and Denmark support the construction of new production capacity clearly more than Finland. The countries' different energy policies also affect the selected electricity production forms. For instance, no new nuclear power plants can be built in Sweden.

The taxation systems should be uniform within one market area, which would mean that power plant investments would always be made where it is most profitable.

The Finnish energy taxation system favours certain fuels for historical reasons. The tax is usually determined based on the coal content of the fuel but natural gas receives a 50% discount. In addition, the taxation of fuel oil is clearly lower in Finland than in its neighbouring countries.

The executor's view is that:

- The harmonisation of Nordic energy taxation and subsidy systems should be supported.

- The line in Finnish energy taxation should be made more uniform. The tax concession for natural gas must be abolished and the taxation of fuel oil tightened.

Self-sufficiency

In the short-term, emissions trading increases Finland's import dependency. The competitiveness of condensing power produced with peat compared to coal is currently particularly weak. Even if the competitive situation for indigenous biomass fuels improves as the price of electricity increases, increasing volumes of electricity must be imported.

Finland is very dependent on energy imported from Russia, mainly electricity and natural gas. In terms of natural gas, the dependency on Russian imports is extremely high.

Coal and oil are used as security stockpile fuels in Finland. The security stockpile obligation of coal is currently based on the fact that coal is used as fuel for electricity production also in normal conditions.

The Finnish climate is cold and the security of supply of fuels used for heating must particularly be ensured. The thermal loads of CHP production act as an additional indigenous energy source in Finnish electricity production. The preconditions for CHP production must be cared for. The favouring of oil heating should be relinquished and indigenous heating options should be supported.

The executor's view is that:

- The risks of energy imports must be charted.

- The taxation of fuel should be changed so that the taxation of fuel oil is tightened and the tax concession on natural gas is abolished.

- The use of peat should be secured in electricity production and a mechanism for starting up peat condensing before coal condensing should be created.

- The investment preconditions for small electricity producing power plants must be improved.

The future of the electricity markets

After the markets were deregulated, the electricity price that has prevailed in the markets has not been enough to ensure power plant capacity development. Because not enough investments in new electricity production capacity is expected and the need for electricity increases further, the price of electricity will continue rising in the future. This is how the electricity market is expected to develop. The price development of electricity will not, however, be this stable and the price will fluctuate heavily and be difficult to predict.

In Finland, electricity has and will continue to be cheap compared to the Central European price level. As the integration of the electricity markets continues, the electricity price in the Nordic countries will continue to rise. In Central Europe, the electricity price level is higher than in the Nordic countries, which is caused by the low level of hydropower production. The integration of the markets will lead to scarcity in the integrated market's daily regulating power capacity. As prices increase in the Nordic countries, investments in new electricity production capacity become profitable, even though the investment preconditions are more favourable in the neighbouring countries than in Finland. Cheap electricity has been a clear competitive advantage for the Finnish energy intensive industry. The industry may transfer production to countries with cheaper energy when the electricity price rises.

Finland is committed to a tight emission reduction obligation during the Kyoto period 2008–2012. The EU's emissions trading system only covers part of the sectors and operations that generate emissions. There is reason to assume that after the Kyoto period, country-specific emission reduction obligation will be tightened further. We should prepare for this well in advance. The cheapest way in terms of national economy to implement the emission reduction obligations are based on cost efficiency and measures that take into account all operations that generate emissions.

The deregulation of the electricity markets and emissions trading have heavily reduced the state's ability to affect the development of the energy system and there really are hardly any means for influencing.

The electricity and emission allowances markets will, in the long-term, continue boosting electricity prices. Higher electricity prices will considerably and partly uncontrollably direct the development of our society's structure by decreasing the share of industry in our gross national product.

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Abstract

During 1995–2005 the Nordic energy system has experienced two major changes, the opening of the electricity market for competition and emissions trading within the EU. The European Union's emissions trading scheme (EU ETS) that began operating at the beginning of 2005 has weakened the competitiveness of Finnish electricity production and raised electricity prices. Most electricity producers have accumulated large profits thanks to higher prices. The payers have been nearly all electricity users. This report studies the effects of emissions trading on the electricity market and the functionality of the power market.

Very little investment has been made in power production capacity in the Nordic countries over the past ten years. Considerable increases have mainly been made in Danish wind power capacity. Simultaneously, the total consumption of electricity and maximum system load have increased more than installed capacity has grown. In the next few years the power and energy balances may be threatened.

In previous years, Finland has often been separated as its own market price area on the Nordic power exchange. The formation of price areas has been affected by the limited capacity in transmission interconnectors, network reparation work and the operating method of the Swedish national system operator, Svenska Kraftnät (transferring domestic bottlenecks to the borders). This study reviews the scale of price differences and the effect on market activities.

On the common Nordic electricity market, Finnish coal and peat condensing power capacity is mainly used during poor precipitation years. These plants were once built for base load production. Carbon dioxide emissions trading has further weakened the competitiveness of these plants.

The biggest problem for the Nordic power exchange, Nord Pool, is regarded to be that market concentration in electricity production is high. Market concentration decreases the investment willingness of existing players as new power production capacity would lower electricity prices. There are also high barriers for market entry.

Due to emissions trading and the good precipitation situation in the Nordic countries, a record level of electricity was imported to Finland in 2005, approximately one-fifth of electricity consumption. Approximately two-thirds of the imports came from Russia.

This study makes several improvement suggestions that would affect market activities. These include clearer financing principles for building new transmission lines, increased Nordic cooperation in power exchange surveillance and restraining the growth in electricity imports. The study also suggests that players who gain windfall profits should be obliged to maintain otherwise possibly unproductive condensing power plants in reserve.

Keywords
electric power, emission allowances, emissions trade, import, export, transmission, taxes, Nordic Countries, electricity markets, self sufficiency

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