TEN PERSPECTIVES on NORDIC ENERGY

Final report for the first phase of the Nordic Energy Perspectives project

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September 2006

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Preface

Nordic Energy Perspectives is an interdisciplinary energy research project which, from a holistic perspective, analyses and creates new insights into the consequences for energy markets and energy systems of the goals and instruments of energy policy in the light of new conditions. The project's aim is to provide better bases for decisions on energy and environmental policy at both national and international levels. It is intended to contribute to constructive dialogue between researchers, politicians, authorities and actors on the energy markets.

A first phase of the project has been carried out during April 2005 – September 2006. This report summarises the most important results.

The first phase has had some twenty financiers, most of whom have been represented on the project's board of directors. The board has held the overall responsibility for the project. The research co-ordinators have led the scientific work. The project managers have been responsible for coordination in the project. Together we have striven actively for rapid and extensive dissemination of the results. This clear distribution of responsibilities and the project's well-planned organisation have ensured that results and deliveries come on time and maintain high quality.

Around fifteen current research issues have been analysed. Some of these issues have been analysed in detail, while others have been studied more generally. This means that we can present a comprehensive flora of results in a number of areas, whereas in regard to other questions the analysis is less deep and the conclusions are not as firmly grounded. We have nonetheless chosen to present the entire range of results in this final report.

The results produced by the project's interdisciplinary research group have been examined and quality-assured, partly by the research co-ordinators from a scientific perspective, and partly at several conferences and workshops with participant experts in the field. The board has been careful not to place limits on “scientific freedom” and therefore the researchers, not the project as such, take accountability for the contents of this report.

An objective of Nordic Energy Perspectives has been to create a forum for fact-based discussion and dialogue between decision-makers and other energy actors from different disciplines and different countries. Today this forum is fully active. We are very eager that the forum should survive and that the discussion should continue concerning the themes treated by Nordic Energy Perspectives. Hence, for each of the chapters 1-17 below, we identify the researchers whom the reader can contact for further dialogue. To the chapter “Ten Perspectives in Nordic Energy”, pages 9-50, all researchers have contributed. Another means of contact is the project’s home page: www.nordicenergyperspectives.org.

We extend warm thanks to the project management as well as to all the researchers who have contributed to the project’s first phase.

For the project board in September 2006

Thomas Korsfeldt
Chairman

Content

Ten Perspectives on Nordic Energy

These “ten perspectives” on the development of the Nordic energy systems and markets summarise briefly the most important findings from the multi-disciplinary research and synthesis work of the first phase of the Nordic Energy Perspectives project. A more profound analysis and presentation of results is found in the different chapters of this report. The ten perspectives, which are based on contributions from the whole research group, have the following headlines:

- **Costly early learnings from the first year of EU ETS: Unforseen price levels hit industries hard**
- **Market based support schemes - do they really work as intended?**
- **New decade in the Nordic energy markets**
- **Reduced CO_2 emissions and more renewables - are we getting there or not?**
- **The interpretation of financial requirements acts as an impediment for environmentally sound investments**
- **Who should invest in infrastructure - private or public investors?**
- **Regulation is not the answer, but framework conditions should promote coordination - need for a visible hand?**
- **Increased infrastructure investments due to EU ETS and support schemes for RES**
- **Energy, welfare and industry - a complex link which is difficult for politicians to consider in the decision-making process**
- **”Fuel” for an energy policy discussion - a possible agenda for a Nordic discussion about energy policy perspectives**

Costly early learnings from the first year of the EU ETS: Unforeseen price levels hit industries hard

The first trading period of the European Union Emission Trading Scheme (EU ETS) was to provide a soft transition to the 2008-2012 period when the EU is committed by the Kyoto protocol to reduce emissions. The cost of the cap-and-trade system in 2005-2007 was expected to be modest: lenient caps, high shares of allowances allocated for free and a limited application was to achieve this. However, the combination of unforeseen development in fuel prices, an immature market with limited transparency, and the link between carbon prices and electricity prices, have had unexpected consequences, especially for power intensive industries. In the long term, the investment incentives of the EU ETS are also questionable.

Due to generous allocations and lack of fundamental market data, market prices were based on speculative information

When the verified emissions for 2005 were reported in April and in May 2006 for the first time in the EU ETS history, the consequences of the lenient caps and generous allocation were revealed. This caused the prices of the EU allowances (EUAs) to plunge over night when the first reports became public in the end of April. Until all verified emissions were published the 15th of May 2006, prices continued to be volatile. Since then the market price seems to have stabilised at about half of the level prior to publishing of the verified emissions. The market developments demonstrate the need for reliable market data. Without knowledge of verified emissions, trade will be founded on speculations.

Asymmetries in the market continue to boost prices

The high price level during the first year was reinforced due to a lack of sellers in the market. A lot of market participants from seller countries could not enter the market due to national non-functioning registries.

Still, buyers – typically power generators – are more active in the market than sellers – typically industrial installations. This contributes to a higher price level than the expected market balance currently suggests. Moreover, power generators can to a large extent pass carbon costs on to end users. Hence, the main buyers in the market do not have a strong incentive to keep EUA prices low. On the contrary, the allocation of free quotas suggests that the power producers have an incentive to keep prices high. A higher EUA price yields higher power prices on all generated power, whereas the total costs increase only by a fraction because of free allocations.

A volatile and immature market influences the electricity market

At the time of writing, the EU ETS is an immature and volatile market. Due to its large influence on the electricity market prices, the electricity market volatility is now influenced by the carbon market volatility. The electricity prices increase when the EUA prices increase because of the increased marginal costs of producing power.

Consequences of increased costs for the European industry

One of the most clear and most discussed drawbacks of the EU ETS is its impact on electricity prices. This has a large impact on the power consumers and especially hits the energy intensive industry hard. Power intensive industries typically sell their products on the world market and compete with producers outside Europe, who are not subject to the EU ETS or similar measures, and who have not experienced the corresponding power price increases. The result of the EU ETS is a massive redistribution of income from power intensive industry to power generators. Therefore, there is a growing concern about the competitiveness and future of the power intensive industry in Europe.

In the long term EUA prices should reflect abatement costs in order to give correct investment incentives

One of the main goals with the EU ETS is to change power and industry production from technologies with high CO_2 emissions to technologies with low CO_2 emissions. Therefore, in the longer term, it is very important that the EUA prices mirrors the least-cost abatement measure to shift technology.

This cost impact electricity prices and hence, the investment decisions both in the power sector and the industry sector. If EUA prices continue to not reflect abatement costs it is difficult to say which investments that will take place, and when they will arise. To create stable investment conditions, the preconditions for trade must be a stable regulatory framework that ensures symmetry, transparency and liquidity in the market.

Allocation of free allowances obscures investment incentives

In terms of investment incentives, the use of free allocation is not efficient. Investments are based on full costs. As long as allowances are allocated for free to CO_2 emitting generation technologies, such as coal and gas, investors will not take the social cost of emissions into account. Hence, the incentives to invest in carbon-efficient technologies are not supported.

Free allocations based on historical emissions, so-called grandfathering, can also prevent closing down of old plants. If an installation receives free allocations in subsequent periods, the higher the emissions will be in the preceding period. It is not only an incentive to emit more, but also to postpone the closing down of old CO_2 intensive plants.

Read more about these issues in Chapters ***3****, 4, 5, 15 and 16.*

Marked based support schemes - do they really work as intended?

Before extensive support systems like the EU Emission trading scheme and the Swedish green certificate system are introduced, a few fundamental factors must be in place for the markets to work well. The participants must have reliable information about the balance between supply and demand and there must be possibilities for short term adjustments between supply and demand.

The theory behind market based support schemes like the EU Emission Trading System (EU ETS) and the green certificate system in Sweden are appealing to many decision makers. The role of the politicians in these systems is limited to setting the target and it is up to the market to find the most efficient way to reach this target. In economic theory these policy instruments are often referred to as quantity based instruments. Other political instruments that can be used to reach certain goals are price based instruments, such as taxes or subsidies or more direct instruments like technical or environmental standards. Often a combination of instruments is used.

Pros and cons

From a principal point of view there are pros and cons with all policy instruments and each situation must be carefully analyzed. Aspects like the need for information, administrative costs and burden sharing are important. A principle advantage with the quantity based instruments is that the (emission) target will be met. However, the disadvantage is that the reduction cost is not known in advance. It could be very high. In this first part of the Nordic Energy Perspective research project we have looked more closely at the Swedish green certificate system and into the EU Emission trading scheme (EU ETS).

An important finding

One very important finding is that the price of these instruments is based on the participants perception of the balance between supply and demand. If there is a deficit the price may soar and if there is a surplus the price could drop to zero.

For the market to work well two things are needed:

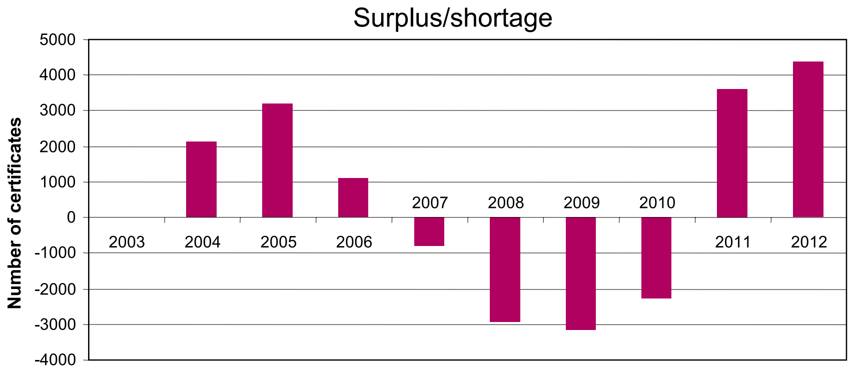
1. First, there must be enough information available for the participants to make reasonable assessments of the balance between supply and demand. In this respect the first and a half year with EU ETS has been a disappointment. Without correct and open information the price will probably continue to be volatile and unpredictable and also an easy target for “gaming”.

2. Second, there must be opportunities for short term adjustments of the balance between supply and demand, either by the possibility to adjust supply or the possibility to adjust demand. This is in economic theory referred to as the system short run marginal cost.

If the markets work well (no market power or lack of information) the price level of these tradable assets will be based on the short run marginal cost. A parallel can be made to the Nordic electricity market were the price normally equals the running cost of the most expensive generation unit, or if there is a deficit situation the willingness to pay of the consumers.

Surplus/shortage in the Swedish certificate system

High certificate prices combined with buyers choosing to pay the penalty has led to a surplus of green certificates in Sweden, i.e. more certificates are produced than are cancelled. The way that the balance between supply and demand is expected to develop in the future is presented in the figure below. This situation explains why prices of certificates have fallen during the last year despite the fact that there is no longer a price cap. An important aspect of the certificate market is that certificates do not have to be cancelled immediately, but they can be stored. A temporary period of surplus does not have to lead to falling prices as long as there are enough people that anticipate a future shortage. The costs for a producer to store certificates



Surplus/shortage in the Swedish certificate system

(build storage capacity) equals the cost of interest. Certificate prices are thus not decided by the current balance between supply and demand on the market, but by market participants' expectations of future price levels. The contrary does not apply if a short term shortage on certificates appears. Customers have to buy and cancel enough certificates whatever the price may be.

The fundamental problem

As mentioned earlier the EU ETS system has been a disappointment regarding information. This may be something that the commission and the member states can overcome, but the fundamental problem is that the total volume of emission rights is huge compare to the reduction targets and a few percentages of difference may have a tremendous effect on the price. In other market based support schemes systems like the sulfur dioxide emission trading system in USA, that is often referred to as a success, the reduction target is much bigger. In this respect the Swedish green certificate system works much better.

The other aspect, the possibility for short term adjustment, is clearly in favor for the EU ETS system compared to the Swedish green certificate system. If the market for CDM and JI products evolve and the rules for letting these products in to the system are liberal enough the system may work quite well. The price of CDM and JI products will be the short run marginal cost in the EU ETS and set the price level. The Swedish green certificate system have no safety valves what so ever and will more or less collapse when it reaches a deficit situation, which may happen already in a few years.

Read more about these issues in Chapters 3, 4, 9, 10 and ***11****.*

New decade in the Nordic energy markets

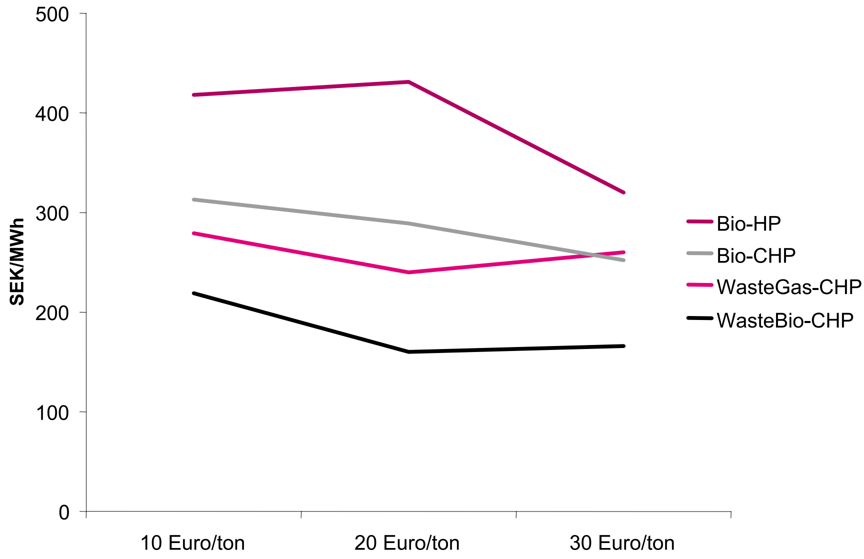
The introduction of the EU's emission trading scheme and other policy instruments has changed the Nordic energy markets and the operating environment of the Nordic companies. At the same time Nordic energy markets are integrating to both East and South, which will further influence the Nordic electricity markets. Increasing demands and phasing out of old capacities in the Nordic area and in neighbouring countries will press electricity prices up, especially in a world of diminishing fuel reserves and more stringent international climate policies.

New challenges for the Nordic electricity and district-heating markets

The first year of the EU's emissions trading scheme (EU ETS) has ”turned a new sheet” in the Nordic electricity market. A new factor, the CO_2 allowance (EUA) price, has changed the behaviour of the electricity markets and also the competitiveness of different power production technologies. The coal fired condensing capacity in Denmark and Finland has lost its competitiveness due to high EUA price levels. A record import of electricity was observed in Finland as condensing power plants were not operating. A new cross-border transmission line to Estonia is being built and Finland is also considering new cross-border transmission to Russia. The model results indicate that increased import capacity from Russia to the Nordic countries may not only lead to increased import but also increased export to continental Europe. The security of supply of electricity will encounter new challenges if the Nordic countries would rely on imported electricity and not keep the unprofitable old condensing power capacities in the system.

Not only the electricity market is affected by the EU ETS, but also other energy markets such as district heating. District-heating systems may differ widely in terms of fuel mix. Therefore, the impact of the

EU ETS may take different directions depending on system characteristics. Modelling of local Swedish district-heating systems indicates that short-run marginal costs for generating district heat, generally, decrease as EUA prices increase (see figure below). This is mainly due to improved competitiveness of combined heat and power.



Short-run marginal cost (model year 2015) for different district-heat production systems (Source: Martes model runs including base fuel-price scenario, 1 € = 9.2 SEK)

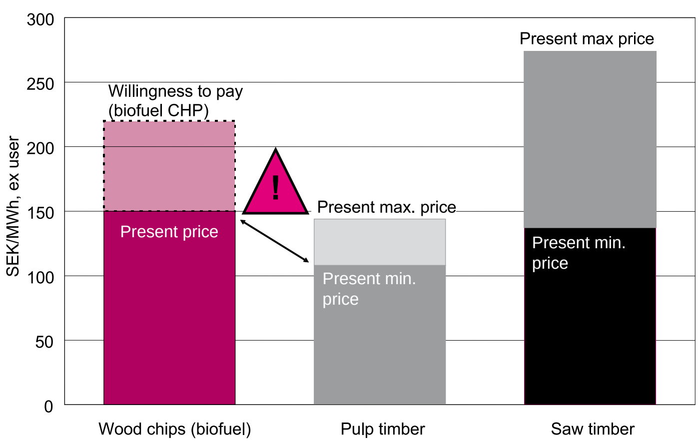
Winners and losers – The electricity market

The emissions trading has increased the competitiveness of existing hydropower and nuclear power plants. All the four largest Nordic electricity generators E.ON, Fortum, Statkraft and Vattenfall gained the best ever or at least excellent profits. In Finland and Sweden, a taxation scheme of these windfall profits is very likely. On the other hand, there is a great risk that taxation will further increase the electricity prices, especially by decreasing incentives for investments in new production capacity.

The increased wholesale electricity prices lead to increased retail prices for industry and private customers. The resulting decrease in competitiveness may be severe for energy intensive industry. Finland has considered compensating the impacts of emissions trading by reducing electricity taxation of those installations. In Sweden this has already been done.

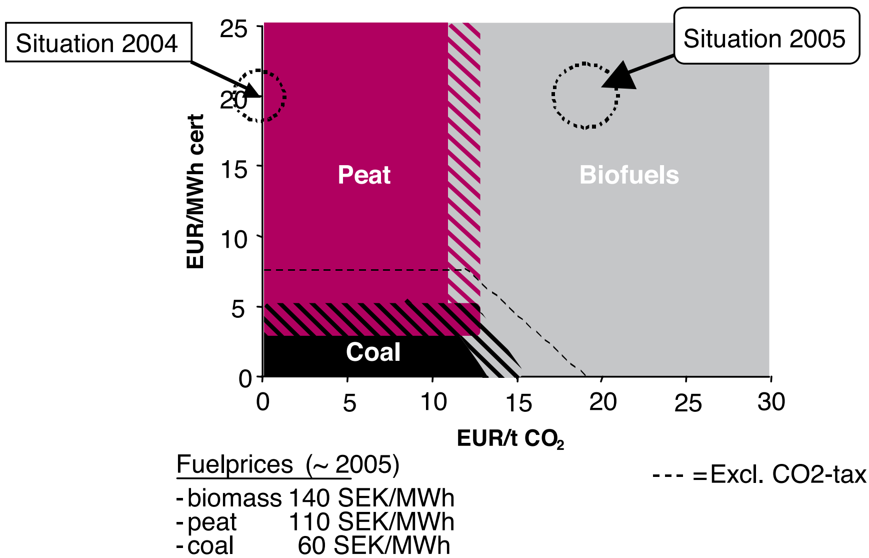
Winners and losers – Indigenous fuel markets

The increased competitiveness of biomass and decreased competitiveness of peat due to high EUA prices have changed the markets of those indigenous fuels. In order to promote renewable energy sources, different policy instruments are used in the Nordic countries. In Sweden, as an example, biofuels used in the energy sector receive support (directly or indirectly) through the electricity certificate system, tax on fossil fuels and the European Union´s emission trading scheme. This has made biofuels very competitive, especially for combined heat and power production. Consequently, the market is prepared to pay a high price. This use of biomass is to an increasing degree competing with the use of biomass for pulp production, which could lead to a general increase in timber prices (and that typical timber for pulp production instead goes to heat and/or power production), see figure below. This is a problem for the pulp and paper industry, since they operate on an international market. The situation is similar in Finland, but not as evident as in Sweden. However, in Finland high biofuel prices are a consequence of the increased peat price caused by high EAU prices.



Competition regarding the forest resources in Sweden today – a price comparison, March 2006 (1 € = 9.2 SEK). (With the warning sign we merely want to focus attention on the issue of increased competition regarding the forest resources.)

As mentioned above the competitiveness of peat has decreased due to high EUA price levels. In Sweden the conditions for peat have changed a number of times during recent years due to changes in the policy-instruments framework. At the price level 15 – 20 €/ton for emissions allowances, and current fuel prices, peat is not competitive compared to biofuels in energy supply in Sweden, as indicated by the figure below. From the peak level for peat use in 2004, the use of peat is decreasing rapidly. Peat is, above all, substituted by biofuels, e.g. wood chips. Interviews indicate that the decrease in peat use will continue. The same tendency can be observed in Finland (where the total use of peat is much larger than in Sweden). In order to improve the competitiveness of peat the Finnish government decided to support peat fired energy production by removing the fuel tax on peat (from 1.7.2005). Further supports are also considered, like feed-in tariffs.



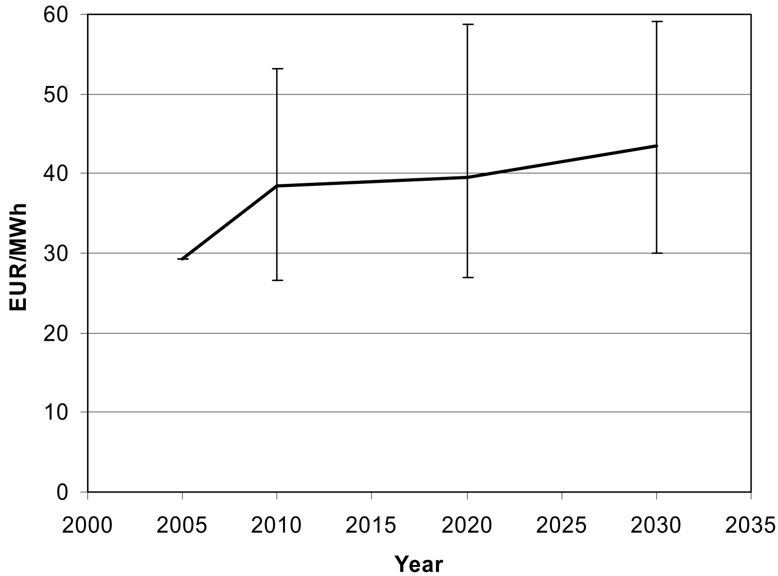
The competition between peat, biofuels and coal for CHP production in Sweden.

Long term scenarios of the Nordic energy markets – hard to predict by researchers, hard to predict by investors

The increasing number of the ”great unknowns” has lead to a situation where it is very difficult to predict future trends of the Nordic energy markets. The short term national and international energy and climate policies create a high risk for investors in the energy sector, where new investments are intended to operate for several decades. Increasing demand for natural gas and the diminishing oil reserves will increase the price levels and volatility of fuel markets. Biofuels will continue to expand in several sectors, i.e. energy, transport and forest sectors, and it is hard to predict the paying ability and the biomass demands of these sectors. Until now, the demand of electricity in the Nordic area have shown steadily increasing trend. In the future, the situation could be changed depending on the future of the energy intensive industry in the Nordic area. Integration of the Nordic and the Central and Eastern European energy markets will also increase the number of unknowns as we should consider the future energy markets of those areas.

On the other hand, the possible trends of tighter emission limits, increasing prices of all fuels (both fossil and renewable), and decreasing surplus of energy production capacities would all imply higher power and heat prices. This encourages further investments in renewables and energy savings, which will reduce greenhouse gas emissions.

The model analyses performed in this project have aimed at dealing with some of the uncertainties discussed above, by carrying out sensitivity and scenario analyses. Some of the model results have shown to be very sensitive to input assumptions. One example of this is found in the figure below showing the development of the future wholesale electricity price in the Nordic market. The figure includes the average price development as well as the maximal and minimal deviations obtained from the model runs.



Wholesale electricity prices vs. model years (averaged over fuel-price scenarios, models and EUA prices)

Read more about these issues in Chapters ***5****, 7, 9, 10, 12 and 13.*

Reduced CO_2 emissions and more renewables - are we getting there or not?

Current signs

There are current signs of a significant increase in the contribution from renewable and low-CO_2-emissive technologies in the Nordic countries. But there are also signs of the opposite. Below we will give a very short account of the mixed picture of progress made during the last years in the Nordic countries.

In **Denmark,** renewables and gas have steadily increased their share in electricity supply. The share of renewables in electricity production has risen from around 5 percent of total supply in 1994 to around 20 percent in 2004. During the same time, the share of gas has risen from close to 10 percent to around 25 percent. The adjusted total CO_2 emissions have declined in all Danish sectors except for transports (Danish Energy Authority 2006).

In **Finland**, the other Nordic country besides Denmark with a significant share of fossil fuels in the power supply, the share of renewables (excluding peat) has remained stable at about 30 percent between 1990 and 2004, while the share of fossil fuels and peat has risen somewhat from roughly 35 to 45 percent. During the same time, total electricity generation increased by roughly 50 percent. With a fifth nuclear-power station in operation 2009 generating around 12 TWh, the contribution of non-CO_2-emissive electricity supply will be significantly higher. Total observed CO_2 emissions in Finland have increased by around 20 percent between 1990 and 2004 (Statistics Finland 2005).

Norway has, like Finland, experienced a similar increase in CO_2 emissions since 1990, mainly due to transports and increased industrial activity (Statistics Norway 2006). In 2007, the first Norwegian gas-fired power station at Kårstø is expected to enter commercial service.

Everything else held constant, this will increase Norwegian CO_2 emissions by almost 3 percent.

In **Sweden**, renewables have almost replaced all coal and oil in CHP and heating plants. End use of oil for heating purposes has constantly been replaced by electric heating (including heating pumps), district heating and biofuel-based heating. Total CO_2 emissions in Sweden have remained at a relatively stable level since 1990 (Swedish Environmental Protection agency 2006).

A mixed picture

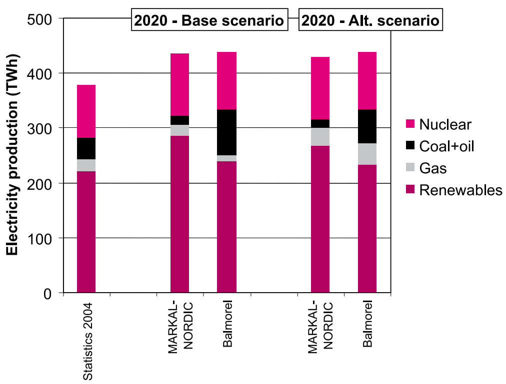
Thus, it is a mixed picture that emerges in the Nordic countries when observing recent trends for CO_2 emissions and renewable energy. The European Environment Agency (EEA) gives Sweden as the only Nordic country a “green light” when it comes to being on track to reach CO_2 targets. When it comes to the progress in renewable electricity, Denmark is the only country that belongs to the group of best performers according to the EEA.

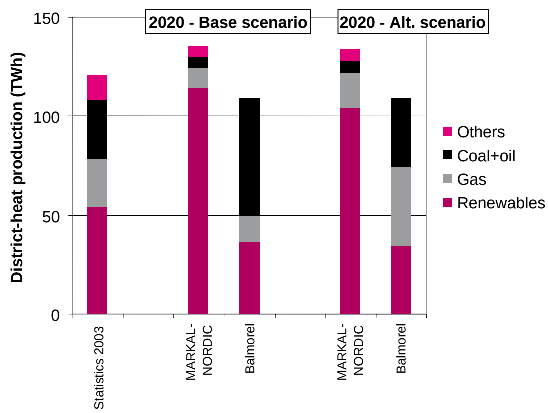
In all four Nordic countries, transports have shown a constant increase in CO_2 emissions over the past years, and do, currently, account for almost 30 percent of the emissions in the Nordic countries. Therefore, this sector presents a big challenge in the future when dealing with CO_2-emission reductions. Transports have, however, been omitted from the analyses in this project.

Projections obtained through modelling

But what can be said about expected progress in the future? The models used in the NEP project do, generally, indicate that renewables increase their share, at least in absolute numbers. However, even if the contribution from renewables is increasing in many of the model results, this does not necessarily mean that future targets or ambitions for renewables and CO_2-emission reductions are reached. Furthermore, energy demand is expected to increase in several sectors which, in some scenarios, leads to a significant increase also in fossil energy use, especially in the electricity sector.

Even if several model results in this project point towards increased shares of renewables, some model results do, in fact, indicate the opposite. In the figure below, results from two different models are shown using the same basic input assumptions. The MARKAL-NORDIC model indicates a strong increase in renewables in electricity and district-heat supply, while the Balmorel model points more towards increased reliance on coal and/or gas. Despite extensive model synchronization, important differences in model input remain such as technology-cost assumptions and the inclusion of other policy measures besides the EU ETS. Such differences in input may be an important reason for not having all model results point in the same direction, even though model differences in terms of mathematical formulation and system boundaries remain. In some model results the future for renewables and the prospects for reducing CO_2 emissions look far gloomier than in others.





Electricity production (left) and district-heat production (right) in 2020 calculated with the MARKAL-NORDIC and Balmorel models for both fuel-price scenarios including an EUA price of 20 EUR/t (Balmorel covers a smaller part of the Nordic district-heat supply than MARKAL-NORDIC)

Current conditions may change

To conclude, model results concerning the future development as well as current observations present a mixed picture of progress in the Nordic countries when it comes to CO_2-emission reductions and new investments in renewables. Presently, a number of conditions act in a direction that may lead to reduced emissions and increased penetration of renewables:

- High, with international standards, carbon and energy taxes
- The EU ETS and support schemes for renewable electricity
- Increased consumer awareness
- Rapid technological development in several areas (e.g. wind power, heating pumps, small-scale biofuel-boilers and alternative fuels for road transports)
- Historically high fossil-fuel prices

However, these conditions may change, especially the latter, thereby mitigating such progress. And even if these conditions are continuing to be favourable, there are no guarantees that future targets are met since the pace of progress may be too slow. Furthermore, investment practice and perception of profitability relating to new investments are also crucial for the development of the energy system and whether we may reach energy and climate-policy goals in the future. This question will be dealt with in the next section.

Read more about these issues in Chapters 2, 4, ***5****, 9 and 13.*

The interpretation of financial requirements acts as an impediment for environmentally sound investments

In the coming decade there will most likely be an accentuated need for investments in order to secure enough production capacity, establish competitive price levels and to comply with commitments made within energy and climate-policy targets. The companies that have to make these decisions will make long term commitments in a sector characterized by its homogeneous products. Despite the importance for society these investments are to a large extent realized based on their financial merits. The perceived profitability of the investments is therefore of decisive importance. The question at hand is what will happen if there are defiance's in the way these perceptions are obtained? If we look at how many decision-makers in the energy companies estimate the profitability of an investment and the required financial demands of the company, we will find several areas viable for questioning.

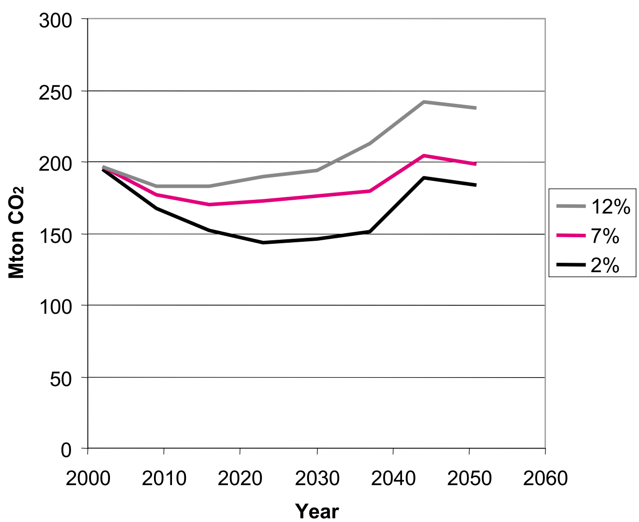
High rates of return

Significant for investments in infrastructure is the long time period needed to capitalize the investment. The outcome of capital budgeting appraisal done for investments in energy production is therefore especially sensitive to the magnitude of the applied hurdle rate and the length of the capitalization horizon. Our examination shows that it is common to use a nominal hurdle rate in the range of five to nine percent. Even though this might be considered a little high, even for many production-oriented investments, it will probably not lead to a dramatic different outcome compared to if a more moderate figure was used. Instead it's the dominating practice of applying a maximum pay-back time on top of these levels that really makes a difference regarding what investments are considered profitable. Typically pay-back times as short as seven to ten years are used. This will de-facto mean that many energy companies demand a 13 to 20 % return! It is fairly safe to say that these levels, at least historically are hard to motivate financially. Even though it is difficult to analyze the aggregated consequences of this practice, higher rates of return will decrease the incentives for investing in new technology and make existing systems stay operative during a longer period of time.

Another unfortunate implication of this practice is that it makes the energy companies favor investments with relatively higher proportion of operative expenses (and lower potion of capital costs) since they tend to have shorter payback times. Production investments that answer to this description are predominately based on non sustainable fuels, such as coal and gas.

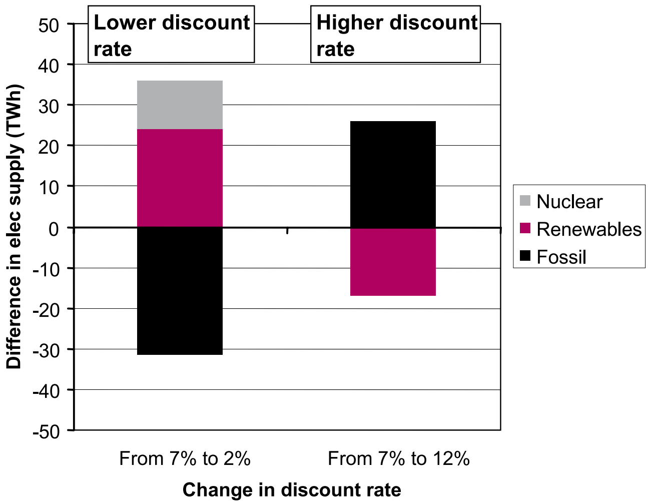
Model calculations

One way of verifying these conclusions is to let the MARKAL model assume a higher rate of return (represented in the model by the societal cost of capital). The results from this exercise show that investments with lower proportion of fixed costs will get a larger share of the total investments. The impact on the future energy system of different rates of returns or discount rates can be seen in the figures below. The higher the discount rate gets the higher the future CO_2 emissions from the Nordic stationary energy system become (as seen in the first figure below).



CO_2 emissions from the Nordic energy system at three different discount rates. Transports included only as constant bulk emissions. Assumptions according to base fuel-price scenario (Source: MARKAL-NORDIC model runs).

As mentioned above, higher emissions under a regime with higher discount rates depend on the relatively stronger preference for existing capacity and new fossil-based technologies compared to a situation with lower discount rates. This can be seen in the second figure showing the *difference* in electricity production in the model year 2023 if the discount rate is *reduced* or *increased* from a default rate of 7 percent.



Change in Nordic electricity supply if we reduce the discount rate from 7% to 2% (left) or if we increase the discount rate from 7% to 12 % (right) (Source: MARKAL-NORDIC model run for the model year 2023 including base fuel-price scenario)

Uncertainties increase the rates of return

It is important to point out that model results as the ones shown here are, obtained by assuming perfect foresight. This means that the model calculates the best solution based on full knowledge of the future, e.g. no uncertainties regarding policy measures, fuel prices, EUA prices etc are present.

This is, of course, a very simplified assumption of the reality that faces actors in the energy market. Lately risk assessments have arguably become even more complex with the introduction of tradable policy measures (EU ETS and electricity certificates). If the future value of these papers are perceived as being more uncertain than traditional policy measures such as carbon taxes, feed-in tariffs and investment subsidies, it might imply an increased risk for investors If this is the case it can lead to a situation where investors postpone investments in new and more efficient technology even if the actual reimbursements through the new market-based schemes (EU ETS and/or green certificates) can be higher compared to older policy and support measures. Uncertainties associated with the new market-based schemes can also lead investors to require even higher rates of return for new investments. Again such a consequence will be especially negative for environmentally sound investments.

Shortcomings in existing capital budgeting practice will not only be an impediment for making changes in the stationary energy sector. This practice unfortunately targets the environmentally sound techniques especially hard and will slow down the development the Nordic energy system. The introduction of market based policy measures might indirectly increase the effect of this disorder.

Fair conditions for new investments

Investments in new technology require fair conditions. On one hand, this means stable conditions concerning energy and climate policy for the investors. The question is whether tradable policy measures really can match this. On the other hand, market players also have to realize that their internal practices for new investments have a significant impact on the development of the energy system as a whole. The higher the rates of returns demanded by their owners and share-holders, the slower the changeover of the energy system becomes and the harder it gets to reach climate and energy-policy targets.

*Read more about these issues in Chapters 5, **8**, 11, and 17.*

Who should invest in infrastructure - private or public investors?

While private owners maximise profit, public owners may have additional preferences (environmental concerns, industrial and community development, etc.), and might therefore be a more suited owner of infrastructure. However, we observe that many public owners require their own companies to behave in a purely profit-maximising manner. This is something the regulators must take into consideration when designing regulatory regimes for energy infrastructures.

A thorough discussion resulting in a final answer to who should invest is not within the scope of this synthesis. Our intention is to draw some preliminary conclusions based on observations in the project, highlighting some of the challenges concerning private versus public ownership.

Infrastructures are characterised by economy of scale, large irreversible investments and external effects, leading to market failure. Therefore, the market may not be the best instrument to implement the optimal solutions. A possible way out of this is public ownership, while an alternative solution is regulation of private (and profit-oriented public) owners.

In the Nordic countries, the energy infrastructure is often owned by the municipalities or by the state, but there are major exceptions. Transferring public ownership of production and/or transmission and distribution systems to private ownership may be a part of a deregulation of an infrastructure.

Owners can influence and control the behaviour of the utility, but will they?

Owners can influence and control the behaviour of the utility, so the objectives of the owner matter. Their objectives may influence the willingness to invest in new infrastructure, and the development of the existing systems. Due to such additional preferences, it is commonly expected that the publicly owned utilities demand a lower rate of return of their investments, and thus realises projects private investors would find unprofitable. This expectation may, however, not be the case in real life, where public owners have been observed to demand very high rates of return of for example district heating investments, as well as for grid investments. Further research is necessary to document and explain this observation. If one accepts the notion that public owners act to maximise social welfare and not profits, public and private owners will have different risk perceptions Also, they will in practise often have different possibilities and abilities for risk management. The crucial issue is whether private owners systematically will require higher returns than public owners, and if this is resulting in systematically non-optimal investment decisions seen from a social welfare perspective.

Is ownership an issue with proper regulation?

Two alternative models for infrastructure ownership could be:

- Public ownership with loose regulation
- Private ownership (including publicly owned, profit-maximising companies) with tight regulation.

A theoretical analysis indicates both pros and cons for these two models. Private ownership results in too low investments and too high prices compared to the optimal social welfare levels. Public ownership, on the other hand, would in theory give the optimal investment level. In practise, however, public ownership has often proved to lead to inefficient investments and operations, reducing social welfare.

Under private ownership, the major challenge is probably how to design a regulation that gives incentives both for efficient utilisation of existing infrastructure, and for optimal investments. Under public ownership, the major challenge is to design incentives for efficient use of resources, avoiding inefficiencies due to high-cost operations and investments.

A different issue is how one should optimise the investments in infrastructure in the energy sector since different investments both in different types of infrastructure and in production/consumption are dependent of each other.

This is mostly an issue of markets vs central planning, and not about ownership, however, public ownership will normally simplify the decision process for central planning solutions.

A preliminary conclusion is that ownership – or more precisely the owners' **objectives** – matters. There is a close relation between the ownership, markets and competition, and the requirements for regulation. Regulators should be conscious of the need for coordination, and the major challenge of designing optimal regulation schemes that give the correct incentives independent of ownership. These are complex questions that require further investigation.

What is "Infrastructure"?

The *American Heritage Dictionary,* defines the term "infrastructure" as:

The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons.

Read more about these issues in Chapters ***6****, 8 and 14.*

Regulation is not the answer, but framework conditions should promote coordination

- need for a visible hand?

The experience from the deregulated Nordic electricity market provides a basis to draw some conclusions as to what is the right balance between market and regulation in the energy system. The Nordic power market has proved that it can deliver efficient short-term price signals, but has still to prove that it can also provide a good basis for the long-term development of the energy system.

Important challenges facing the development of the Nordic energy system are:

- Policy and framework conditions which yield incentives for investments in new power generation capacity when it is profitable
- Improving the basis for correct trade-offs between investments in infrastructure and power generation capacity
- The introduction of new infrastructure and energy forms and the coordination of investments in different kinds of energy systems

Policies must provide the right framework for the market

Like most markets, the functioning of the energy markets depend upon adequate framework conditions in order for competition to provide efficient resource utilization, reasonable prices and the right investments. The energy sector is however more complex than most markets, owing to the combination of technology possibilities and limitations, the characteristics of different energy carriers, important environmental implications, and the relationship between an infrastructure often characterized by economies of scale and irreversible and lumpy investments on the one hand, and market-based generation and consumption decisions on the other. It is therefore both important and right that policy targets and means play an important role in these markets.

A centrally based planning system may provide predictable and stable framework conditions but contrary to the market, will usually fail to utilize the flexibility of market-based decisions and tend to yield much weaker incentives for creativity and new solutions and technology development. For a given system configuration, lack of competitive pressure tends to yield higher cost and price levels in the short term, although short term prices based on average costs may be lower than marginal cost prices. Whereas average cost pricing yields more stable end-user prices, the price signal is inefficient and will typically induce too much demand in shortage periods and too little demand in surplus periods. In the long term, total system costs tend to be higher in a planned system than in a market system.

The question is therefore not whether the development of the energy sector can be left to the market, but what role the market can play, what policy framework is necessary and how the policy framework should be designed.

Long term investments require long-term policy conditions

In a market-based system investors do not have a guarantee that their costs will be covered over the lifetime of the investment. Policies may however contribute to increasing or reduce the uncertainty of future income flows from the market. All market-based investments must face risks, but it is imperative that politicians understand their responsibility to assist the market and not sabotage it. In that respect, one might say that a market-based energy system poses a more challenging environment for policy makers than does a planning system, but the rewards may be substantial.

Trade-offs between infrastructure and production require increased coordination

The regulatory framework has to take into account that whatever investment policy is chosen, it will not have a neutral effect on the market. National infrastructure such as high-voltage electricity transmission and gas trunk lines are natural monopolies and must be regulated by the government. There is however, a close link between the development of infrastructure and production capacity. To ensure a cost-effective development of the electricity system, and avoid unnecessary investments in transmission capacity when investments in generation capacity may achieve the same result at a lower cost, it is important to improve the coordination between transmission and generation development. For example, wind power generation in Finnmark will not be developed if a new transmission line is not built, and a new transmission line is not profitable unless substantial wind power generation is realized in Finnmark. The deadlock situation may be solved if the TSO could coordinate the decisions to a larger extent than today.

Investments in new energy infrastructure require flexible and innovative policies

All energy infrastructures are not equally developed and mature in all parts of the Nordic market. The introduction of new energy carriers and energy infrastructures poses a particular challenge. The new solutions often have to compete with developed infrastructures with sunk costs, but may also be more small-scale than the developed infrastructure. Moreover, there is no comprehensive regulatory framework to cover all kinds of energy infrastructure. Private investors would probably not invest in alternative energy carriers requiring new infrastructure, if the incumbent is protected either by the existing regulation or by his first-mover advantage. For example, the risk of investing in natural gas distribution in Eastern Norway based on LNG shipped from Western Norway proved to be too high for private investors to accept. This was partly due to the compulsory connection for all new buildings to district heating, an important protection of the incumbent district heating plants in the area. The possibility of mandatory third-party access to the natural gas grid added to the risk for the investors. To allow for private initiatives to ensure competition between different energy carriers, while ensuring adequate monopoly regulation to avoid exploitation of consumers, calls for innovation and flexibility in the policies towards infrastructure investments and operation in general.

Read more about these issues in Chapters ***6****, 8, 13, 14 and 17.*

Increased infrastructure investments due to EU ETS and support schemes for RES

The EU emission trading scheme (EU ETS), other support schemes for renewable energy sources (RES) and other policy measures influence investments in new generation capacity, and hence the need for new infrastructure investments. The resulting cost of new infrastructure depends on location of new generation, but also on existing infrastructure and available capacities. Some measures, like fuel switching, require minimal infrastructure investments. So far the NEP model results are not detailed enough to estimate the infrastructure effects for the different energy carriers in each of the Nordic countries. In general, increased investments in district heating systems based on biofuelled combined heat and power (CHP) and strengthening of the transmission system for electricity seem to be unavoidable. The need for new transmission pipelines for natural gas, on the other hand, is highly unpredictable and thus involves a high risk for investors.

Increased energy production and energy use lead to increased need for new infrastructure investments. Model results show that the contribution from renewable energy sources in absolute terms is likely to increase in all parts of the stationary energy system. This is due both to the EU ETS and to other policy measures such as taxes and support schemes for renewable electricity, in addition to the expected high gas and oil prices in the future.

Uncertain how the ETS will affect the total costs

The intention of the EU ETS is to introduce a cost on alternative energy production technologies that corresponds with their CO_2 emissions. However, the allocation of free allowances to new installations which emit CO_2, and the uncertainty of allocation methods, make it very uncertain how the ETS will affect the total costs of alternative production technologies. How this actually affects the choice of new energy production also depends profoundly on the existing energy system, indigenous energy resources and, last but not least, the energy policy of each country. In Sweden, bio energy is favoured twice, i.e. through the green certificate system and through the ETS. In Norway, current signals suggest that investment in gas power plants with CO_2 sequestration may be supported beyond the incentives produced by the EU ETS, although natural gas is a non-renewable fuel. Both the bio energy solution and the natural gas solution require new infrastructure. In Sweden, the widespread use of district heating (DH) simplifies the realisation of combined heat and power (CHP) based on biomass, compared to Norway with a limited use of district heating. This further increases the competitive advantage of biomass CHP in Sweden, while it reduces the attractiveness of this solution in Norway.

Model results

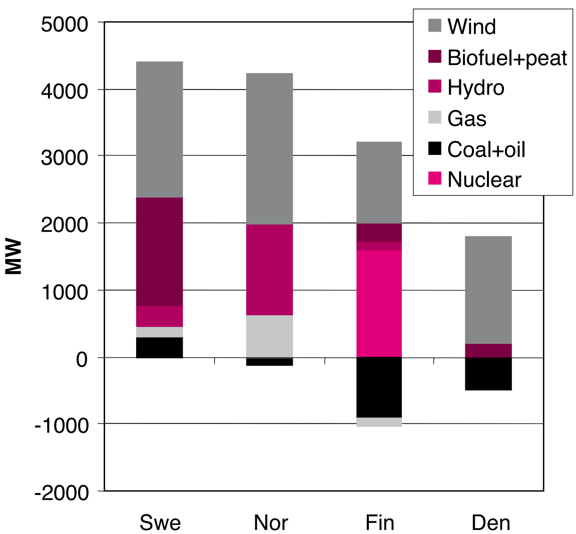
The model results concerning natural gas are very sensitive to input assumptions. In the analysis, the use of natural gas for electricity and district heating production ranged between 20 and 180 TWh in 2020. Depending especially on gas prices (with relatively modest price changes), a significant increase as well as decrease in gas use is observed. This implies a significantly higher risk in natural gas infrastructure investments, compared to for example investment in DH/CHP based on biomass (Sweden).

A significant part of renewable electricity capacity (wind, biomass CHP, small-scale hydro) supplies unregulated power to the grid. Thus the electricity system, including regulating capacity and the grid infrastructure, must be reinforced to accommodate variations, in order to be able to maintain a high quality of supply. Model results also indicate that the Nordic countries may become a transit area for Russian electricity exported through increased interconnector capacity to Finland. This would also require strengthening of the transmission infrastructure.

For both electricity and natural gas, national energy markets have now been extended to international systems. Investment in new energy production in one country might require infrastructure investments in other countries. This is the case if the Nordic countries become a transit area for Russian electricity and gas to Europe. Such a development creates new demands and challenges for Nordic cooperation and coordination of energy infrastructures.

Large investments in new infrastructure are necessary

Also on a national level, large investments in new infrastructure may be necessary. In the case of increased share of wind power in Norway, the effect on infrastructure investments becomes obvious. The greatest potential for new wind power plants is located in Finnmark, in the northern part of the country. Wind resources are plentiful, and the utilisation of the wind power plants is high compared to locations in other parts of Norway. The drawback of exploiting this wind energy potential is that it calls for large investment in the transmission system in order to bring the power to the market. Without increased coordination between transmission and generation investments and a clearer investment philosophy of the TSOs, the risk of making the wrong investments is very real. The model results also indicate similar infrastructure challenges concerning new offshore wind farms in Sweden and Denmark, with increased electricity production located far from the main transmission system. This is shown in the figure below where energy-model runs indicate that the lion share of new investments in the mid-future (in this case until 2020) will be carried out in renewable electricity production given base-scenario assumptions. Finland may be somewhat of an exception with 1.6 GW of new nuclear power.



Change in installed electricity capacity between 2005 and 2020 (ECON-Classic model run including base fuel-price scenario and an EUA price of 20 EUR/t)

As an alternative to the rejected system of green certificates, the Norwegian government has launched a new fund for subsidising renewable energy production (20 billion NOK). A substantial part of the new fund is expected to be used to establish new district heating systems and CHP plants, in order to achieve a significant increase of biomass in the stationary energy system. Thus, the authorities recognise the need for infrastructure investments to increase renewable energy production. However, this recognition does not extend beyond the distribution level, i.e. local DH networks. There is nothing to suggest that support to wind power will take account of the resulting need for investments in the national and regional electricity distribution networks.

Read more about these issues in Chapters ***5****, 6, 7, 10 and 14.*

Energy, welfare and industry

- a complex link which is difficult for politicians to consider in the decision-making process

The complex link between energy-policy and welfare makes it difficult for politicians to consider the welfare aspect in the decision-making process. The reason for this is partly the lack of a scientific foundation to support the decision-making process.

A complex link

Is the close link between energy policy and the economic activity in a country so complex that the politicians simply cannot use the information in the decision-making process? Will new business that evolves around the new ”environmentally friendly” generation of technology be enough to replace the jobs lost in the energy-intensive industry? Will the service sector in the economy replace the jobs lost in the industrial sector? These are questions that illustrate the complex links between energy policy and economic activity.

Energy, an important part of the economy

Energy is an important part of all economic activity in the society, and without security of supply (important for most commercial enterprises) and affordable prices (important for the energy-intensive industries) our way of living would not be possible. The energy business is also part of our economy as such. Generating, transmitting and distributing electricity is employing a lot of people. Building new generation plants and natural gas pipelines is employing large numbers of construction workers and engineers. Industries manufacturing the components for these constructions will grow. Especially in the Nordic countries, the electricity industry is an integrated part of the production of electricity-intensive products like steel, aluminium, and paper and pulp. Without plenty of electricity at affordable prices this electricity-intensive industry cannot exist.

Model analysis

Some of the complexity of the economy can be analysed with the help of General Equilibrium Models such as the GTAP models used in this project. In these models the economy is allowed to adjust. A competitive disadvantage due to increased energy prices in one industry is regarded as an advantage for another, less energy-dependent sector. The greater the flexibility of economy is, the less impact on welfare the policy decision will have.

These general equilibrium models are often used to illustrate the effect of policy measures. The results we got by looking at the EU ETS system indicate very low welfare costs (high efficiency in the EU ETS system). What the model missed, though, was the effect on the electricity price due to the introduction of EU ETS. Other studies in this project indicate that the electricity price effect is of great importance. Since the general equilibrium model covers the whole world economy, it is not very detailed when it comes to specific industries. The competitive disadvantage that some of the most electricity-dependent industries will have is captured in the model only to a small extent. With some realistic modifications, the negative effects in welfare terms from EU ETS were drastically increased.

If we instead rely on partial analysis there is an obvious risk that negative welfare consequences are overestimated. There are ”healing processes” in the economy, and possibilities that must not be neglected.

One aspect that is not at all captured in these efficiency studies is the redistribution of wealth due to different energy policy schemes, but for politicians this is of course of great importance. In the Nordic countries alone, the EU ETS has made the power companies at least 6 billion EUR richer in a year. It is the electricity consumers that pay the bill.

Read more about these issues in Chapters 2, 3, 4, 13 and ***16****.*

“Fuel” for an energy policy discussion

- a possible agenda for a Nordic discussion about energy policy perspectives

The interaction between politics and markets has been a central focus during this first stage of the project Nordic Energy Perspectives. A basic theme of the project has been to identify and define the Nordic perspective and context of energy policies. We have also analysed the consequences for the energy markets of the present energy policies (expressed through the policy instruments which are in operation). The results of this analysis are presented in this report.

A number of the research results have been presented and discussed during the project conferences and workshops. Representatives from branch organizations, agencies, and ministries have thus been given a broader perspective on results and conclusions.

It is our hope that the project results and analyses contribute to improve the basis for development of energy policies and stimulate further discussions on these issues at the Nordic level. Naturally, it has not been possible to conclude on all issues in the first phase of the project. Some important issues for further discussion are briefly presented here.

Large similarities but a few important differences

There are large similarities between the policies of the Nordic countries, but differences in a few specific goals / policy instruments has a great impact on the development of the national energy systems.

Our survey of goals and policy instruments shows large similarities between the policy goals of the European Union, the Nordic region and the Nordic countries, but at the same time the analysis shows that a few specific differences exist, which result in distinctive national energy politics characteristics. From a European perspective, with the EU ambition to establish a common policy, it is relevant to discuss if these characteristics/differences between countries are as important as they are presented to be in the energy policies of the different countries.

Political direction and focus

The future political direction seems to be to "concentrate powerfully on everything"! Is there a need to make clearer priorities?

The centre of gravity of current energy policies is on climate/environment and efficiency. This is also where the most important policy instruments are operative. The political debate/decisions during recent years however show that also security of supply (e.g. the Akureyri declaration) and policy for economic growth (e.g. the Lisbon agenda) are of high priority. The EU Green paper expresses an ambition to focus simultaneously on all policy areas which influence, or are influenced by, the energy sector. The Nordic energy policy is moving in the same direction. The question whether if it is possible and effective, in the EU and in the Nordic region, to "concentrate powerfully on everything at the same time".

The complexity of policy instruments is a problem in itself! ('One goal – one policy instrument' is distant.)

A powerful concentration on all areas will result in increasing complexity regarding directives and policy instruments. Increased complexity leads to increased risks for the actors in the energy market. The complexity itself could also open up for more differences between the countries, which further complicate a common European or Nordic policy.

Risks when introducing new policy instruments

– Examples of unexpected/negative consequences of new policy instruments

The present introduction of new policy instruments has led to a number of unexpected and negative consequences. The electricity prices have increased substantially due to the unexpected high CO_2 price in the EU ETS, existing taxes acquire a new role when new, market-based policy instruments are implemented in parallel and the electricity certificate system (in Sweden) still show uncertainties, e.g. concerning the price formation. When the decisions to introduce these new policy instruments were made, there was little debate regarding the negative consequences and the uncertainties of their effects.

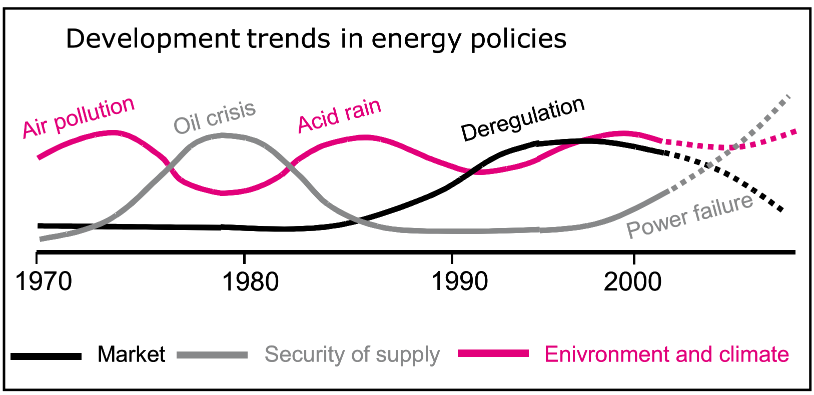
Another example is the combined effect of a number of policy instruments which have made biofuels very competitive for energy production in

Sweden. The result is a high price for biomass. This use of biomass in energy production is therefore to an increasing degree competing with the use of biomass for pulp production, which could lead to a general increase in timber prices. This is a problem for the pulp and paper industry, since they operate on an international market.

The increasing number of parallel policy instruments is also a problem in itself, since their combined consequences are difficult to foresee for policy makers and market participants alike. A recommendation may therefore be to analyze the effect of new policy instruments and the combination of policy instruments more carefully before drastic changes are implemented.

Is a stable political framework a utopia?

- Policy or market, national versus international: constant balancing?
It is a truism to state that the energy policy is dynamic. It is constantly changing, both when it comes to the political agenda and challenges, and when it comes to the implementation of different policy instruments. It is important to realise that these changes to a large extent are consequences of the dynamic development of the society as a whole, i.e. the framework conditions of the energy system and not in the policies as such. Our simple picture of the dynamics of energy policy illustrates this.



Development trends in energy policies

Due to the dynamic nature of society and politics, and the complexity of energy systems and their importance for society and the environment, the energy branch must be prepared to live in a less than perfectly stable political framework even in the future. Somewhat more stability and a more long-term perspective on energy policies is however desirable.

A possible Agenda...

...for a Nordic Energy Policy disussion based on findings in the Nordic Energy Perspectives project

- Important differences in energy policy of the Nordic countries
- Dare to choose political direction!
- Be careful about changes in policy!
- Is a stable political framework a utopia?
- etc.

Read more about these issues in Chapters 4, 7, 9, ***13*** *and 14.*