NordREG
Nordic Energy Regulators

Handling extreme situations in the Nordic Countries

Report 5/2006

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List of Abbreviations

NVE	Norwegian Water Resources and Energy Directorate (Norges vassdrags- og energidirektorat)
DEA	Danish Energy Authority (Energistyrelsen)
DERA	Danish Energy Regulatory Authority (Energitilsynet)
EMV	Finnish Energy Market Authority (Energiamarkkinavirasto)
NESA	National Emergency Supply Agency (Huoltovarmuuskeskus)
EMI	Swedish Energy Markets Inspectorate (Energimarknadsinspektionen)
STEM	Swedish Energy Authority (Energimyndigheten)
SvK	Svenska Kraftnät
NordREG	Nordic Energy Regulators
SEfAS	SINTEF Energy Research (SINTEF Energiforskning AS)
TSO	Transmission System Operator
MW	Megawatt (1,000 kilowatt)
MWh	Megawatt hour (1,000 kilowatt hour)
CHP	Combined heat and power
VAT	Value Added Tax

Preface

According to the work program of NordREG 2005 a working group was established with the objective to create common understanding concerning various extreme situations that can affect the security of supply in the different countries and the Nordic market as a whole. The energy shortage in the Nordic region due to the dry winter 2002/03 is an important background for the project.

The project started with a meeting of the working group on March 10, 2005. In addition, four group-meetings have been arranged. The working group consisted of the following persons:

- Nils Martin Espegren (convener), NVE
- Stig Haugen, (secretary from August 2005), NVE
- Uffe Strandkjær, DEA
- Ritva Hirvonen, EMV
- Margareta Bergström, EMI

Terms of reference for the group were given in the NordREG Work programme 2005.

At the end of June 2005 Econ Energia in Paris was tasked with contributing to working out a report regarding the following issues:

1. "Will the market send the right signals to market participants under extreme situations?" Extreme situations include both capacity and energy problems that might be handled. “Market participants” include system operators, producers, transmission companies and end users.
2. “Are there any structural differences between the Nordic countries that might influence the signals sent to the different participants?”

The project arranged a workshop on October 18th with following participants in addition to the working group: Håkon Borgen (Statnett), Gerard Doorman (SEfAS), Peter Børre Eriksen (Energinet.dk), Kristin Munthe (Econ), Paal Sørheim (Econ), Hege Søreng (NVE) and Marit Fossdal (NVE).

Oslo, June 19, 2006

Nils Martin Espegren

Summary

The working group has not been able to create a common definition of extreme situations because of the diversity of variables within the framework of the different countries. There is although a common understanding of the importance of being aware of the main challenges of the different severe situations that might occur in the different Nordic countries and how they might be handled.

There are major and understandable barriers to achieving harmonized rules in the different Nordic countries in handling extreme situations as well as in other areas within the electricity market area. There is, however, a common understanding within the group that the most important issue is that the regulations be compatible when it comes to handling severe or extreme situations. There should not be regulations in one country having a major negative effect on handling extreme situations in neighbouring countries.

The question of compatible rules for handling extreme situations should be limited to challenges where two or more of the Nordic countries are directly involved. Extreme situations within one country should be handled according to national regulations and acts and without any need for common Nordic rules. Extreme situations directly involving more than one country will still have to be handled according to national regulations in each country, but the need for coordination and compatibility becomes greater.

Conclusions and recommendations are described in greater detail in Chapter 6 and following headlines; measures to reduce the risk of extreme situations, improving information routines, common training for actions during extreme situations, regular meetings, and hearing of new regulations.

1 Introduction

Objective according to the NordREG work program

The objective of the project was to create common understanding within the NordREG concerning various extreme situations that can affect the security of supply in the different countries and the Nordic market as a whole. The project's aim was to scrutinize legislative and regulatory issues and differences in the various countries affecting security of supply.

Outline of the tasks

The Forum of Nordic Energy Regulators, FNER, later changed to NordREG, was tasked with creating a common understanding among the regulators concerning extreme situations and how they affect security of supply. The objective was to point out barriers to achieving common rules for handling such situations.

The working group's tasks were to:

- scrutinize legislative and regulatory issues affecting security of supply.
- describe and define extreme situations
- briefly describe the different power systems in each country
- describe the existing legislative and regulatory frameworks for handling extreme situations in the various countries
- scrutinize EU-directives to elaborate any impacts concerning the legislative or regulatory framework applied.

2 The Nordic Power System

2.1 The importance of electricity

Modern way of living is based on electricity being available in sufficient amounts and at all times. Such supply, for most consumers, is taken for granted as the normal supply is not regarded to be a problem unless it breaks down unexpectedly. Gradually society has become more and more dependent on electricity. Thus, our entire basic infrastructure – telecommunications, information technology, transportation systems, the financial sector including electronic payments, drinking water supply, etc., just to mention some examples – will experience severe difficulties in case of a power outage. Likewise, this applies to health services, industries, distribution networks, shops, offices, etc. in both the private and public sectors.

The power sector is one of the few sectors having the potential to cause major and widespread breakdowns in many other sectors. Of course, this does not happen during the frequent local and brief blackouts. But it could happen in case of a power outage covering a large part of the population for a significant period of time.

Moreover, electricity is an extraordinary commodity having significant differences from other commodities. It cannot be stored in large amounts. It cannot be transported over long distances without high costs. It is dependent on complex networks between producers and consumers, and disturbances in these networks can drastically interrupt the delivery. Further, it has to be produced at the same time as it is consumed, thus functioning under an ultimate "Just-in-Time" principle. Each of these characteristics can be found in other commodities, but very seldom together, and certainly not for a commodity as important as electricity.

Furthermore, the national transmission networks linking production and distribution have gradually become more dependent on each other. The interconnectors have changed from being bridges between different national networks to being integrated and vital parts of these networks. Thus, the national power system has to some extent acquired trans-national characteristics.

All these elements – the importance of electricity, its fundamental characteristics and the increasingly international character of the power systems – are significant in the work regarding security of supply, contingency planning and crisis management in order to avoid that a critical situation in the power system develops into a severe power outage or an extreme shortage situation with critical consequences for society.

This work requires coordination: First, coordination within the power sector between industry and authorities; second, coordination between the power sector and other sectors in society, and third, coordination between the national power sector and the power sectors in neighbouring countries. Such coordination can take many forms. It may consist of information sharing, understanding of each other's systems, vulnerabilities and capabilities, identification of problems of mutual interest, joint projects, etc. It can also be more far-reaching and may include joint crisis handling mechanisms and standardisation (of equipment, methodologies, goals, etc.).

2.2 The Nordic Power System

The Nordic power system and electricity market have undergone a restructuring process since the beginning of the 1990s when the deregulation of the electricity market began. Now there is a common electricity market consisting of Denmark, Norway, Sweden and Finland. Iceland takes part in the Nordic cooperation but is not interconnected with the Nordic power system.

Essential in developing the Nordic power market was the establishment of the Nordic power exchange, Nord Pool. The Nord Pool Group has three markets: long-term trading (financial), day-ahead (Elspot) and intra-day (Elbas). Nord Pool Spot AS is owned by the TSOs in Denmark, Finland, Sweden and Norway. In addition to Nord Pool there is substantial bilateral trade of electricity. Bilateral trade for physical delivery (day-ahead or intra-day) can only be done within Elspot areas since Nord Pool has been given the task of allocating all interconnector capacity between the Nordic countries. This process is integrated into the trading process.

Free market admission and the absence of tariffs between the countries are also essential for the Nordic power market to function efficiently.

Each country has chosen an independent TSO solution, meaning that the TSO owns, maintains and operates the national grid. Common system responsibility has been mapped by Nordel [1] and NordREG [15] to include tasks such as operational security and long-term adequacy of the transmission network.

Since 1999 the Nordic TSOs have an agreement on the operation of the Nordic power system (Nordic system operation agreement, 2004-04-01). This agreement includes, among other issues, power balancing, congestion management and handling of system failures [8].

The peak load in the interconnected Nordic system is a little less than 70.0 GW and the total installed production capacity in 2004 was about 92.6 GW. Table 1 below shows the basic characteristics of all the Nordic countries.

Nordic data	Denmark	Finland	Iceland	Norway	Sweden	Total
Area [1 000 km2]	43	337	103	324	450	1 257
Inhabitants [million]	5,4	5,2	0,3	4,6	9	24,5
Installed capacity [GW]	12,7	16,5	1,5	28,3	33,6	92,6
Consumption [TWh]	35,5	86,9	8,6	122	146,4	399
Production [TWh]	38,4	81,9	8,6	110,5	148,5	388
Hydroelectric [%]	0	18	83	99	40	49
Nuclear [%]	0	26	0	0	50	25
Other thermal [%]	76	42	0	0	4	18
Renewable [%]	24	14	17	1	6	8
Consumption per capita [kWh]	6 600	16 700	28 700	26 500	16 300	16 300

Table 1: Principal power characteristics of the Nordic countries, [Source: Nordel 2004].

The Nordic national grids consist of a mainly east-west grid in Norway and north-south grids in Sweden, Finland and Denmark with voltage levels primarily of 220, 300 and 400 kV. The exchange capacities between the Nordic countries are according to Figure 1, where you can also see the capacities between the Nordic countries and Russia, Germany and Poland, including the planned interconnector to the Netherlands.

Figure 1. Interconnectors between the Nordic countries.

As Table 1 indicates, the power systems in the Nordic countries are somewhat different. Structural differences between the electricity power systems might explain some of the differences in how the electricity branch is organised between the Nordic countries. These differences as well as different legal traditions have led to differences in the area of regulation and supervision of the market as well. The power systems in Sweden, Finland, Norway and Denmark and their main structural differences are briefly presented here. A more detailed description of the power systems in Denmark, Finland, Norway and Sweden can be found in Appendixes 1 - 4.

2.2.1 Denmark

Power generation in Denmark consist mainly of combined heat and power (CHP), conventional condensing power and wind power. The total amount of power generated in 2004 was 38.4 TWh, of which 76% were produced from thermal power like coal and gas, and 24% from renewables. The total consumption in Denmark amounted to 35.5 TWh in 2004 whereof about 65% was consumed by the service and residential sectors and the rest by industry and agriculture. Installed capacity was 12.7 GW.

Main characteristics possibly influencing the regulations and organisation of the Danish power sector are:

- CHP power plants near the cities to supply both heat and power. This has tied the electricity production to the production of heat and to the distribution heating system.
- Available production capacity during peak demand is higher than peak demand even without counting the production from wind power.
- Less predictable and less adjustable wind power has a major influence on the production system.
- Denmark has strong interconnections to its neighbouring countries Norway, Sweden and Germany. The interconnection capacity is about 40% of installed capacity which is significantly more than in the other Nordic countries (Sweden 25%, Finland 20% and Norway 16%).
- Short transmission system compared to Finland, Norway and Sweden due to significantly smaller area to cover.
- The power systems of East Denmark and West Denmark are not synchronously connected. There are no direct connections between the two parts - only via Sweden and Germany.
- The tax system in Denmark has made the electricity consumption expensive for consumers except for large industries. The result of this and other parts of the Danish energy policy is a significantly smaller power consumption per capita in Denmark compared to the other Nordic countries as indicated in Table 1.

2.2.2 Finland

Finnish power generation consists of CHP, nuclear power (26%), hydro power (18%) and thermal power of which some of the production is based on fossil fuels and renewables (14%). Total production in 2004 was 81.9 TWh. Finland consumed 86.9 TWh of electricity in 2004, and net imports of electricity amounted to 5 TWh. Total installed capacity in 2004 was 16.5 GW. All-time maximum peak demand in Finland occurred in January 2006 and measured 14.8 GW. There are 120 electricity-producing companies in Finland and the number of production plants is about 550.

Main characteristics possibly influencing the regulations and organisation of the industry are:

- Several energy sources such as nuclear, hydro, peat, natural gas and coal are important to the national power supply.
- Dependency on energy import (electricity, natural gas and oil) from neighbouring countries, especially Russia. Transmitting a significant amount of power from Russia to Sweden in 2003 and 2004 (about 6 TWh/year).
- Deficit in the total power balance in coming years. According to Nordel [4] available production capacity during peak demand is about 13.6 GW. Peak demand during a cold winter (one of 10 winters) is estimated to be about 14.8 GW.

- Production and consumption tightly connected mainly in the southern, central and western parts of the country, hydro production mainly in the northern part.
- Power-intensive industry represents a significant share (about 1/3) of the total electricity consumption in Finland, [2]

2.2.3 Norway

The Norwegian power generation is dominated by hydro power plants (99%). On average, Norway can produce 119 TWh of electricity. In 2004 the generation was 110.5 TWh. The average consumption in Norway is 122 TWh. Total installed capacity is about 28.3 GW. The maximum demand was measured in February 2001 at 23.1 GW. According to Nordel [4], available production capacity during peak demand is about 23.1 GW. Peak demand during a cold winter (one of 10 winters) is estimated to be about 23.3 GW. There are approximately 630 hydro power stations with an installed capacity larger than 1 MW.

Main characteristics possibly influencing the regulations and organisation of the industry are:

- The power production is solely dependent on hydro power, and the system is highly sensitive to variations in precipitation (energy dimensioned). The production capacity might vary between about 90 TWh (dry year) and about 150 TWh (wet year).
- The main production is along the mountains and located far away from the main cities.
- Power-intensive industry which has a major impact on total consumption (about 27% of total consumption) is mainly located near the large hydro power plants.
- In the southern part of the country long overhead lines transmit power from west to east (Oslo region).
- The topology (fjords and mountains), scattered population, the stretched-out country, the former duty to secure power supply for a region, have brought strong regional power systems with quite weak interconnections between some regions/parts of the country.
- Electricity is commonly used for space heating and consumption is therefore sensitive to changes in outdoor temperature.

2.2.4 Sweden

In Sweden, the generation mix varies with the hydrological situation. In a normal year a typical generation mix would be hydro power (40%), nuclear power (50%), and thermal and renewable energy (10%). Electricity generation from CHP and wind power is increasing. During normal and wet years the energy balance is positive. Total electricity production in 2004 was 148.5 TWh with a total electricity use of 146.4 TWh. Maximum demand in Sweden occurred in February 2001 and amounted to about 27.0 GW. Installed capacity in 2004 was 33.6 GW. The electricity use in Sweden is mostly composed of the residential and service sectors (50 %) and industry (40%).

Main characteristics possibly influencing the regulations and organisation of the industry are:

- Large surplus in the northern part (north of transmission cross-section 2) and large deficit of power in the southern part (about 30 TWh) means large amount of power transmission.
- Hydro power is mainly located in the north (north of transmission cross-section 2) and nuclear power in the south (south of transmission cross-section 2).
- Uncertainty connected to the future of nuclear production plants. After Barsebäck 2 was closed down in May 2005, there are 10 nuclear power blocks left at 3 sites. The capacity in the remaining nuclear plants is being upgraded.
- Import dependency during peak load hours. According to Nordel [4], available production capacity during peak demand is about 27.9 GW. Peak demand during a cold winter (one of 10 winters) is estimated to be about 28.8 GW.
- Few and dominating production companies makes the Nordic market important for the efficient working of the market.
- Sweden has many interconnections and the total exchange capacity is about 8.5 GW as seen in Figure 1. These amounts to about 25% of total installed production capacity in Sweden. The transmission grid between the north and south of Sweden is the main connection in the Nordic power system between the hydro power in the north and the thermal power in the south, and is an important transit link. The power flow in the Swedish transmission grid and the interconnections vary due to variations in production, especially in the hydro power plants (in the north of Norway, Sweden and Finland).
- Exposed to variations in precipitation. Variations in the Swedish production can be illustrated by comparing the power production in 2001 with 2003 showing a reduction of about 25 TWh (20%).

3 Extreme Situations

It is a great challenge to describe and define extreme situations. A number of definitions may be considered, depending on the perspective. There is a major variation between the Nordic countries regarding both the probability and the possible consequences of different kinds of disturbances. Basically, from the power system point of view, critical situations that could lead to major disruptions occur relatively frequently. Thanks to system design and redundancy these situations are seldom even noticed by the end users. The market design, where demand and supply are balanced, has up to now spared the Nordic market from the need to ration electricity since the market was opened up.

In recent years there have been a number of serious blackouts and severe power situations in several countries/areas around the world. Extreme situations are surely those that fall outside of normal operating conditions and usual operating practices.

SINTEF [3] has divided extreme situations into 3 aspects:

- Energy shortage associated with the power system's ability to cover energy consumption. It is a long-term problem with a time horizon from one month up to several years.
- Capacity shortage associated with the power system's ability to cover instantaneous demand, characterized by lack of available generation or transmission capacity.
- Power system failures are incidents where the power system components' ability to perform its function is interrupted or reduced.

The consequences can be high prices, curtailment or blackouts. High-price situations are related to an Elspot price significantly higher than the normal level for a long period of time; say one month up to several years. Such situations are mainly related to energy shortage. Curtailment situations involve controlled rationing or load shedding. Curtailment may occur due to energy shortage or in the short run due to capacity shortage. Blackout situations refer to extensive interruptions that are affected for longer periods and larger areas than can normally be expected.

In this chapter we describe the different situations and how likely they are to occur in the Nordic power system.

3.1 Energy Shortage

The concept of energy shortage in the Nordic market area is generally and specifically in Norway and to some extent in Sweden, and is basically connected to dry-year situations.

3.1.1 Dry-year problem

Hydro power plants can be divided into two groups: those with reservoirs and those without. To be able to produce during winter time when the consumption is higher, there is a need of reservoirs to store water. During summer and autumn, when the snow melts, the precipitation comes in the form of rain and consumption is low, the water level in the reservoirs increases and normally reaches the highest level late in the autumn. Some of the reservoirs are so large that the connected power plant(s) cannot process the entire reservoirs' content in a year. In that way water can be saved from one year to another. These reservoirs are useful when there is a lack of precipitation over a long period of time, like one or more years. Lack of precipitation can also be regional, i.e. in part of a country.

Within some fundamental rules, the power producers themselves decide how much water to draw from the reservoirs. Based on the expected electricity price in the future, the producers make an assessment of the value of the water. If the price is expected to be higher in the future, it makes sense to save the water in order to produce later. This way the producers do not need official requirements to save extra water in case of extremely little precipitation.

Figure 2 below illustrates how much the production from hydro power plants in Norway drops in a dry year. The figure also shows assessed deficit in dry years in 2010, 2015 and 2020, [10].

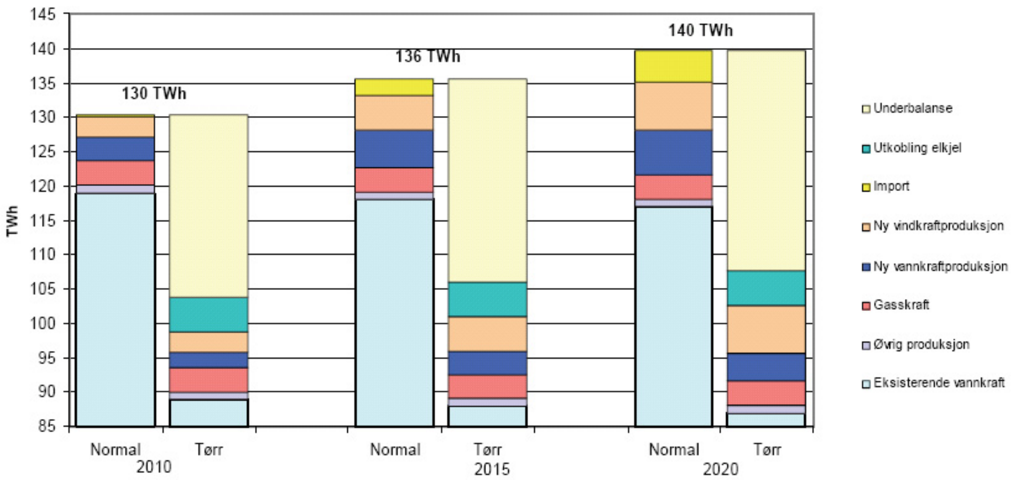

Figure 2: Power balance in Norway in an extremely dry year compared with an average year - basis alternative [10].

3.1.2 The importance of handling bottlenecks in the grid

The transmission grid is the physical backbone of an electricity market. Inadequate interconnector capacity for instance can limit possible imports into an area that has a production deficit, leading to a situation where demand cannot be met. If this continues over a longer period of time, due to hydrological conditions for instance, a lack of energy can occur in the deficit area. Thus, a good practice for congestion management can be seen as one of the tools for reducing the consequences of dry-year situations as well as all situations when access to interconnector capacity is vital to meet demand in an area, such as during peak load situations.

The TSOs are responsible for developing and maintaining an adequate transmission grid. However, it is not socio-economically feasible to invest in the grid to eliminate all congestions. The grids were originally built in order to satisfy national transmission needs. The opening of the market has increased the flow of electricity, responding even to small differences in prices between areas, which means that the flow of electricity varies considerably even between hours.

The building of interconnectors between countries is a complicated matter, due to both regulatory and financial reasons. Further, investment in transmission capacity is a lengthy process, thus there will always be a need for good practices for congestion management. New EU guidelines on congestion management are expected to be approved shortly. The Nordic TSOs cooperate in Nordel. An important task is related to congestion management and the building of new interconnectors. Even after several years of studies, there are still different opinions of how internal structural congestions in the Nordic market should be managed in the short/medium term in order to apply the best solution for the market and the power system operation. Nordel is continuing their work. A group in NordREG is also addressing this question.

3.1.3 Probabilities and consequences

SINTEF [3] has analysed the probability of energy shortage for the present energy system faced with different hydrological conditions. The analysis is based on historical inflow of water in the Nordic countries. SINTEF has used a multi-area power markets simulation model, the EMPS model, in the analysis. The model calculates the system price for electricity given these hydrological conditions and other parameters. Given these preconditions and assumptions the consumer loss caused by high prices can be calculated.

Figure 3 shows the consumer loss caused by high prices for the present system.

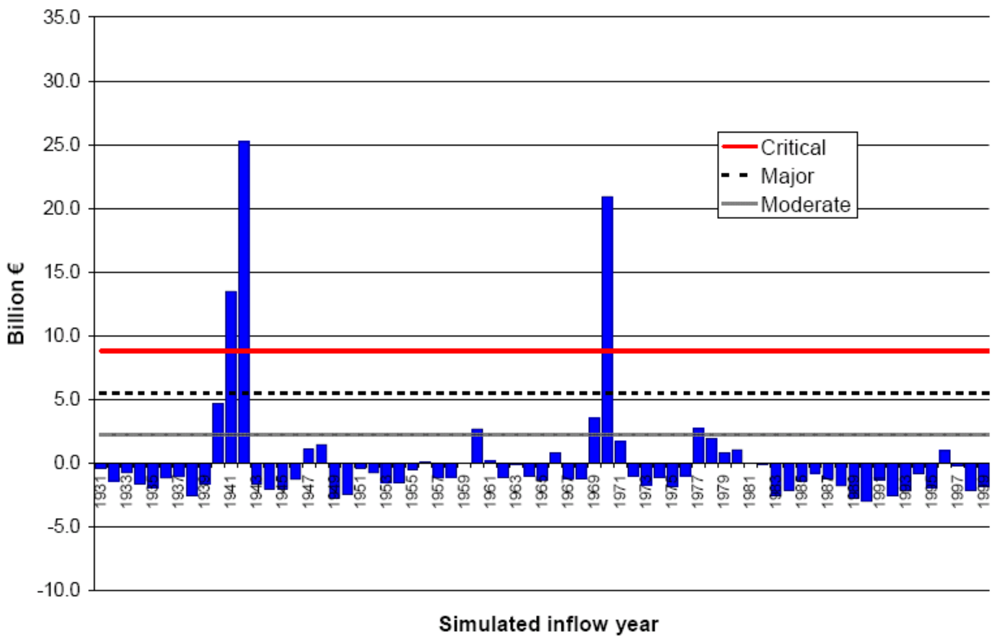

Figure 3: Consumer loss caused by high prices, present system (2005), [3].

According to SINTEF [3], the Nordic power system is in a medium risk state with respect to energy shortage. Consequences can however be critical, especially in Norway and

Sweden. The consumers' losses caused by high prices can be up to 20-25 billion euros, according to SINTEF [3] (see Figure 3 above). These losses are about 4-5 times higher than in 2002/2003 and amount to 2%-3% of total aggregated gross national product (GNP) in Denmark, Finland, Norway and Sweden. Based on historical inflow (1931-2000), the probability for this is small – it happens in two out of 70 years, i.e. 3%. Situations like in 2002/2003 or worse seem to have about twice the probability, i.e. about 6% (four out of 70 years).

3.1.4 Mechanisms to handle energy shortage

If there is lack of power production in the Nordic countries, import will normally increase. If there is also a lack of import capacity, the price in the Nordic Power Exchange (Nord Pool) and the whole power market will react with increased prices. The consumers will to some extent react to this by reducing their use of electricity. If production and import do not balance the consumption after the price increase has been in effect for some time, administrative measures like rationing may be used.

3.2 Capacity Shortage

Capacity shortage is lack of power generation and/or import to balance demand in the operational hour. This challenge is mainly to do with lack of available production capacity in the winter season to cover the peak demand.

3.2.1 Lack of production capacity

Investing in production capacity that may only operate a few hours per year may not be commercially attractive. Figure 4 below illustrates that the last hundreds of megawatts of production capacity are only needed for a few hours every year.

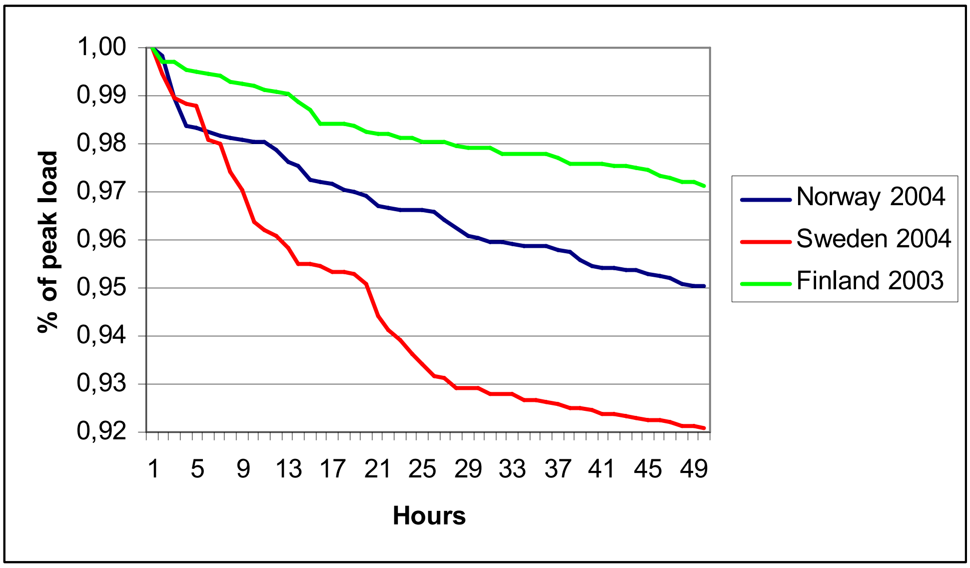

Figure 4: High load hours in Norway (2004), Sweden (2004) and Finland (2003) [11].

In addition to resources to cover the peak load, there must be capacity reserves all the time to handle changes in consumption (balancing/frequency reserves) and failures (disturbance reserves).

The reserves that are not being used but held on standby are not included in the power price for consumption (or the company responsible for balancing). Today, capacity reserves are mainly handled through different arrangements by the TSOs. In that way, the costs may be put on the network tariffs directly or charged separately by TSOs. The Nordic TSOs have made an operation agreement that covers momentary reserves. In Appendix 6 more information is presented about how capacity reserves are acquisitioned and used in the Nordic countries.

3.2.2 Probability and consequences

SINTEF [3] has analysed today's Nordic power system. The study considers three scenarios:

- Reduced import availability
- Reduced availability of hydro generation
- Outage of one nuclear unit

The outcomes in 2005 are mainly within the low risk area, but probability of a critical shortage is higher than desirable, and within the medium risk range.

Figure 5 shows the risk graph for capacity shortage for 2005 (and 2010).

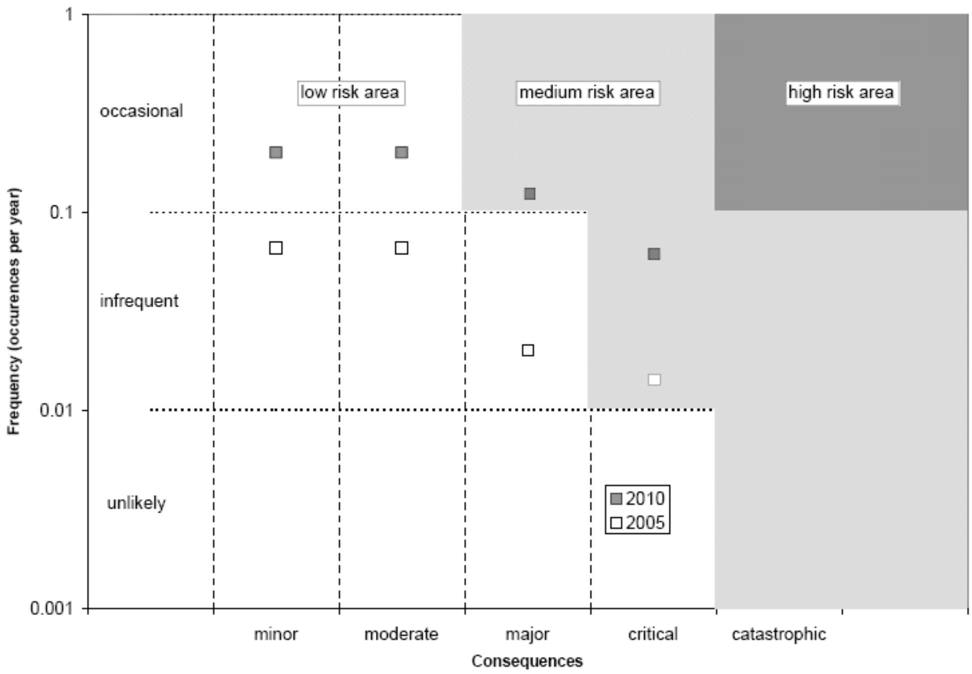

Figure 5: Risk graph capacity shortage, [3].

According to SINTEF [3], a normal winter peak (every two years) will have a positive capacity balance for all outcomes, even with reduced imports, low hydro availability and one nuclear unit out of operation. In case of a cold winter (every ten years), the Nordic countries have a need for imports exceeding the assumed realistic import capability in some cases. However, the need for import never exceeds physical import availability.

3.2.3 Mechanisms to handle capacity shortage

If the TSOs cannot handle the momentary balance between production and consumption by normal means, they will have to disconnect consumers by coercive measures. In case of a severe imbalance between generation and consumption an automatic disconnection of consumption (automatic load shedding) is used, based on the decreasing frequency in the system. The objective of this arrangement is to save the power system from collapsing.

3.3 Power System Failures

Power system failures are connected to failures in the installations that cause large interruptions.

3.3.1 Types of failures

Failures occur in the power system occasionally without extreme consequences. It is failures that cause large consequences that must be avoided and handled in efficient ways that are discussed here.

Situations that can bring severe interruption can be two or more failures in the main grid, malfunctioning of protection system after a failure in the main grid or one failure in the main grid at the same time as failure in a large power plant. Other failures in the regional and/or distribution network can also be severe. One example of severe failures in the distribution network is the storm “Gudrun” in the south of Sweden.

3.3.2 Probability and consequences

SINTEF [3] has analysed various blackout scenarios related to certain geographical areas in the Nordic countries. Five scenarios are characterized with consequences as critical or worse. These are Southern Finland (import and export case), Southern Sweden, Southern Norway and Southern Scandinavia. All these events are expected to happen infrequently, i.e. with frequency of occurrence once every 10-20 years. Thus, they are considered to be in the medium risk category.

It is interesting in that perspective to look back on historical incidents. Figure 6 below shows some blackouts in the Nordic countries since 1983 and how critical they where.

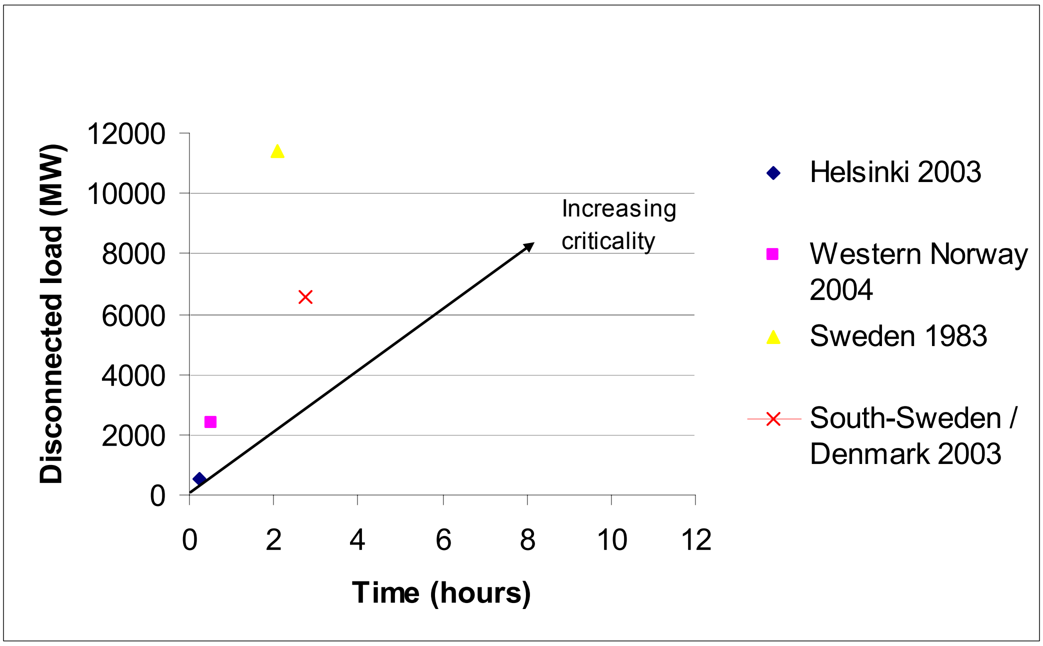

Figure 6: Illustration of criticality of some historic blackouts in the Nordic power system. [3].

The blackout in Southern Sweden and Eastern Denmark in September 2003 was a large and severe situation (10,000 MWh / 3,000 MW in Sweden and 8,000 MWh / 1,850 MW in Denmark.

Megawatts (MW) and Megawatt hours (MWh) is a somewhat technical description and should be translated to more understandable figures like number of people affected. In Sweden about 2.6 million people (about 857,000 customers) lost their power supply and in Denmark, about 2.4 million people. They lost power supply from minutes up to seven hours. The impact of the interruption was that elevators stopped between floors, electrical doors and locks stopped working, train traffic stopped, air traffic was delayed, some problems occurred with mobile telephones due to lack of power in the base stations, problems with production and deliveries in the industry, retail trade and banks had problems with securing the goods and economical transactions [7].

Long lasting interruptions during winter time can bring even worse consequences for those being affected.

Possible consequences in different sectors of long interruptions may be as described in Table 2 [5].

Sector	Consequences
Households	Maintaining inside temperature may be a significant problem during the winter period. During long interruptions, frozen water pipes may also be a problem. Spoilt food because of fridges and freezers getting warm and problems cooking can be some of the consequences.

Agriculture	The risk of losing livestock because of stoppage of the ventilation equipment may be the most important impact in this sector.
Public service	Increased costs for consumers. Possible lack of telecommunications and problems in rescue centrals may cost people's lives. Risk of penetration of polluted water due to loss of pressure in the water pipes.
Retail trade and service sector	Lost sale because of less effective IT and payment systems.
Industry (food)	Significant costs in this sector because of lost food. This is usually no problem when this can be imported.
Transport	Railroads, subways and trams will stop. Stop in IT systems will probably also be a problem. Other transport based on oil, petroleum and other corresponding fuels may be delayed due to use of hand pumps at the filling stations that have such.
Power intensive industry	Production equipment like melting furnaces in the aluminium industry may be destroyed. In addition to that, market shares abroad can be lost.
Finance	Because of reduced or non-operating IT and payment systems, the sector will operate at a low level. Losing customers to competitors abroad may also be a problem.
Offshore	The impact will probably be small thanks to reserve aggregates in the processing installations onshore.

Table 2: Possible consequences of long interruptions in different sectors, [5].

According to a study of the Norwegian power system done by ECON [5], long-lasting disconnections are a much larger potential problem than periods with high prices. They assess the probability for the price level to be so high that it creates problems as low and there are instruments available to limit the consequences.

3.3.3 Mechanisms to handle power system failures

Power system failures are very difficult if not impossible to avoid. It is important to operate the system in such a way that failures do not cause severe consequences and the consequences should be minimised. In addition, adequate maintenance and knowledge of the condition of the components in the grid is vital in order to reduce the risk of failures. Furthermore, contingency planning is of paramount importance to limit the duration of interruptions as far as possible. In Norway the income cap regulation of the grid companies includes the cost of non-delivered energy. This gives the companies one economic incentive to optimize the quality of supply according to the consumer costs of interruptions. In Sweden, the regulation model takes the quality of supply into account. Also, the grid company will soon have to pay a “fine” to customers that were out of power for more than 12 hours. In Finland the network operators have to pay standard compensation to customers for interruptions over 12 hours.

3.4 Vulnerability in the Nordic Countries

3.4.1 Denmark

Denmark has a significant surplus of power generation, and the production is mainly based on fossil fuels with such stocks normally corresponding to at least 3 months' production. Thus the vulnerability due to energy shortage seems to be low in this sense.

Production capacity is larger than peak demand both in the western part (surplus of about 0.5 GW) and in the eastern part (surplus of about 0.1 GW). The vulnerability connected to capacity shortage seems to be quite low.

The production is to a large extent close to the consumption in Denmark. This and a smaller grid with a larger proportion of underground cables in the distribution system than the other Nordic countries should make Denmark less vulnerable to blackouts than the other Nordic countries. Large volumes of import and export (due to transit and wind power) compared to production capacity will increase the vulnerability.

3.4.2 Finland

Finland has deficit in the energy balance. Although there are reserves of fuels covering five months' of consumption, there is some vulnerability because of dependency on gas and electricity imports, especially from Russia.

Finland also has a negative power balance (about 1.2 GW) and is also vulnerable in that context because of dependency on imports.

Based on SINTEF [3], Finland seems also to have some vulnerability connected to power system failures.

3.4.3 Norway

99% of Norway's power production comes from hydro power. Average production is about 119 TWh, and in 2005 consumption was 125.6 TWh. Total reservoir capacity is about 84.3 TWh. Based on historic inflow data, the production in Norway can be reduced to about 90 TWh during a dry year. Assuming a maximum import of about 18 TWh per year, this will mean that the consumption has to be reduced by about 15-20 TWh per year, or about 15%. In that regard Norway seems vulnerable to energy shortage.

Regarding power balance, Norway seems to be have a small deficit (about 0.2 GW) and is in that context not very vulnerable to a capacity shortage.

Based on SINTEF [3], southern Norway and Oslo seem somewhat vulnerable to power system failures.

3.4.4 Sweden

There seems to be a historic correlation between Norway and Sweden regarding changes in precipitation. It seems probable that Sweden also will be a high-price area during a dry year, and that the combined import capacity to the area Norway/Sweden will set the limit. Sweden seems to be somewhat vulnerable to an energy shortage.

Sweden seems to have a significant deficit in the power balance (about 0.9 GW) and seems is in that way vulnerable to a capacity shortage.

According to SINTEF [3], Southern Sweden seems to be vulnerable to power system failures. This has also recently been experienced by the failure on the 23rd of September 2003 that also affected the eastern part of Denmark.

3.5 Discussion

The working group has not been able to establish a common definition of extreme situations because of the diversity of issues connected to the definition. There is, however, a common understanding of the importance of being aware of the main challenges of the different severe situations that might occur in the different Nordic countries and how they might be handled. The criticality of a situation depends on the consequences. During winter time a severe outage could have catastrophic consequences compared to the same outages in summer time. A multi-dry year period would be defined as more extreme in Norway than in Denmark for instance.

The group, however, would like to draw attention to the methodology used in SINTEF [3] concerning system failures.

4 Legislative and Regulatory Framework

According to the EU-Directive 2005/89 of January18· 2006 concerning measures to safeguard security of electricity supply and infrastructure investment, "Security of supply" means the ability of an electricity system to supply end users with electricity.

Denmark, Finland, Norway and Sweden have different legislations and regulations to ensure the security of supply in each country. In the following, legislations, regulations and authorities involved in securing the supply are presented.

Although worded slightly differently in the legal mandates, each TSO is responsible for the technical functionality and operational reliability in the short term. There are also common agreements between the TSOs related to the integrated operation of the system during extreme situations. The significant differences are concerned with to what extent the TSOs are responsible for maintaining an adequate long-term security of supply.

One way of describing extreme situations are by categorizing them into 1) Energy shortage, 2) Capacity shortage and 3) Power system failures. In chapters 4.3 to 4.6 we have tried to describe how this is handled in the Nordic countries, and we have also given an introduction to the framework in the EU.

4.1 Main National Legislation

4.1.1 Norway

The relevant legislation for contingency planning and crisis management in Norway is:

- The Energy Act (Energiloven) (1990-06-29 no 50)
- The Energy Act Regulation (Energilovforskriften) (1990-12-07 no 959)
- Regulations relating to System Responsibility (2002-05-07 no 448)
- Regulations relating to Contingency Planning (2002-12-16 no 1606)
- Regulations relating to Energy Planning (2002-12-16 no 1607)
- Regulations relating to Quality of Supply (2004-11-30 no 1557)
- Regulations governing the planning and implementation of requisitioning of power and enforced reductions in supply in connection with electricity rationing (2001-12-17 no 1421)

4.1.2 Sweden

In Sweden the relevant legislations for contingency planning and crisis management are:

- The Electricity Act (1997:857)

- The Electricity Preparedness Act (1997:288)
- The Rationing Act (1978:268) (needs updating)
- Price Regulation Act (1989:978) (needs updating)
- Ordinance regarding the responsibility for peacetime crisis management and high preparedness (2002:472)
- Ordinance with Instructions for "Affärsverket Svenska Kraftnät" (1991:2013)
- The Standby Power Capacity Act (2003:436)

4.1.3 Finland

The relevant legislations in Finland are:

- The Electricity Market Act (386/1995)
- Decision of the Council of State (350/2002)
- The Preparedness Act (1080/1991) (including amendments)

4.1.4 Denmark

In Denmark the relevant legislation with respect to contingency planning and crisis management for the power sector is:

- Article 24 of the Civil Emergency Procedures Act
- Article 85 b of the Electricity Supply Act
- Regulation no. 58 of 17 January 2005 governing contingency planning and crisis management for the power sector.
- Regulation no. 917 of 13 November 2002 governing contingency planning regarding fuel storage in the electricity sector.

4.2 Energy Shortage

Concerning energy shortage, there are several aspects to consider. In the Nordic countries there are different participants who have the responsibility for long-term generation adequacy and meeting of demand and long-term and short-term demand and supply monitoring. This is described in the following text.

4.2.1 Norway

In the deregulated power market the power suppliers are responsible for meeting demand in the form of contracts with their customers.

Every area-license holder is responsible to do a long-term power system study every year to ensure a social economic development of the power system. This is a statutory provision in the Energy Act (§5-B1).

According to §12 in the Regulations relating to System responsibility, every concessionaire shall prepare a plan for effective restoration of normal operation of their own grid in the case of a disturbance. This plan must be available for the TSO. According to §13 in the same regulation, every concessionaire must develop a plan to handle forced disconnection from the grid. In special situations, the TSO can impose a concessionaire to start a short-term disconnection of load.

In §22a in the Regulation relating to System Responsibility, it states that the TSO has the responsibility to continuously review and develop necessary means to handle periods of a very straining power situations. The TSO shall inform the NVE about instruments studied, and these instruments cannot be used without a resolution from the NVE.

The TSO shall also inform the NVE about the development of the power system and the capacity and energy balance.

In times of crisis or war, the power supply industry is subordinated the body KBO. This is stated in the Energy Act, §5A-2, where it says that the government selects a rationing authority and this authority can delegate responsibility to the power supply preparedness organisation (KBO). This is further described in the Regulations relating to Contingency Planning and Regulations governing the planning and implementation of requisitioning of power and enforced reductions in supply in connection with electricity rationing. Further information is described in Appendix 3.

4.2.2 Sweden

The power suppliers are responsible for meeting demand in the form of contracts with customers because of the deregulated power market.

The Energy Authority is responsible for the planning and coordination of preparedness preparation for different energy sources including planning for rationing. They are also responsible for who should store fossil fuels and to what extent. The storage capacity is based on the oil consumption the previous year. The Energy Authority controls how Sweden fulfils its storage obligations to the EU and the IEA.

The Electricity Preparedness Act contains information about preparedness and responsibility during times of crisis and war. The Swedish TSO, Svenska Kraftnät (SvK), is responsible for planning for society's power requirements during times of crisis and war. In addition, responsibility for dam safety rests with SvK. More information is described in Appendix 4.

4.2.3 Finland

In the deregulated power market the power suppliers are responsible for meeting demand in the form of contracts with their customers.

To meet its responsibilities as TSO, Fingrid shall develop its grid so that an efficiently functioning electricity market can be ensured. This system responsibility is described in Section 16 of the Electricity Market Act (EMA).

According to Section 35 of the Electricity Market Act, the government may decide on the organisation of a public invitation to tender for new electricity generation capacity or demand-side actions in order to secure the energy supply. This may be an alternative if the existing power system cannot meet the electricity demand in Finland.

When it comes to forecasting of supply and demand, the Electricity Market Authority are obligated to publish annual reports on the supervision and development of the balance between supply and demand of electricity. This is given by Section 38 in the Electricity Market Act. The section does however not say anything about how far into the future this monitoring should occur. In practise the long-term monitoring is done by the Ministry of Trade and Industry, because they are responsible for preparation of the Finnish energy strategy and this includes scenarios for long-term demand and supply.

4.2.4 Denmark

The State-owned company Energinet.dk is the system operator (TSO) in Denmark. As TSO, Energinet.dk is responsible for several tasks concerning the power system. In the short term Energinet.dk is responsible for ensuring the balance between demand and capacity. In the long run the responsibility for ensuring the capacity balance rests with the market, but is monitored by Energinet.dk, and as a last resort the responsibility rests with the Danish Energy Authority.

The energy balance is not an important issue in the Danish power system in the longer-term perspective as the system is based on thermal power plants. In the short run it is important to have sufficient stocks of fossil fuels to cover the demand in case of a crisis situation where such fuels cannot be imported to the country.

According to §27a in the Electricity Supply Act Energinet.dk is responsible for the security of supply in Denmark. One implication of this is that Energinet.dk has the responsibility of ensuring that there is a sufficient production capacity in the power supply. For instance, Energinet.dk shall provide the Danish Energy Authority with an assessment of the security of supply situation 10 years ahead, including forecasts of demand and supply. Based on this assessment the government can take actions to commence the tendering procedures launched in the EU directive, as a last resort.

During the operational hour Energinet.dk can demand that the power producer adjust his production provided this is necessary to secure the supply.

In addition, under §28 of the Electricity Supply Act Energinet.dk shall prepare yearly overviews and predictions to be used by relevant and potential participants in the market.

According to Regulation no. 917 Energinet.dk shall also monitor the level of the stocks of fossil fuels of the power producers and compare this with the amount necessary to cover the expected power demand during the subsequent three months. If these stocks are not sufficient, Energinet.dk will notify the Danish Energy Authority, which can then decide on the need for taking actions.

4.3 Capacity Shortage

The Nordic countries have placed the responsibility for momentary (within an hour), balance and capacity reserves with the TSOs, but there are some differences which are described in the following subchapters.

4.3.1 Norway

Statnett has the responsibility to ensure that there is a momentary balance between generation and consumption, including international connections to other grids. Statnett is also responsible for securing capacity reserves in the long term. These responsibilities are given through the Energy Act, §5A-1, and the regulations relating to System Responsibility.

The Norwegian system operator is required to dispose on sufficient operating reserves to be able to balance the system in real time. In case of insufficient generation to meet demand, Statnett will be penalized financially if it should have to disconnect load to save the system. Due to the limited generation margin that has developed Statnett developed an option market to secure sufficient fast operating reserves during high demand periods (November – March). This reserves option market (RKOM) in its first version was launched in 2000 [12]. According to Terms and Conditions published 19 October 2005 [13], Statnett determines when bids for RK options will be invited. Offers are normally requested for a period of one week, Monday-Sunday. Offers can be made for several weeks, but every week will be treated separately. Norway is divided into three geographical areas (NOA-south, NOB-mid and NOC-north). Statnett decides which offers are to be accepted. The primary criterion for acceptance within each grid area is the offering price, but local grid conditions and the balance between generation and consumption can result in exceptions from this criterion. All bidders with accepted offers in the same grid area will in general be given the same price, equal to the price of the highest accepted offer (marginal pricing). This marginal price will be published on Statnett's web-page. More information is described in Appendix 6.

4.3.2 Sweden

The Swedish TSO Svenska Kraftnät (SvK) has been given the responsibility for momentary balance and capacity reserves in the central grid. This responsibility has been given through the Electricity Act (1997:857) and the ordinance (1991:2013) with instructions for the "Affärsverket svenska kraftnät". There is also a temporary law (until 2008), The Standby Power Capacity Act (2003:436), that gives SvK the responsibility for making sure that there is a long-term supply of capacity. The Act gives SvK the right to purchase special peak load reserves. After 2008 the market is responsible for this task. More information is described in Appendix 6.

4.3.3 Finland

The Electricity Market Act states the tasks for the system responsibility including the momentary (hourly) balance between demand and supply and availability of reserves. The system operator and balance providers are responsible for keeping the momentary balance. All the participants are required to provide measurement data and other information regarding production, consumption and supply needed to fulfil the balancing responsibility. In addition, any electricity market participant is responsible for ensuring that the generation and purchase of electricity cover the participant's electricity consumption and supplies each hour. These regulations are given in Section 16 of the Electricity Market Act. Balancing service is provided with market-based methods using the Nordic regulation market.

As far as the power reserves are concerned, the TSO's goal is to make sure that sufficient volume of reserves is maintained continuously in Finland in a cost-efficient manner and in accordance with the system-operation agreement signed between the Nordic transmission system operators. The TSO produces only part of the system services (TSO owns 515 MW gas turbines used as fast disturbance reserve) and the maintenance of reserves is primarily arranged as a service purchased from electricity producers and reserve holders. The TSO has established a "reserve bank" where companies owning controllable capacity can register their resources. The resource owners maintain the agreed and measured properties at their power plants in the agreed manner and receive the compensation from the TSO. As far as the agreements concerning the maintenance of primary reserves (frequency controlled normal operation reserve and frequency controlled disturbance reserve) are concerned, the terms, contents and compensations specified in the agreements are identical for all service providers. The load shedding serving as primary and secondary reserve (frequency control and fast disturbance reserve) have been agreed upon with companies in the pulp and paper, chemical, and metal industries. The agreements provide for a total power of around 1,000 MW and will be in effect from 2005 to 2015. More information about this is described in Appendix 2 and 6.

4.3.4 Denmark

Under § 27a of the Electricity Supply Act, Energinet.dk shall secure a momentary balance between production and consumption. This is secured through agreements on power reserves which have been concluded by Energinet.dk with power producers. More information is provided in Appendix 6.

4.4 Power System Failures

When it comes to power system failures, the responsibility for the security of grid infrastructure and grid operation can vary depending on whether it concerns long-term or short-term aspects and transmission or distribution grids. There is also the aspect of contingency plans and resources. This is described below.

4.4.1 Norway

Every grid concessionaire is responsible for long-term and short-term security for grid operation. For electrical installations with a voltage above 22 kV installations concession is needed. According to conditions for installation concessions the concessionaire must operate and maintain the installation according to §3-4 in the Energy Act Regulations. Statnett is responsible for the central grid operation and infrastructure according to the regulations relating to System Responsibility and the white paper from 1990 about the splitting of Statkraft (Power producer) and Statnett. The area concessionaires are responsible for distribution grid operation and infrastructure according to §3-3 Duty of Supply in the Energy Act Regulation.

The TSO is also responsible for developing a plan for future demand of transmission capacity in the grid and connection to other grids according to Regulations relating to System Responsibility and Regulations relating to Energy Planning.

In Norway all the grid and production companies are responsible for contingency planning for their own installations and for having an adequate level of contingency preparedness. NVE is responsible for the overall coordination of contingency planning in the power sector.

4.4.2 Sweden

SvK has been given the responsibility for the short-term and long-term security of transmission grid operation while the area concessionaire is responsible for short-term and long-term security of distribution grid infrastructure through the Electricity Act (1997:857), Chapter 3. This includes satisfactory technical quality of the grid, through maintenance and new investments.

The TSO is also responsible for developing a plan for future demand of transmission capacity in the grid and connection to other grids.

When it comes to contingency planning, the Swedish Energy Authority has the overall responsibility for the coordination of contingency planning for all energy regarding both the electricity system and the customers. Svenska Kraftnät is the electricity preparedness authority according to the Electricity Preparedness Act, and can issue regulations in this area. SvK has the responsibility to plan, lead and coordinate the resources of the electricity system.

4.4.3 Finland

Electricity Market Act (EMA) sets the responsibility for both the short-term security of transmission grid operation and long-term security of transmission grid infrastructure to the transmission company. The system operator shall maintain, operate and develop its electricity system and the connections to other systems. This is given by section 9 and 16 in the Energy Market Act. The Energy Market Authority has given Fingrid the licence to be the TSO, and thereby Fingrid has this responsibility in Finland.

When it comes to the distribution grid, section 6 in EMA assigns the responsibility to the distribution companies (DSO). Every DSO has the responsibility within defined regions. These regions are defined in the network licence.

The responsibility for contingency plans is divided between the TSO and DSOs in the same way. The TSO has the responsibility in the transmission grid, whereas the DSO is responsible for the distribution grid.

In Finland the Preparedness Act regulates the contingency planning. This act is administrated by The National Emergency Supply Agency (NESA) which is planning and operating activities to maintain and develop the country’s preparedness.

4.4.4 Denmark

Transmission and distribution activities can be performed by enterprises under a licence. Such licences are granted by the Danish Energy Authority.

All grid owners have the responsibility of providing satisfactory technical quality of their own grids. A licensed company in each area shall secure that its distribution grid is in a satisfactory shape.

Energinet.dk is responsible for the quality of the transmission grid and for developing a plan for the future demand of transmission capacity in the grid and connections to other grids.

All companies providing power production, transmission and distribution, including Energinet.dk, are responsible for their own contingency planning and for having an adequate level of contingency preparedness. Energinet.dk is responsible for overall coordination and planning with respect to the entire power sector as regards contingency situations and for supervision of the contingency planning, etc. of the companies. Further information is described in Appendix 1.

4.5 EU-directives

In Article 4 and Article 7 of the Directive 2003/54/EC monitoring of security of supply and tendering procedures for new capacity are dealt with. Besides this directive a new Directive 2005/89/EC, concerning measures to safeguard security of electricity supply and infrastructure investment, was published on January 18, 2006. In general the Directive establishes measures aimed at safeguarding security of electricity supply to ensure a proper functioning of the internal market for electricity. In addition, the Directive seeks to ensure an adequate level of generation capacity, an adequate balance between supply and demand and an appropriate level of interconnection between Member States for the development of the internal market. It establishes a framework so that each Member State can define its own policies on security of electricity supply compatible with the requirements of a competitive internal market for electricity.
According to the Directive, all Member States shall monitor the balance of supply and demand on the national market, the level of expected future demand, capacity being planned or under construction, and quality and maintenance level of the networks. Member States shall also ensure that transmission and distribution system operators comply with the minimum operational obligations on network security, and make sure that the TSOs maintain an appropriate level of technical transmission reserve capacity.

The Member States shall ensure a high level of electricity supply by taking the necessary measures to facilitate a stable investment climate and by defining the necessary roles and responsibilities of competent authorities. The possibility of providing for new capacity or energy efficiency/demand-side management measures shall be ensured through a procedure that is both transparent and non-discriminatory in order to secure the supply. An authority or public or private body that is independent from electricity generation, transmission, distribution and supply activities shall be responsible for the organisation, monitoring and control of this. More information is provided in Appendix 5.

4.6 Summary

In all the Nordic countries the market is responsible for the balance between production and demand in the long term.

The TSOs in the Nordic countries are all responsible for maintaining the momentary balance in their respective systems, including interconnectors to other grids. They are also responsible for securing capacity reserves within the operational hour. The TSO in Denmark is responsible for securing long-term reserves (years ahead), while the TSO in Norway has a shorter perspective and purchases the reserves on a weekly basis. In

Sweden there is a temporary law that states that the TSO is responsible for securing capacity reserves, but after 2008 this will be left to the market. In Finland the TSO is responsible for securing the balance between demand and supply during the operational hour.

In all the Nordic countries the TSOs and the local or regional network licence holders are responsible for the short-term and long-term security of their own grids. In Norway, Sweden and Denmark the TSOs are also responsible for developing a plan for the future demand of transmission capacity in the grid and connection to other grids. The TSO in Finland is responsible for development of the grid, and also secures the maintenance of operational security which implies that the power system is planned and operated in a way that the impacts of disturbances are minimised. Here the grid planning, transmission limits, disturbance management and reserves (frequency-controlled and fast-disturbance reserves, black-start reserves) are considered.

When it comes to contingency planning, the countries have somewhat different approaches. In Denmark, Sweden and Norway all companies providing electricity production, transmission and distribution are responsible for their own contingency planning. In Denmark, Energinet.dk is responsible for overall coordination and planning with respect to the entire power sector as regards contingency situations and for supervision of the contingency planning, etc. of the companies. In Sweden, The Swedish Energy Authority has the overall responsibility for coordinating the overall contingency planning in the energy sector, and SvK has the responsibility to lead and coordinate the resources of the electricity system in a war-like situation. In Norway, NVE is responsible for the overall coordination of contingency planning in the power sector. In Finland, the National Emergency Supply Agency (NESA) is planning and operating activities for the country's preparedness.

There is Nordic cooperation between the authorities and other parties involved in contingency planning in the electricity sector. This cooperation does not in general involve the regulators.

5 Common Handling of Extreme Situations

5.1 Introduction

In the project, different challenges in handling extreme situations has been discussed. The discussion has been interesting and to some extent fruitful as a way to achieve a common platform for further work. There are major and understandable barriers to achieve harmonized rules in the different Nordic countries in handling extreme situations as well as in other areas within the electricity market area. There is however a common understanding within the working group that the most important issue is that the regulations be compatible when it comes to handling severe or extreme situations. There should not be regulations in one country having a major negative effect on handling extreme situations in neighbouring countries.

In this chapter we have focused on some barriers (explanations) because of which it is problematic to achieve a fully harmonized regulation of handling extreme situations, but we have also pointed out some areas where it might be possible to improve the capability of the Nordic countries to handle extreme situations.

5.2 Barriers

5.2.1 Different physical and administrative structure in the energy sector

Earlier in this report the physical structures of the power systems in the Nordic countries have been described. This description shows that there are, in part, significant differences concerning the power generation in the different Nordic countries. For instance, there are surplus of power production and secure supply of fuels to the thermal power plants in Denmark. Denmark is therefore less concerned about regulations connected to power rationing than Norway, and to some extent Sweden, where the energy balance can be strained in dry years.

5.2.2 Different legal framework and responsibility

The Nordic countries have different acts and regulations regulating the power sector in each country. Concerning security of supply and handling of extreme situations, each country has several acts and regulations dealing with these issues. Norway and Sweden have acts/regulations concerning rationing, while Denmark and Finland do not have such regulations. Instead, they have a regulation securing sufficient fuel stocks for the power industry.

Regarding the handling of the power balance, there are some differences but also similarities in the legal framework. In Norway Statnett is given the responsibility by regulation (System responsibility) to handle the momentary balance at any time including securing sufficient reserves. In Sweden Svenska Kraftnät (SvK), as the authority responsible for the system, has the responsibility to hold reserves based on a temporary act (The Standby Power Capacity Act 2003:436). In Finland Fingrid has the system responsibility, including securing the momentary balance between demand and supply according to the Electricity Market Act. In Denmark Energinet.dk has the responsibility of momentary balance and reserves through §27a in the regulation governing contingency planning and crisis management for the power sector.

Regarding operation, maintenance and development in the transmission grid, all the Nordic countries seems to have quite similar responsibilities. All the TSOs seem to be responsible for operation, maintenance and investing in the main transmission grid. However, the main transmission grids are somewhat differently defined in the Nordic countries. In Norway the transmission grid (sentralnettet) covers almost all 420 kV and 300 kV grids (including transformer stations) and some of the 132 kV grid. In Sweden the transmission grid (stamnätet) covers the entire 400 kV and 220 kV grid (including transformer stations). In Finland it (kantaverkko) covers the entire 400 kV and 220 kV grid (including transformer stations) and some of the 110 kV grid. In Denmark it (transmissionsnettet) covers the entire 400 kV grid (including transformer stations) and most of the 150 kV and 132 kV grid.

Responsible for operating, maintaining and developing the distribution grids are the distribution owners (operators) in all the Nordic countries. In Denmark and Norway all the grid and production companies are responsible for contingency planning for their own installations and for having an adequate level of contingency preparedness. In Denmark Energinet.dk is responsible for the overall coordination of contingency planning in the power sector, and in Norway NVE has this responsibility. In Sweden, The Swedish Energy Authority has the overall responsibility for the coordination of contingency planning for the energy sector. Svenska Kraftnät is the electricity preparedness authority according to the Electricity Preparedness Act, and can issue regulations in this area. SvK has the responsibility to plan, lead and coordinate the resources of the electricity system in a war-like situation. In Finland the Preparedness Act regulates the contingency planning. This act is administrated by The National Emergency Supply Agency (NESA) which is planning and operating activities to maintain and develop the country's preparedness. Grid companies have the responsibility to operate, maintain and develop their grids within their area or region. This also includes the contingency planning part.

5.3 Possibilities

In this chapter possible measures are suggested to reduce the risk of extreme situations and to improve the handling of extreme situations.

5.3.1 Measures to reduce the risk of extreme situations

Different measures to reduce the risk of energy shortage, capacity shortage and interruptions should be considered. Regarding energy and capacity shortage, the energy regulators have an important role in developing the regulation so that the market and arrangements are efficient and well-functioning. In this context congestion management and price flexibility are important.

Finland has implemented, and Norway and Sweden are implementing, an arrangement to reduce long-lasting interruptions and faults in delivery. This implies compensation for interruptions lasting for more than 12 hours being paid to consumers by network companies. This arrangement will give incentives to the grid companies to make sufficient investments and maintenance to avoid severe interruptions. In the future other possible socioeconomically-beneficial arrangement could be introduced to reduce the risk of extreme situations. This could be regulation of the revenues of the grid companies and the TSOs depending on the quality of supply and amount of bottlenecks. The working group suggests that NordREG initiate a discussion of this subject in the near future.

5.3.2 Improve information routines

According to Nordic system operation agreement between the Nordic TSOs, statements of incidents and disturbances of larger category and implemented measures must consecutive be available for the contracting parties during the operation hour. Beyond that the existing information routines regarding handling of extreme situations seem to be somewhat different in the Nordic countries. This is described further in the following text:

Denmark

Energinet.dk is responsible for exchanging the relevant information with the other TSOs in case of extreme situations.

Finland

Fingrid is responsible for exchanging relevant information with the other Nordic TSOs. Fingrid as the entity responsible for the system should provide market participants with information relevant to power system security, including relevant measurements and also information on risks of power shortages.

Norway

In extreme situations the rationing authority (NVE) has a special responsibility to ensure overall and coordinated information about the power situation to the participants in the power market and to the public. In such situations, the rationing authority may provide guidance to the TSO regarding their information activity [14]. The rationing authority shall secure an adequate coordination of the information given to the Ministry of Petroleum and Energy (OED), the power supply emergency preparedness organisation (KBO), the Directorate for Civil Protection and Emergency Planning (DSB) and Nord Pool. Further information about this is described in Appendix 3.

Sweden

In an extreme situation Svenska krafntät is responsible for maintaining or recreation the operation of the system. In order to fulfil this task, Svenska kraftnät has the right and the obligation to exchange information with the market players and the relevant central, regional and local authorities.

In summary

It is important to have a timely and sufficient exchange of information between the Nordic countries before, during and after extreme situations. This working group has not evaluated whether the existing information exchanges of this character need to be improved. However, such evaluation could be a task to be undertaken by the authorities responsible for contingency planning and crisis management regarding the power sector. NordREG could recommend to these authorities that such evaluation be undertaken.

5.3.3 Common training for actions during extreme situations

The existing training regarding handling of extreme situations seems to be somewhat different in the Nordic countries. This is described further in the following text:

Denmark

It is a matter for each company to secure adequate training of their personnel.

Finland

In principle, each company should take care of the training of their personnel to also handle severe situations, e.g. situations which are not regarded to be under the preparedness actions. Functioning of plans for severe situations is tested through training exercises, where several companies may be involved at the same time to test how the co-operation works.

Training regarding handling of severe operational situations within the power system is carried out in Fingrid's control centre with the help of a power system simulator, where the unexpected and most severe incidents occurring in the power system can be trained.

Norway

Different kinds of training regarding handling of extreme situations have been carried out in Norway. The close dependency between power supply and the Information and Communication Technology (ICT) suppliers, and the possible large consequences of outages, was the background to an exercise last autumn between NVE, Norwegian Post and Telecommunications Authority (PT), Statnett and Telenor. Other exercises connected to shortage of power and power outages have been carried out together with participants like the County Governor, the Directorate for Civil Protection and Emergency Planning (DSB) and district managers (KDS). Also, in 2006 there are plans to implement exercises in Norway.

Sweden

Contingency training is coordinated by Svenska kraftnät and other relevant authorities. The aim is that all personnel in critical positions shall know what to do in an extreme situation.

In summary

The need for common training of personnel involved in crisis management regarding the power sector should be considered by the authorities responsible for contingency planning and crisis management.

5.3.4 Regular meetings

It might be worthwhile for the regulators to meet regularly - once a year or once every two years - with the authorities responsible for contingency planning and the TSO's in order to discuss matters including compatible rules and information exchange regarding the handling of extreme situations. The working group suggests that a small NordREG group be established for this purpose, provided that the other authorities and parties in question agree to participate in such discussions.

5.3.5 Hearing of new regulations

When there are proposals in one of the Nordic countries to change acts and regulations concerning the electricity market and power system, the other Nordic countries would possibly also benefit from being informed. The working group suggests that NordREG assess whether it is possible to send a consultation paper to ministries, regulators and TSOs of the other Nordic countries within existing legislations or whether legal changes are necessary.

6 Conclusion and Recommendations

In all Nordic countries the market is supposed to handle the balance between production and demand under normal conditions. On the other hand, the energy regulators (and the ministries) are responsible for securing a framework for investments and ordinary grid-operation that create an efficient and well-functioning power market. The TSOs are responsible for maintaining the momentary balance in their respective systems, including interconnectors. They are also responsible for securing capacity reserves within the operational hour. In all the Nordic countries the TSOs and the local or regional network licence holders are responsible for the short-term and long-term security of their own grids.

When it comes to handling of extreme situations like energy shortage, capacity shortage and power system failures in the operational hour, there are different arrangements in the Nordic countries. Norway and Sweden, for instance, have an act/regulation concerning rationing, while Denmark has regulations about contingency planning in the power sector, and Finland has a regulation securing sufficient fuel stocks to the power industry.

The working group has not been able to create a common definition of extreme situations because of the diversity of variables within the framework. There is, however, a common understanding of the importance of being aware of the main challenges of the different severe situations that might occur in the different Nordic countries and how they might be handled. The severity of a situation depends on the consequences. During winter time a severe outage could create very severe or even catastrophic consequences compared to the same outage in the summer time. The consequences of a dry period lasting several years would be much more severe in Norway than in Denmark, for instance. However, the group would like to draw attention to the methodology used in SINTEF Energy Research's report "Vulnerability of the Nordic power system" [3], concerning system failures. The responsibility for handling extreme situations within Nordic authorities differs. Thus the competent authorities should be involved when co-operation is required at Nordic level.

All the Nordic countries and relevant actors in the market area should work towards preventing and preparing for extreme situations with respect to

- prevention of such situations and the reduction of the vulnerabilities of the power system; and
- handling of such situations and management of the consequences.

The question of compatible rules for handling extreme situations should be limited to challenges where two or more of the Nordic countries are directly involved. Extreme situations within one country should be handled according to national regulations and acts and without any need for common Nordic rules. Extreme situations directly involving more than one country will still have to be handled according to national regulations in each country, but the need for coordination and compatibility becomes greater.

The working group suggests that the following issues be considered to be included in further work by either NordREG and/or by other authorities or parties with respect to the handling of extreme situations:

- **Measures to reduce the risk of extreme situations**: Different measures to reduce the risk of energy shortage, capacity shortage and interruptions should be considered. Regarding energy and capacity shortage the energy regulators have an important role in developing the regulation so that the market and arrangements are efficient and well-functioning. In this context congestion management and price flexibility are important.

  Finland, Norway and Sweden are implementing an arrangement to reduce long-lasting interruptions and faults in delivery. This implies compensation for interruptions lasting for more than 12 hours being paid to consumers by network companies. This arrangement will give incentives to the grid companies to make sufficient investments and maintenance to avoid severe interruptions. In the future other possible socioeconomically-beneficial arrangements could be introduced to reduce the risk of extreme situations. This could be regulation of the revenues of the grid companies and the TSOs depending on the quality of supply and amount of bottlenecks. The working group suggests that NordREG initiate a discussion on this subject in the near future.

- **Improve information routines:** It is important to have a timely and sufficient exchange of information between the Nordic countries before, during and after extreme situations. This working group has not evaluated whether the existing information exchanges of this character need to be improved. However, such evaluation could be a task to be undertaken by the authorities responsible for contingency planning and crisis management regarding the power sector. NordREG could recommend to these authorities that such evaluation is undertaken.

- **Common training for actions during extreme situations:** The need for common training of personnel involved in crisis management regarding the power sector should be considered by the authorities responsible for contingency planning and crisis management.

- **Regular meetings:** It might be worthwhile for the regulators to meet regularly - once a year or once every two years - with the authorities responsible for contingency planning and the TSOs in order to discuss matters including compatible rules and information exchange regarding the handling of extreme situations. The working group suggests that a small NordREG group be established for this purpose, provided that the other authorities and parties in question agree to participate in such discussions.

- **Hearing of new regulations**: When there are proposals in one of the Nordic countries to change acts and regulations concerning the electricity market and power system, the other Nordic countries would possibly also benefits from being informed. The working group suggests that NordREG assess whether it is possible to send a consultation paper to ministries, regulators and TSOs of the other Nordic countries within existing legislation or whether legal changes are necessary.

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Appendix 1. Denmark

Legislation

The relevant legislation with respect to contingency planning and crisis management for the power sector is as follows:

- Article 24 of the Civil Emergency Procedures Act whereby all ministers shall, each within their respective areas, plan for the maintenance and continuation of social functions in case of incident and catastrophe.
- Article 85 b of the Electricity Supply Act governing contingency planning and crisis management for the power sector in general.
- Regulation no. 58 of 17 January 2005 governing contingency planning and crisis management for the power sector.
- Regulation no. 917 of 13 November 2002 governing contingency planning regarding fuel storage in the power sector.

The Danish regulations with respect to contingency planning and crisis management are almost identical with respect to the power and natural gas sectors.

Authorities

The Danish Energy Authority (Energistyrelsen) is, on behalf of the Minister for Transport and Energy, responsible for contingency planning and crisis management in the different energy sectors, including the power sector.

Transmission system operator (TSO)

State-owned *Energinet.dk* is the TSO. This company was established in 2005 by merging the former TSO's (Elkraft System and Eltra in the power sector and the natural gas TSO Gastra). *Energinet.dk* has the overall, coordinating responsibility for contingency planning and crisis management in the power and natural gas sectors in Denmark in relation to the power companies.

Contingency planning and crisis management in relation to the power sector.

Thus, matters concerning contingency planning and crisis management relating to the power sector are handled by the Danish Energy Authority. This work is based on Article 85 b of the Electricity Supply Act which stipulates:

- All companies providing power production, transmission, and distribution pursuant to the Act, including the TSO Energinet.dk, shall prepare the necessary planning and shall take the necessary steps to safeguard the power supply during crises and other extraordinary situations.
- The TSO - that is Energinet.dk - shall manage the general and coordinating tasks regarding planning and operational matters with respect to contingency planning and crisis management which are carried out by the power companies.
- The Minister for Transport and Energy has the authority to lay down rules with respect to the contingency planning and crisis management tasks.
- The Minister for Transport and Energy has the authority to lay down rules with respect to the performance of inspections of the contingency planning and crisis management tasks, including the submission by the companies of material as supportive data for the inspections and other related matters. Such regulations may specify that the TSO shall carry out the inspection tasks in relation to the companies.

More detailed rules regarding contingency planning and crisis management with respect to the power sector came into force as of 1 February 2005 and are presently in the process of being implemented by the TSO and by the companies in the power sector. The stipulations cover the following topics:

a. Organizational matters.
b. Contingency planning and crisis management, including the preparation of vulnerability analyses, general contingency plans, detailed contingency plans, and security plans.
c. The general, coordinating tasks to be carried out by the TSO, Energinet.dk.
d. Training, exercises, the reporting of relevant incidents, statistics, etc.
e. Operational matters during a crisis.
f. Inspection of the companies' work regarding contingency planning and crisis management.
g. Other matters.

Participants in handling major crises situations regarding the power supply.

Modern way of living is based on electricity being available in sufficient amounts and at all times. As society has become more and more dependent on electricity our entire basic infrastructure will experience severe difficulties in case of a power outage. Thus, the power sector can potentially cause breakdowns in many other sectors in case of a large and long-lasting power outage.

Therefore, the handling of a severe power outage may involve other participants than just the power sector. The general Danish crisis management system may be involved. This will involve a number of Danish authorities both at the national level and at the regional level.

Thus, the crisis management will be handled at two different levels:

a. The handling of the power outage within the power sector. The coordinating tasks will be handled by the TSO, Energinet.dk. Further tasks will be handled by other companies in the power sector. The Danish Energy Authority may participate in more general parts of this work.
b. The handling of the consequences for the society of the power outage. This will be handled by the general Danish crisis management system both at the national level and regional level. The Danish Energy Authority and Energinet.dk will participate in this work.

Appendix 2: Finland

Introduction

Finland is a part of synchronously operated Nordic power system. It has 400 kV and 220 kV AC interconnectors to Sweden and 220 kV AC interconnector to Norway. Furthermore there exists Fenno-Skan DC line between Finland and Sweden. Finland has also interconnectors to Russia (back-to-back DC converter station at Vyborg and a 400 kV and two 110 kV AC interconnectors synchronised to Finnish power system).

The transmission capacity from Finland to Sweden is 1 750 MW and from Sweden to Finland 2 150 MW. The transmission capacity between Finland and Norway is 100 MW to both directions. Outside the Nordel area, Finland has an interconnector capacity of 1 500 MW on the Russian border. The total import capacity of the interconnectors between Finland and the Nordel countries as well as Russia is 3 750 MW. The import capacity as a percentage of the total installed capacity is nearly 23 per cent. Taking only the interconnectors between Finland and the Nordel area (Sweden and Norway) into consideration the corresponding percentage amounts to nearly 14 per cent.

As regards the development of the interconnections of the Finnish electricity transmission network with other EU countries' networks, there are two significant projects. In February 2005, the Finnish and Swedish TSOs (Fingrid Plc and Svenska Kraftnät) published their decision to construct a new cross-border transmission line between Finland and Sweden. The connection – a DC cable of 600 - 800 MW capacity– will strengthen transmission interconnections between the countries and contribute to a decrease in temporary electricity price differences between Finland and Sweden. The submarine cable will be ready in autumn of 2010 and the TSO's will share the ownership and investment costs of the cable, amounting to some 200 million euros and with a total length of almost 300 kilometres.

In February 2005, the Energy Market Authority granted an exemption to Estlink – a commercial line to be built between Finland and Estonia – from certain requirements of the Electricity Market Directive (No. 2003/54/EC) and Regulation (No. 1228/2003). Estlink will be the first interconnection between the Baltic and Nordic electricity systems having transmission capacity of 350 MW. The total cost of the project will be some 110 million euros. The commissioning of the Baltic-Finnish submarine DC cable is scheduled to the end of 2006. The interconnector shall be operated on a commercial basis (merchant line) until year 2009-2013 according to the exemption granted by the Energy Market Authority, where after it shall be bought by TSOs on both sides of the interconnection. Estonian company, Nordic Energy Link AS, has been formed to construct and own the Estlink connection. During the merchant operation the transmission capacity is divided, by contractual arrangement, between Pohjolan Voima Ltd, Helsingin Energia, AS Eesti Energia, State JSC Latvenergo and AB Lietuvos Energija. Unused capacity shall be dealt with the use-it-or-lose-it –principle.

Generation capacity

The Finnish electricity market has been an integrated part of the Nordic electricity market since the latter half of the 1990's. Finland consumed 86.8 TWh of electricity in 2004.

Cogeneration of heat and power covered 32 per cent of the consumption of electricity, nuclear power nearly 25 per cent, hydro power 17 per cent and coal-based and other conventional condensing power a good 20 per cent. Wind power accounted for 0.1 per cent. Electricity was imported from Russia to Finland nearly according to the maximum capacity of the import connection (1500 MW) and a substantial amount of electricity was exported to the west. Net imports of electricity covered 5.6 per cent of electricity consumption. The peak demand amounted to 13 570 MW. Table 1 shows electricity net production, imports and exports in Finland in 1999-2004.

Table 1. Electricity net production, imports and exports (TWh) in Finland.

TWh	1999	2000	2001	2002	2003	2004
TOTAL PRODUCTION	69.4	70.0	74.3	74.9	84.3	85.7
Consumption in power plants	2.8	2.7	3.1	3.3	3.9	3.7
PRODUCTION	66.7	67.3	71.2	71.6	80.4	81.9
Hydro power	12.5	14.5	13.0	10.6	9.5	14.7
Wind power	0.0	0.1	0.1	0.1	0.1	0.1
Nuclear power	22.1	21.6	21.9	21.4	21.8	21.8
Conv. thermal power	32.0	31.2	36.3	39.5	49.0	45.3
Co-generation, CHP	24.8	24.5	25.7	27.2	28.0	27.9
district heating	12.8	12.7	14.1	14.9	15.3	14.8
industry	12.0	11.7	11.6	12.3	12.7	13.1
Condense etc.	7.2	6.7	10.6	12.4	21.0	17.4
conventional	7.2	6.7	10.6	12.3	21.0	17.4
gasturbine etc.	0.0	0.0	0.0	0.0	0.0	0.0
IMPORTS from	11.4	12.2	11.8	13.5	11.9	11.7
Sweden	6.0	7.6	4.1	5.4	0.5	0.4
Norway	0.1	0.1	0.0	0.1	0.1	0.1
Russia	5.2	4.5	7.7	7.9	11.3	11.1
TOTAL SUPPLY	78.0	79.5	83.0	85.1	92.3	93.6

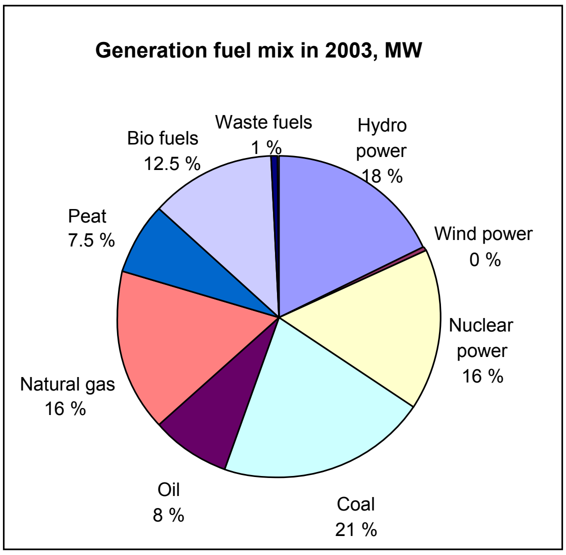
TWh	1999	2000	2001	2002	2003	2004
EXPORTS to	0.2	0.3	1.8	1.5	7.0	6.8
Sweden	0.1	0.2	1.6	1.4	6.9	6.6
Norway	0.1	0.2	0.2	0.2	0.2	0.2
Russia	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL CONSUMPTION	77.8	79.2	81.2	83.5	85.2	86.8
Incl. electric boilers	0.1	0.1	0.1	0.1	0.1	0.1

Source: Adato Energia Ltd, Statistics Finland

The Finnish electricity generation sector is characterized by a large number of actors. The total number companies producing electricity amounts to some 120 and the number of production plants is circa 550. In Finland there were four companies with at least 5 per cent share of installed capacity. The share of the three biggest companies of the total installed capacity was estimated to be in the range of 45 – 50%.

The total installed capacity[1] at the end of 2004 was 16 488 MW consisting of traditional thermal power (8 423 MW), nuclear power (2 671 MW), hydro power (2 986 MW) and capacity based on renewable energy sources like bio fuels, waste and wind (2 408 MW). Generation fuel mix from the year 2003 is presented in Figure 1. During the next three years (2005-2008) it is not expected to be any significant changes in fuel mix for power generation in Finland.

[1] Source: Nordel annual statistics 2004, S1 Installerad effekt den 31 december 2004, MW.



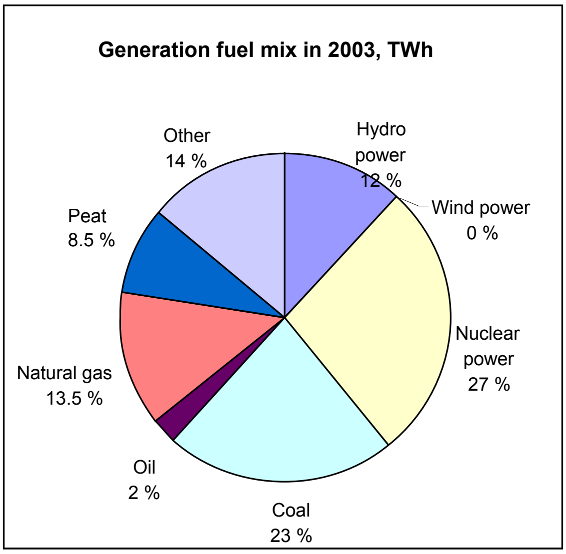


Figure 1. a) Generation fuel mix in year 2003 (MW), b) Generation fuel mix in year 2003 (TWh)

The total available generation capacity for peak load at beginning of 2005 was about 13 600 MW in Finland. Table 2 presents the generation capacities in peak loading by production type during the years 1999 – 2005.

Table 2. Electricity Generation Capacities in Peak Load Period, MW.[2]

	Separate Electricity Generation			Gas turbines and engines	Combined Heat and Power		**Capacity of power stations**	Power system reserves
	Hydro power	Nuclear power	Condensing power		Industry	District heat		
1999	2420	2640	3990	800	1610	3310	**14770**	..
2000	2430	2640	4000	800	1570	3320	**14760**	..
2001	2460	2640	4000	800	1610	3400	**14910**	..
2002	2480	2640	3990	800	1780	3420	**15110**	..
2003	2490	2680	3200	20	2180	2910	**13480**	1030
2004	2500	2680	3200	20	2200	2900	**13500**	1080
2005*	2520	2680	3200	10	2290	2900	**13600**	1080

Source: Adato Energia Ltd, Statistics Finland, Fingrid Plc

At the start of 2005, the Government granted a construction licence for the construction of Teollisuuden Voima Ltd's new nuclear power plant unit at Olkiluota. The construction work started in spring year 2004 and the Olkiluoto 3 power plant unit will be commissioned in 2009. It will improve Finland's chances of achieving the reduction targets for GHG emissions. The power plant unit to be constructed is of the pressurised water type. The power plant unit's thermal output will be 4 300 MW and net electric power output 1 600 MW.

Supply-demand situation during the peak load

The maximum level of peak load demand in Finland measured on the 20th of January 2006 amounted to 14 776 MW. At the same time the available electricity generation capacity in Finland during the peak load period was estimated to be about 13 650 MW. The power reserves related to system disturbances in Finland were 1 080 MW. In addition to the production capacity, capacity totalling 435 MW was either mothballed or local reserve.

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[2] The simultaneously available capacity (net) of power plants during extreme cold and dry water situations, which can be produced during one hour in Finland. The calculation method was amended in 2003, when the reserve capacities related to system maintenance were placed into a separate column. In addition to production capacity, there are 435 MW of machinery out of production or local disturbance reserve. Numbers for 2005 are at beginning of year.

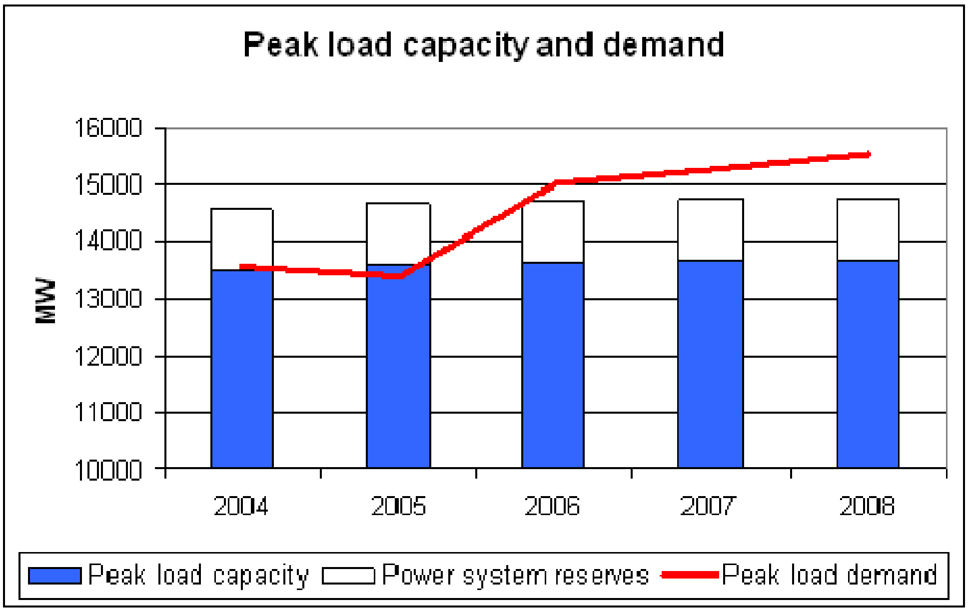


Figure 2. Peak load demand and generation capacity balance based on presented forecasts and forthcoming generation investment (excluding capacity of mothballed generation or local disturbance reserve of 435 MW).

Total demand for electricity in Finland in 2006 is estimated to be 90.2 TWh and the corresponding peak load demand is estimated to be 15 000 MW. For the year 2007, the forecast for the peak load is 15 300 MW (total demand 91.7 TWh) and in 2008 forecast for the peak load is 15 500 MW (total demand 93.2 TWh) as seen in Figure 2.

Tasks of network companies

According to the Electricity Market Act the electricity network operation calls for a licence issued by the Energy Market Authority (electricity network licence). The licence is granted for the time being or, on special grounds, for a specified period.

In the Finnish legislation the electricity network operation has been defined as placing the electricity system against payment at the disposal of anyone needing transmission and similar system services. Electricity network operation also includes any such design, construction, maintenance and use of electricity network, connection of customers' electric equipment to the network, metering of power, and other measures necessary to transmission of electricity and for similar system services.

The network operators have various obligations:

- obligation to develop the electricity network;
- obligation to connect; and
- obligation to transmit electricity

The electricity network licence granted to a distribution network operator specifies the operator’s geographical area of responsibility. According to the legislation the distribution network operator has an exclusive right to construct a distribution network within its area of responsibility. A third party is entitled to construct a distribution network within the distribution network operator's area of responsibility only if:

1. the network to be built is an electricity consumer's service line with which the consumption site is connected to the electricity network of the distribution network operator of the area of responsibility;
2. the network to be built is an electricity consumer’s service line with which an electricity generating plant is connected to the electricity network of the distribution network operator or other network operator of the area of responsibility;
3. the network to be built is an internal network for a property or, respectively, a group of properties; or
4. the network operator allows another network operator to construct a network.

At the Finnish electricity market legislation electricity distribution network have been defined as network below 110 kV level. Some of the electricity distribution network operators have also 110 kV lines. There are also 13 regional network companies having only 110 kV lines.

Fingrid Plc, the transmission system operator, is responsible for the main transmission grid. It owns and operates electricity transmission lines of 400 kV and 220 kV and additionally some 110 kV lines. Based on the Electricity Market Act, the Energy Market Authority has granted the company an electricity network license, in which the Authority has ordered the company to be responsible for the functioning of the power system at a national level (system responsibility). As the transmission system operator – TSO – Fingrid’s tasks include the responsibility for electricity transmission in the main grid, the development of the main transmission grid, maintenance of instantaneous balance between electricity consumption and production, clearing the electricity deliveries between various parties at a national level and promoting the functioning of the electricity market.

The electricity market legislation does not require that the network operators shall own the network. However, almost every network operator in Finland owns the network it is operating. Many network operators in Finland have outsourced a part of their activities, for instance construction and maintenance of lines.

Transmission capacity and congestion management

Congestions across the borders (from Finland to Sweden and Norway) are managed by implicit auctions (market splitting) in the day-ahead market (spot market) in power exchange Nord Pool. Implicit auctions imply that market-based methods are applied in capacity allocation and congestion management is wholly integrated to the functioning of the Nordic wholesale market. Finland is considered as a single price area within Nordic market and congestions within Finland and after spot market closure are managed by counter-trade.

Transmission capacity to/from Finland is calculated using simulation models, which represent typical seasonal base load flow cases in the Nordic power system (winter, summer):

- winter day load representing high loading
- summer night load representing light loading

These base cases are defined from measurements and forecasts. The operational situation in neighbouring countries is normally based on the worst case load flow scenarios. The base cases are updated with production, loads, transmission capacity and outages when monthly, weekly and daily capacities are calculated. In the future the real time data from SCADA system can be used more effectively to build simulation cases.

The transmission capacity is estimated a year, a month (six weeks) and a week (every Tuesday the end of week and the following week) ahead. The capacity for a year ahead is calculated with the intact grid. Capacities a month and a week ahead are calculated taking into account planned outages in the system (both grid and production). The daily capacity is announced at 10 o'clock (EET) in the morning for the next day. This capacity is binding to the TSO and in case of congestion the TSO has to counter-trade to relieve congestion.

The transmission capacity is calculated with variable transmission situations (realised by modifying production and load) using a contingency list consisting of credible line and production outages with allowed consequences according to the Nordic dimensioning criteria.

TSO and security of supply issues

The TSO secures the system operation in Finland by delivering the following services:

- Maintenance of operational security
- Maintenance of frequency (by power reserves)
- Maintenance of voltage
- Data exchange to maintain operational security

Maintenance of operational security implies that power system is planned and operated in a way that the impacts of disturbances are minimised. Here the grid planning, transmission limits, disturbance management and reserves (frequency controlled and fast disturbance reserves, black start reserves) are considered.

The power system in Finland is planned in accordance with principles agreed jointly between Nordic TSOs in Nordic Grid Code[3]. The main planning principle is that the power system has to withstand any single fault (N-1 criteria). A dimensioning fault (worst possible fault) varies on the basis of the operational situation of the Finnish grid, but is often the tripping of the largest production unit or an extensive busbar fault.

Electricity transmissions in the main grid are kept during real time operation within the predefined limits given by operational reliability calculations, which take into account potential faults and planned outages in the power system. The transmission limits are defined for each probable fault and network situation. Short-term congestion problems in the main grid are managed commercially through counter trade, and long-term congestions are managed by applying price areas or by investments in the grid.

The Nordic electricity grid is synchronously interconnected and the frequency is allowed to vary in normal state between 49.9 and 50.1 Hz. The frequency controlled normal

[3] Available on website www.nordel.org.

operation reserve and frequency controlled disturbance reserve are power reserves which are activated automatically by frequency changes. Within the Nordic power system, it has been agreed that the Nordel countries maintain continuously a total frequency controlled normal operation reserve of 600 MW for frequency control in a normal state. Of this volume, Finland's share is presently 141 MW.

For disturbance management purposes, both power and transmission reserves are maintained in the Finnish power system. TSO is responsible for the maintenance of reserves that are needed in the Finnish power system. For this, TSO uses its own resources and also purchases reserve maintenance from other resource owners. Restoration of the power system from severe disturbance incidents is headed by TSO's Power System Control Centre.

The frequency controlled disturbance reserve begins to activate when frequency goes below 49.9 Hz, and the full reserve has been activated at a frequency of 49.5 Hz. The frequency controlled disturbance reserve used includes both active power reserves of power plants and load shedding. During a normal operational situation, the interconnected Nordic system is required to have approximately 1 000 MW of frequency controlled disturbance reserves, of which Finland's obligation is approximately 240 MW.

The fast disturbance reserve consists of active and reactive power reserves that can be activated manually within 15 minutes. After activating this reserve, the power system has been restored to such a state that it can withstand another potential disturbance. In the Nordic grid, each country must have a volume of fast disturbance reserve that equals the country's dimensioning fault. In Finland, this volume is normally 850 MW. Table 3 presents summary of reserves for securing system operation in Finland.

Table 3. Summary of reserves for securing system operation in Finland (Source: Fingrid Plc).

Type of reserve	Contractual capacity	Obligation
Frequency controlled normal operation reserve	- Power plants - Vyborg DC link, 10% of transmission power	141 MW
Frequency controlled disturbance reserve	- Power plants - Load shedding	220 – 240 MW
Fast disturbance reserve	- Gas turbines - Load shedding	850 MW

The voltages in the power system are maintained at a technically and commercially optimal level during both normal and disturbance situations. The objective of voltage level and reactive power adjustment is to prevent overvoltage and undervoltage, to achieve nominal voltages specified in agreements (110 kV network) and to minimise the grid losses. The voltage level in the Finnish transmission grid is adjusted by using reactors and capacitors. The voltage ratio between different voltage steps is controlled with on-load tap changers of transformers.

Instantaneous reactive power reserve is also needed in order to secure the technical functioning of the Finnish power system during the disturbances. The reactive power reserves of the main transmission grid are located in synchronised generators. Reactors and capacitors also serve as reserves. Reactive power reserves are activated automatically when the voltage in the grid decreases as a result of a disturbance. Compensation is paid to power producers for reactive power reserves reserved in generators.

As far as the power reserves are concerned, the TSO's goal is to make sure that sufficient volume of reserves is maintained continuously in Finland in cost-efficient manner and in accordance with the system operation agreement signed between the Nordic transmission system operators.

The TSO produces only part of the system services (TSO owns 515 MW gas turbines used as fast disturbance reserve) and the maintenance of reserves is primarily arranged as a service purchased from electricity producers and reserve holders. Agreements of this kind exist specially in three first categories of system services.

The participation of electricity producers and others in the maintenance of the reserves as a service provider is fully voluntary. The TSO has established a "reserve bank" where companies owning controllable capacity can register their resources. The resource owners maintain the agreed and measured properties at their power plants in the agreed manner and receive the compensation from the TSO.

As far as the agreements concerning the maintenance of primary reserves (frequency controlled normal operation reserve and frequency controlled disturbance reserve) are concerned, the terms, contents and compensations specified in the agreements are identical for all service providers.

The agreements to provide instantaneous reactive power reserves have been established with all generators over 10 MVA when they are connected to the network and the terms, contents and compensations specified in the agreements are identical for all generators within a voltage level.

The load shedding serving as primary and secondary reserve (frequency control and fast disturbance reserve) have been agreed upon with companies in the pulp and paper, chemical, and metal industries. The agreements provide for a total power of around 1000 MW and will be in effect from 2005 to 2015.

Balancing service is provided with market based methods using the Nordic regulation market.

TSO takes care of data exchange required by the maintenance of operational reliability in the power system. TSO and parties connected to the grid supply each other with planning and measurement data needed in the maintenance of operational reliability. Such data includes production plans, generator power measurements, and status data on generator circuit breakers and connecting stations. If necessary, the amount of data exchanged and the technical details of data exchange are agreed upon between TSO and the other party through a separate data exchange agreement.

The Regulatory Authority for electricity markets

Organization and legal basis of the regulatory authority

The Energy Market Authority is the regulatory agency for electricity and natural gas as well as the emissions trade authority in Finland. The Authority is a monocratic office, which means that it is directed by the head of agency. The head of agency is responsible for the decisions of the authority.

The legal basis for the Energy Market Authority lies within the Act (No. 507/2000) and Decree (No. 621/2000) on Energy Market Authority as well as in the Electricity Market Act (No. 386/1995), the Natural Gas Market Act (No. 508/2000) and the Emissions Trade Act (No. 683/2004).

As per the 1st of July, the total number of staff in Energy Market Authority amounted to 30 of which 27 were permanent. Of this number, 11 were occupied with the electricity market issues, 4 with natural gas market issues and 6 with emissions trading issues. The remaining staff was involved in all of these three areas providing assistance for IT, general administration and secretarial services. The total amount of the budget for 2005 is 2.7 million euros whereof 0.66 million euros are for the emissions trade.

Main tasks, statutory objectives and legal powers within electricity markets

As regards to the mission of the Energy Market Authority is to supervise and promote the operation of the electricity markets. Here the Energy Market Authority shall

- regulate the pricing and conditions of electricity transmission and distribution;
- grant licences for electrical power networks and construction of power lines;
- supervise the obligation to develop the electrical power network;
- monitor the security of electricity supply;
- supervise the guarantee of origin system for electricity; and
- gather and publish data on prices of network services and electrical energy

The Energy Market Authority is mandated to issue both administrative decisions and administrative regulations. The administrative regulations are binding on individual entrepreneurs (network operators, retail sellers). The decisions are subject to appeal the first appellate level being either the Market Court (market supervision issues) or the Administrative Courts (licence issues). The final appeal body in both cases is the Supreme Administrative Court.

On the basis of the Electricity Market Act the Energy Market Authority is empowered to issue administrative regulations on certain clearly defined issues. The administrative decisions are binding on all the entrepreneurs who are active in the defined operation (for instance electricity distribution network operators, electricity retail supplier who have the obligation to supply). The administrative regulations are not subject to appeal.

The administrative regulations cover the following issues:

- a regulation on the basis of the Authority can issue more detailed instructions on what information and which key figures the network operator has to publish and how the publication shall be carried out;
- a regulation on the publication of technical key figures of the network operation;
- a regulation on the itemization of bills;
- a regulation instructing the retail suppliers on how to publish and inform prices as well as sales terms and conditions; and

- a regulation instructing the network operators on how to publish and inform prices as well as sales terms and conditions.

In the field of electricity, the Energy Market Authority is responsible for regulating 91 distribution network operators, 13 regional network operators and one transmission system operator at the start of 2005. Furthermore, the Authority is mandated with the supervision of altogether 70 electricity retailers with the obligation to supply.

Independence and accountability

The agency head – director – is appointed for an undefined period of time by the Council of State. As the Energy Market Authority is in the Ministry of Trade and Industry's field of administration the appointment is made on the proposition of the Minister of Trade and Industry. The head of the Authority cannot be dismissed for political reasons.

The Energy Market Authority is overseen by the Ministry of Trade and Industry and especially by its Energy Department according to the standard principles applied in the Finnish public administration. This means agreeing on an annual basis of the objectives and results of the work of the Authority and checking the achievements bi-annually. The Authority has to present an annual report for information to the ministry.

On the other hand, the ministry cannot interfere or influence the decisions by the Authority, as they can only be appealed to the Market Court, Administrative Courts and finally to the Supreme Administrative Court. This guarantees the independence in decision-making.

The Energy Market Authority's operating expenses are financed mainly with supervision and license fees collected from electricity and natural gas network operators and the actors falling within the scope of emissions trading.

Role in security of supply

The investment decision to build new generation capacity will depend on market based criteria and mechanism. However, according to the Electricity Market Act in very extreme balance situation the Government can take actions to acquire more generation capacity or to organise some balance options to avoid expected difficult problems in case of power and energy shortage.

On the basis of the amended Electricity Market Act, which entered into force at the end of 2004, the monitoring of the balance between electricity demand and supply will be intensified and the monitoring will be carried out in a more detailed manner, where electricity producers will provide data on power plants. Also the division of tasks between the Ministry of Trade and Industry and the Energy Market Authority underwent a change, as the monitoring of issues related to security of supply was transferred to the Energy Market Authority, along with the tasks related to the rules and regulations concerning the monitoring of electricity generation. The Ministry of Trade and Industry continues to be responsible for the forecasts of electricity consumption and strategic long-term planning of supply and demand.

In cooperation with other authorities, the Energy Market Authority monitors the development of the balance between the supply and demand for electricity in Finland. To be able to estimate the generation capacity, the Energy Market Authority is establishing a register of the generation capacity available in Finland, consisting of all production units with an output of more than 1 MVA.

The Electricity Market Act includes provisions on maintenance outages of power plants scheduled for the period 1 December – 28 February. The Energy Market Authority may order that the date of a maintenance outage of an electricity-only power plant with an output above 100 MVA be rescheduled outside the winter season due to a tight generation situation, provided that there are no technical or safety-related obstacles that would prevent this. The Energy Market Authority shall consult the Safety Technology Authority and, if the maintenance outage concerns a nuclear power plant, the Radiation and Nuclear Safety Authority, before making the rescheduling decision. However, maintenance outages resulting from unplanned maintenance needs do not fall within the scope of the notification procedure and the related rescheduling possibility.

The above-mentioned provision on the notification procedure does not, however, oblige the power plant to generate electricity at the time concerned.

In Finland the State can grant investment subsidy for power plant construction project if the new production is based on renewables, including wind power. Power producer can also get subsidy for produced electricity generated by wind power or low capacity hydro power and also for electricity generated by certain fuels (for example wood and biogas).

Preparedness and emergency activities

Introduction

In cases of serious disturbances and in emergency situations, public authorities need special powers to safeguard society's essential activities. The most important provisions are contained in the Preparedness Act (Statute Book of Finland nr 1080/1991). In crisis situations, the Act empowers the Government to issue provisions concerning rationing, national economy, work force, functioning of the financial sector, health care, and factors concerning other essential social activities. The Government's decisions shall be examined by Parliament, which has the power to repeal them.

The present Preparedness Act has been enacted by the procedure required to amend the Constitution because the Act does not fit very well into the present constitutional framework. The Ministry of Justice is currently modernising the Preparedness Act.

Securing supply in Finland has been organized as a comprehensive co-operation network. Participants are various sectors of the public administration and business, as well as branch organisations. Emergency preparedness is extended to cover the entire national economy and to reach all its branches, including certain plants producing goods and services that are necessary for securing supply. Various sectors of public administration, from central government to local administrative agencies, are prepared to take the necessary measures under emergency conditions. The National Emergency Supply Agency supports, guides, and co-ordinates the development of these activities.

Objectives for preparedness and emergency

The Council of State defines the objectives for preparedness. The present objectives were defined in 2002 in Decision of the Council of State nr 350/2002. According to the

Government's Decision on Safeguarding the Security of Supply of 8th May 2002 (Finnish Statute Book 350/2002) the objective is to reach such a degree of preparation that the population's capacity to make a living, to carry out necessary social activities and to achieve the material preconditions for an effective national defence are not endangered (basic preparedness level). In addition to traditional threats, the risks of terrorism and of the use of nuclear, biological and chemical substances (NBCs) shall be taken into account.

Energy supply shall be safeguarded, where the well-functioning energy markets are the basis for the security of supply. Energy production based on several kinds of fuels and sources of supply shall be maintained to safeguard the energy supply. Imported fuels shall be kept in emergency stocks to an amount corresponding to five months' normal consumption. Preparations shall be made for maintaining the capacity to produce, transfer and distribute heat and electricity for twelve months on a basic supply level. Production and consumption of energy shall, if needed, be regulated so that scarce resources suffice.

National Emergency Supply Agency

The National Emergency Supply Agency (NESA) is a body working under the auspices of the Ministry of Trade and Industry. It was established by the Preparedness Act and Decree on the National Emergency Supply Agency defines its most important tasks. Its task is planning and operating activities to maintain and develop the country's preparedness. Their objective is to safeguard economic activities necessary to the population's livelihood, the national economy, and national defence during emergency situations and serious disturbances to normal life. Today the core activity is safeguarding the functioning of technical systems. Special attention is paid to society's essential information systems.

The National Emergency Supply Agency manages the Preparedness Fund, which is an independent fund outside the State Budget. The Fund is used for financing centrally security of supply stockpiling and for certain emergency arrangements to safeguard technical infrastructures.

The National Emergency Supply Agency is the secretariat of the National Board of Economic Defence. NESA and NBED analyse threats against the security of supply and they also formulate plans and guidelines for public authorities and business companies in respect to the management and control of such threats.

Appendix 3: Norway

Emergency preparedness in the Norwegian power system

Due to dimensioning aimed at withstanding stress from natural causes, the Norwegian power supply system is generally robust. This robustness is explained by an extremely decentralised production pattern and a grid structure with increased robustness as it enters densely populated areas. However, the infrastructure is very visible and easily available in the landscape; it can hardly be kept under constant surveillance and will therefore always be vulnerable to human intentions of sabotage. The hydro-based Norwegian electricity system is close to a balance in a year with average rainfall and temperatures. A dry and cold year, or worse, two consecutive dry years, will cause a shortage in energy in Norway (and most likely in Sweden). Therefore, Norway is planning for a situation where rationing is the only option.

The production system

The Norwegian production system has developed over almost 100 years, and the main characteristic is that the production is very distributed. Since the production system is based on hydropower, the production is situated in areas suitable for such development, mainly the south western and the northern part of the country. The early development of power stations was mainly dedicated to power consuming industries in its vicinity. Due to restructuring some of these power-demanding industries have moved, closed or reduced demand. However, there are still several communities in rural areas with heavy industry and partially dedicated production facilities (with Odda, Sunndalsøra, Rana, Bremanger and Sauda as prominent examples). There is increased demand from the oil and gas industries.

There have been requirements that power stations above certain capacities have ability to control frequency and voltage during situations of emergency or contingencies where parts of the grid are isolated from the rest of the Nordic grid.

In 2003 the Norway produced 107 TWh of electricity and 2.2 TWh of district heating. In addition Norway produces large amount of oil and gas, mainly for export. In a year with normal precipitation Norway can produce 118 TWh of electricity. The production depends on the precipitation, runoff and temperature. The last 10 years the production has varied between 143 TWh (2000) and 105 TWh (1996). In the period 1994 to 2003 Norway had net import 5 out of 10 years. To stabilise the security of supply Norway has built magazines for storage of water and transmission connections to our neighbouring countries enabling us to import when the Norwegian demand exceeds the production ability (and export in other periods). Both climate and topography gives Norway natural ability to exploit hydropower and Norway is among few countries in the world covering 100% of its electricity needs with renewable hydropower.

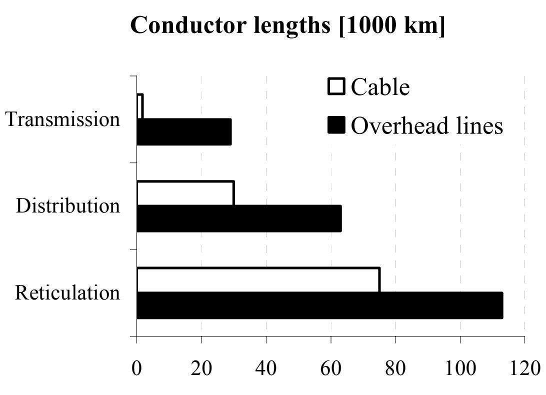
Norway has a tiny heat production compared to electricity when related to our neighbours. This is mainly due to a historical abundance of electricity available for heating purposes. There has therefore not been a need for a large amount of additional heat production in Norway, and the infrastructure for district heating is miniscule.

Electricity supply is a considerable business in Norway. The total turnover in 2000 was 2.3% of GDP. Investments during the same year were 4 billion NOK, and total employment was 17.000 persons. The Norwegian power supply industry is under strong public ownership (by government, counties and municipalities) and is governed through a set of acts and regulations.

Characteristics of the transmission and distribution system

By 1 July 2004 there were 148 companies owning distribution grids, 93 owning regional grid and 30 having assets in the central grid. There were 162 production companies and a total of 223 wholesalers. Most companies have activities within several of these categories

The grid is divided into three main categories, namely distribution (low and high voltage), regional (33 – 132 kV) and central grid (132 – 420 kV). Lengths of lines and cables as per 2001 are illustrated in this figure:



Note that the low voltage is longer than all sum of all high voltage, even though the high voltage stretches from county to county and from north to south.

There are approx 600 power stations with installed capacity above 1 MW, the total installed capacity is approx 28.000 MW and the production capacity in a normal year is 118 TWh.

Due to the mentioned localisation of the production facilities and a concentration of population in the southeastern part of the country, a grid mainly stretching west – east has developed. The purpose has been to steadily increase the transmission capacity from surplus areas to demand centres. Concurrently, in order to maintain access to electricity during one or several consecutive dry years, import capacities with mainly Sweden and Denmark has been built. In addition to the east west grid, there is a relatively weaker connection from north to south.

Typical demand patterns

The demand pattern in Norway in closely linked to the fact that electricity is the main source of heating. The demand in power consuming industries is rather constant over the year. The demand therefore follows a seasonal pattern and a day-to-day pattern following the current temperatures. On the weekly basis, demand is governed by consumption in trade and small industries. Therefore, load is higher on weekdays than during the weekends and holidays, and there is a regular peak in demand on the beginning of the working day and in the afternoon. On the national level maximum demand always occurs in the morning on a weekday during the middle of winter.

A maximum demand of 23 000 MW occurred in February 2001. The demand was close to the maximum production capacity in Norway. In order to increase flexibility during such peak situations, Statnett has introduced an options market, where more than 1 300 MW has been offered for short-term load reduction. Also Statnett is aiming at making non-prioritised demand more responsive during periods with short-term capacity restrictions.

Vulnerable end users

In the regulations regarding rationing there is a strict prioritising of consumer groups when it comes to access to electricity. This is in stark contrast to the economical regulation of the utilities, where economic values connected to the loss of delivery are supposed to guide the utilities in their priorities during relatively short interruptions (and for investment decisions). For longer duration interruptions, which will occur during rationing, life and health is the main priority, thereafter comes vital institutions within civil society. Economic interests have the lowest priority.

In directive 2003/54/EC of 26 June 2003 concerning common rules for the internal market in electricity, there are some provisions of protection of consumers. One of them is the member states' obligation to appoint a supplier of last resort. After the winter

2003/2004 this became a relevant issue in Norway after the failure of one reseller to service its customers. Today the distribution company servicing the affected customer is obliged to offer supply at prices reflected at the power exchange, elspot. The directive also has a clause saying

> "Member States shall take appropriate measures to protect final customers, and shall in particular ensure that there are adequate safeguards to protect vulnerable customers, including measures to help them avoid disconnection…."

The directive requires the member countries to protect vulnerable customers against disconnections inter alia based on disability to pay for services. Within the acts regulating the energy industry there are no such protection of vulnerable customers in Norway. This is in contrast to some Nordic countries where there are explicit rules against such disconnections. However, the social legislation indirectly affects the vulnerable customers' ability to pay. The Ministry contends that the interest of end consumers generally is well protected through sector legislation.

Power and energy balance

Norway is close to a balance in production and demand of electricity. Therefore, the Government wishes to increase heat production in order to substitute electricity for heating with other energy sources. A large amount of the heat is consumed close to the production, mainly in the industry, dwellings and apartment buildings. In addition there is some district heating in some major towns. The heat production of 38 TWh in 2001 consisted of 14.4 TWh bio-energy, 12.2 TWh petroleum products, 7.9 TWh gas and approx 2 TWh district heating. Environmentally friendly heat amounts to 40% of the total heat production.

The most recent prognosis of the future energy balance in Norway was made by NVE in 2002. The prognosis was based on a prolongation of current trends in demand and production. The results found were that Norway heads towards a situation with increased dependence on its import capacity and that severe lack of energy could occur in dry years.

After the mentioned report was issued, the increase in demand has slowed down, partly due to increased prices in the energy market since 2003/2004. Also, the introduction of a market for green electricity in 2007 may stimulate increased investments in new production. NVE therefore concludes that the future energy balance may not be as tight as the prognosis of 2002 indicates.

The middle part of Norway experiences increased demand, mainly due to increased aluminium production and processing of gas. NVE and Statnett have had a special attention towards the energy balance in this part of the country for some years. Statnett is currently planning investments in the transmission grid, which aims at increasing the security of supply in the region. A new power line to a surplus area further north and increased import/export capacity with Sweden is under consideration. In addition there are some major plans of gas and wind power plants in this part of the country.

Participants in handling extreme situations

NVE has been delegated emergency preparedness authority and rationing authority through a separate delegation from the Ministry. However, it is still the Ministry which decides when rationing shall be introduced. Cases of considerable conflicting public interests shall still be brought to the Ministry.

OED, Ministry of Petroleum and Energy

The Norwegian government represented by the Ministry of Petroleum and Energy is the owner and ministry responsible for Statnett, the system operator. The Norwegian Water Resources and Energy Directorate (NVE), which is the regulator and licensing authority for the electrical power sector in Norway, also reports to the Ministry of Petroleum and Energy.

During extraordinary situations with lack of energy, the Ministry can initiate rationing (based on advice from Statnett and NVE). This is done in order to ensure that the power system and power market functions as smoothly as possible and at the same time ensuring that especially sensitive consumer groups and civil functions get sufficient access to electricity. Rationing consists of planning and enforcing implementation of supply restrictions and requisitions of electrical energy and district heating. The Ministry has appointed a rationing authority, NVE, which is responsible for administrative implementation and measures related to rationing.

NVE, Norwegian Water Resources and Energy Directorate

The NVE has the authority to grant trading licences for electrical power and construction licences, and to stipulate system operator guidelines. The NVE also stipulates guidelines for transmission tariffs and sets the income caps for the grid companies. The latter includes tools to increase the efficiency of natural monopolies.

NVE has a central role in emergency preparedness planning during floods and disasters in watercourses and it manages the power system emergency preparedness. NVE has the responsibility of coordinating the emergency preparedness planning and governs the power supply during extraordinary circumstances, during emergencies and war. For this purpose a dedicated national organisation has been developed, the power system contingency planning organisation, or KBO. It consists of NVE and all units involved in production with associated watercourse regulation, transmission and distribution of electrical energy or district heat.

When it comes to rationing, NVE has the following tasks:

- Inform and advise the Ministry on when to start rationing
- Instruct the KBO to prepare for rationing. Take leadership in KBO.
- Approve all kinds of national energy awareness campaigns.
- Advice about rationing based on assessments of the supply situation in various regions.
- Follow up the effect of ongoing rationing actions.
- After a period of rationing, NVE shall evaluate the entire rationing process.

NVE as rationing authority makes guidelines on rationing. The reasoning behind this is the wish to inform all units involved on how to fulfil their duties during rationing. The guidelines describe the process leading to decision of rationing, how to organise and implement the rationing and the different tools that can be used: information, imposing quotas, control and as a last means: brownouts (revolving short term disconnection of load).

Statnett SF, the system operator

Statnett is the Norwegian transmission system operator. Statnett's area of responsibility is to develop the Norwegian transmission grid and international connections, as well as the development, maintenance and technical operation of sections of the main grid, main grid tariffs and the aforementioned system operator responsibility, including key operating functions. Statnett is the owner of over 80 % of the main grid.

As a transmission system operator Statnett is responsible for the system safety of the Norwegian power system in the short and long term and to help ensure that the transmission grid develops in a manner that is efficient and beneficial to society. As the transmission system operator, Statnett is supposed to be a neutral facilitator for the power market, based on socio-economic criteria, and at the same time to ensure that the customers' demand for cost-effective operations is fulfilled.

Statnett has, as system operator and owner/operator of the main grid with associated control systems, a central role in KBO when activated due to extraordinary situations. Statnett assists NVE both in its role as emergency preparedness authority and rationing authority. Statnett shall practice its system operation tasks by ensuring momentary balance between demand and production. This is especially important in cases of faults, damage or extraordinary stress that may occur during emergency handling and restoring of functionality in the main grid.

When the KBO takes over the responsibility for the national power supply, Statnett as system operator is subordinated the central management of the power system (KSL), and Statnett then is the implementing agency for the regulation of power production and distribution. The system operator has command of a nationwide control system for optimal utilisation of the production and transmission system. To achieve this, and to maintain the balance in the power supply system, the system operator is able to implement changes in the power producers' production programmes.

Through the regulations regarding system operations Statnett is given the task at all times to ensure instantaneous balance between production and demand at a satisfying quality of delivery. In order to carry out this task, the system operator must coordinate the disposals of everybody fully or partially involved in production, grid, end users, wholesale and organised marketplace. The system operator has been given several tools enabling him to achieve this

- Determine elspot areas and trading capacities, transmission capacities, degree of regulation and capacity reserves.
- Technical requirements to installations.
- Coordination of disruptions.
- Protection and relay planning.
- Requirements to notifications of production and production plans.
- Enforce disconnection of load.
- Determine connection settings etc

The system operator shall monitor the developments in the power supply system and regularly inform the authorities about developments in the energy and power balance. The clause in the regulation that the system operator can enforce producers to declare all available capacity in the market ensures access to all installed capacity in constricted situations. It is however up to the producer to declare his price for this regulation capacity. Enforced disconnection according to the regulation can only be used as last resort and only as a short-term measure during capacity restrictions.

During rationing, Statnett has the following obligations:

- Keep the authorities informed on the current power and energy balance and assess the situation.
- Make the actual provisions needed in order to reach the aims of the rationing authority.
- Monitor the development and impacts of actions taken.
- Receive reports about status, deviations from plans and suggestions of other actions from the KRS, and give a summary including own assessments to NVE.

Nord Pool Spot, the power exchange

Nord Pool Spot, consisting of Nord Pool Spot AS and its wholly owned subsidiary Nord Pool Finland Oy, organizes the physical day-ahead market - Elspot - in the Nordic countries. In addition, Nord Pool Spot operates the intra day market - Elbas - in Finland, Sweden and Zealand (Eastern Denmark). Nord Pool Spot is a part of the Nord Pool Group and is owned 20% by Nord Pool ASA and the Nordic Transmission System Operators: Statnett SF, Svenska Kraftnät, Fingrid Oyj, Energinet.dk own 20% each.

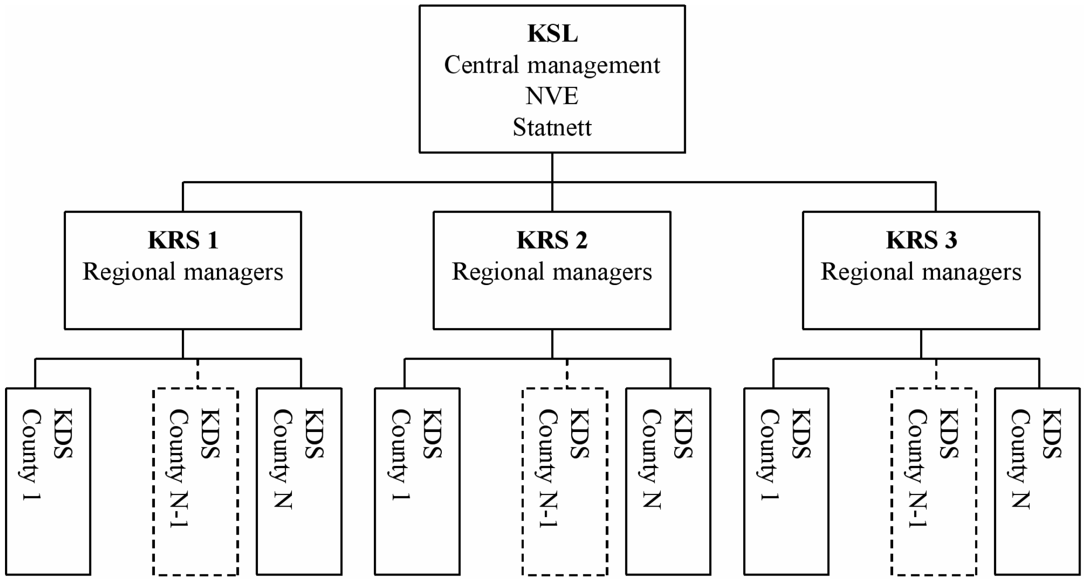
Nord Pool Spot provides a marketplace to producers, distributors, industrial companies, energy companies, trading representatives, large consumers and TSOs on which they can buy or sell physical power. Nord Pool Spot is the central counter party in all trades guaranteeing settlement for trade and anonymity for participants.

Nord Pool shall contribute to a well functioning market also during rationing. In order to achieve an optimal utilisation of the available production reserves it is of paramount importance to maintain marked based conditions also during rationing. Administrative interventions shall only be used when market based instruments cease to work. The rationing authority shall therefore ensure that market based instruments are used before, during and after rationing.

KBO, the power supply emergency preparedness organisation

NVE is responsible for coordination of the emergency preparedness planning, and governs the national power supply sector during emergency preparedness and war. In order to achieve this aim, a nationwide organisation, the KBO, consisting of NVE and other companies within the power supply sector is established. KBO consists of all companies owning or operating power production with associated watercourse regulation, transmission and distribution of electrical energy and district heating.

When the KBO, during situations of general alert, takes over the responsibility for the national energy supply, all units within the energy supply industry have an obligation to adhere to directives and orders from the superior authority of KBO. This does not lead to any change in the ownership of the companies. Each company within KBO is still responsible for its own operations and shall ensure that the production and transmission system is as functional as possible. In peacetime, the KBO shall be able to solve all tasks related to damages in the power system resulting from nature, technical breakdown, terror or sabotage and related to rationing according to the energy act and regulations. To achieve these goals KBO shall prepare, establish and maintain a structure which gives all relevant units in the power supply sector tasks and responsibilities enabling efficient handling of extraordinary situations in the power supply system with associated water courses.



KBO is organised as in the figure above. The central management of KBO, the KSL, consists of NVE and Statnett in their roles as emergency preparedness authority and system operator. The CEO of NVE, or a person empowered by him, chairs the KBO. KBO is dived into regions similar to Statnett's operational regions, presently 3. Statnett, as system operator, is delegated the authority to appoint KBO regional managers, KRS. The KRSs are the regional managers of Statnett. At district or county level, there are district managers or KDSs. The KDS is KBO's representative at the county level. She represents one or more counties. The KDS communicates directly with the County Governor about actions taken and their background. At the local level each distribution utility, producer and district heating company are represented in KBO, and shall follow orders from KSL communicated through the KRS and KDS.

The manager of units in KBO has the emergency preparedness responsibility in his organisation. The unit appoints an emergency preparedness manager. This manager shall ensure the necessary planning and exercise the emergency preparedness work, including establishing and maintaining contact with authorities and relevant units in KBO. All units in KBO shall have an emergency preparedness coordinator. She is the unit's administrative contact towards NVE.

KDS in counties where the county Governor has a regional responsibility for emergency preparedness shall be the link between the KRS and this County Governor[4]. In cases where one electrical utility supplies several municipalities, and there is conflict of interests between these municipalities during rationing, the case shall be brought to the KDS for decision. The KDS shall consult the county Governor before decision is made.

[4] The county governor office has its own emergency preparedness organisation, a county emergency preparedness council (FBR). This is the formal unit for regional emergency preparedness work. This council has representation from the power supply sector.

The county Governor and the police

In the counties there are special emergency preparedness organisations or FBR, with representation from the county mayor, the county manager, DSB, a chief constable, the Civil Defence and preferable the National Defence. In cases related to emergencies in watercourses, NVE through its regional offices is represented, and in cases related to emergencies in the power supply, KBO is represented through the KDS. During rationing the County Governor informs other regional units and the municipalities about the situation.

DSB, the Directorate for Civil Protection and Emergency Planning

DSB shall have an overview of the risks and vulnerability on the society. DSB shall be a driving force in the prevention of accidents, crisis and other unwanted incidents. The DBS shall ensure god emergency preparedness and efficient handling of crisis and accidents.

DSB shall contribute to prevention of loss of life and defend health, environment and physical values during accidents, catastrophes and other unwanted incidents during peacetime, crisis and wartimes. The DSB is responsible for following up fire and electricity safety issues, dangerous substances and product safety and DSB is the central authority for the fire service.

DSB is also the central authority for the County Governors' work within emergency preparedness and the FBR. DSB is represented in the FBR, where KBO also is represented in matters related to electricity. DSB also has the responsibility for the civil defence, National Emergency Planning College and the National Fire Service College. Within the energy sector, DSB shall contribute to a reliable electricity supply by ensuring that the owners systematically inspect and maintain their installations. DSB focuses on organisational responsibilities and work routines, systematic maintenance and utilisation of technical design promoting electrical safety, and systematic development of information about risk areas. During rationing the DBS receives information about actions from NVE and conveys it further to the County Governor

The municipalities

A prerequisite for efficient emergency handling at the local level is that the municipalities co-operate about planned actions. The municipalities shall also take part in the prioritising of local actions. During rationing the municipalities are obliged to activate local emergency boards. The municipalities are obliged to have emergency plans in case of rationing.

Legislative and regulatory framework

Extreme situations may occur due to acts of terror, war, natural disasters and severe lack of energy or capacity in the Norwegian power system. The handling of such situations is described in several acts and regulations. This chapter will describes the most relevant legislation.

The energy act and regulations

This act was last updated 1 January 2002, when amongst others, a new chapter 5A which authorises the Ministry of Petroleum and Energy to make regulations regarding system operations and rationing (and quality of supply). The act also has a comprehensive chapter dealing with emergency preparedness.

Regulations regarding rationing

The energy act authorises the Ministry to initialise rationing, restrictions in supply and requisition of production capacity during extraordinary circumstances. The Ministry appoints a rationing authority responsible (RA) for the planning and administrative implementation of necessary measures during rationing. The RA may further delegate authority to make decisions regarding the implementation of rationing to special vehicle within the power system dealing which emergency situations, the KBO. Decisions made by the KBO during rationing shall be based on just and neutral modes of treatment, but such decisions are exempted from ordinary rights of appeals based on the administration and civil services act.

The energy act regulation has a paragraph regarding rationing, reiterating the Ministry's authority to initialise rationing and to appoint an RA, including its handling of information and routines before, during and after rationing. This is further elaborated in special regulations regarding rationing drafted by NVE and put into operation on 1 January 2002. The regulations define the responsibilities of those affected by the act, namely the rationing authority, all entities fully or partially operating grids, production or marketplace according to §4-5 in the energy act, wholesalers and end users. The rationing authority (RA) is not appointed in the regulations, but a later delegation from the Ministry gives NVE such authority.

The regulations state that the RA shall inform and advise the Ministry when there is a risk that rationing may be necessary. The Ministry initialises and ends rationing based on this advice. The RA shall at all times be informed about the energy situation and have plans for information campaigns for the public and also that at all times plans and procedures for safe and efficient reporting of initiation, implementation and cancellation of rationing exist. The regulation gives the RA certain tools and guidelines of prioritising during rationing. The tools are:

1. Enforcement of supply restrictions based on objective and controllable criterions. The RA shall at all times have plans for the implementation of such supply restrictions.
2. Requisitions of energy from producers. The affected producer is entitled to compensation according to prevailing rules regarding expropriation and compensation.

The prevailing principle before, during and after rationing is that marked based instruments shall be used. The regulations give a strict definition of how to prioritise during supply restrictions:

1. Life and health
2. Vital institutions within civil society, such as government administration, information, safety, infrastructure, supply etc and
3. Business activities and economic interests

The RA must at any time ensure that plans of priorities exist. These plans must be made in cooperation with other authorities and affected private interests. The RA must also, in cooperation with other administrative bodies and affected parties, ensure that development of plans, procedures, warning, reporting, practicing is carried through in an expedient manner. All those affected by the regulation shall contribute and cooperate with the RA, enabling it to carry out its duties in a rational way for the total society. The regulations enable NVE to inflict economical penalties on those not adhering to the regulations.

Regulations regarding system operations

The regulations regarding system operations in the power system contribute to an effective energy market and a satisfactory quality of supply in the power system. The regulations affect the system operator and those who fully or partially own grid, production or marketplace and wholesalers and end users. A new §22a regarding severe power supply situations was added to the regulations 1 January 2005. In this paragraph, the system operator is required to constantly analyse and develop necessary tools for managing severe situations. The system operator shall keep NVE informed about this work, and the tools developed can only be used after decision made by NVE.

Regulations regarding emergency preparedness

In chapter 6 of the energy act it is stated that during war the power supply industry is subordinated the KBO, in which entities performing power supply during peacetime are included. The Ministry coordinates the emergency planning and governs the power supply industry during emergency situations and war. The KBO may be imposed duties during peacetime as a result of damage of power supply equipment, emergency situations due to nature, technical failures, terror or sabotage and during rationing.

The Ministry can make decisions regarding protection of equipment against damage caused by nature, technical failure or intensions of damage during peacetime, emergency and war. Such protection may include the management in the power sector and operations.

The act defines nominal limits of the capacities of installations that may be subject to protective measures. These include power stations, substations, converter stations, power lines, dams, district heating with capacities above given limits. Dispatch centres are also included. Companies affected by the act may be required to make protective measures at their own cost; however there is a clause of compensations in case costs are not balanced by other advantages. The Ministry may decide that operating costs of the emergency preparedness authority may be covered by fees payable by owners and users affected by chapter 6 in the act.

The energy act regulations have a more detailed chapter 6 about emergency preparedness. The KBO shall establish a satisfying emergency preparedness by:

1. Performing systematic analysis and assessments.
2. Performing protective measures on all installations with importance for the national power supply system.
3. Ensuring integrity, confidentiality and access to information, resources, installations and systems of importance for power supply management, operations and recovery ability.
4. Ability to perform efficient crisis management.
5. Ability to perform efficient rehabilitation of own activities after injury, damage or other disturbances.

NVE can impose protective measures (including routines and guarding) on all installations covered by §6 in the energy act (ie installations with rating and capacity above specified limits) and IT systems vital for power system operations, handling of sensitive information and for administrative or emergency rooms or facilities. These safety measures include:

1. Protection of sensitive information systems.
2. Access control on vital premises.
3. Restrictions on visits to vital premises.
4. Contracts dealing with security for suppliers, contractors or consultants involved in construction, rebuilding, extensions of supply systems, including dispatch control systems.
5. Protection of power supply installations, physical security and access control

Owners of new installations or extensions of installations shall cover the costs of all measures decided by NVE. If existing installations are imposed security measures, up to 50 % of the costs may be compensated.

Comprehensive regulations about emergency preparedness have been drafted by NVE and put into operation 1 January 2003. These regulations define an emergency preparedness concept, which all entities within the KBO are obliged to implement. This concept shall optimize prevention and management of all extraordinary situations that may restrict production, transmission, distribution of electricity. This concept shall be integrated in the companies' ordinary activities. The concept shall consist of the following phases:

1. Aanalysis of risks and threats.
2. Implementing preventive measures.
3. Plan and organise so that extraordinary situations are handled.
4. Handling of extraordinary situations and restore functionality.
5. Evaluate training and incidents

All entities in KBO are thus required to have a documented quality system, perform and update risk and vulnerability assessments, perform emergency planning and training. The regulations further define the tasks, setup and responsibilities of the KBO. Its organisation is as follows:

1. The central management of the power supply (KSL) shall consist of the emergency authority and the system operator.
2. The regional managers (KRS) are appointed by the system operator (regional managers in Statnett).
3. The district managers (KDS) are appointed from an entity of the KBO and
4. Other entities in KBO

The manager of a unit within KBO has emergency preparedness responsibility, and the unit appoints an emergency preparedness manager. She ensures necessary planning and implementation of the emergency preparedness tasks, including establishing and maintaining contacts with authorities and relevant entities in KBO. Each entity in KBO shall have an emergency preparedness coordinator, who is the entity's administrative contact with NVE.

The regulation has a chapter requiring each unit in KBO to have adequate personnel and competence in order to maintain and re-establish operations during and after emergency situations. During such situations the unit shall quickly be able to establish an organisation with the competence and endurance required for safe and efficient operations. This requires access to transport, spare parts, repair tools and other resources.

All units in KBO are required to have an information plan and efficient information preparedness during extraordinary situations both internally, towards relevant authorities, the public, media and guidance to its customers.

The manager of a unit in KBO has responsibility for security and shall ensure establishment of security routines and instructions. Access to information is restricted according to the act of security of 1998. Contractors getting access to sensitive information must sign a security contract with NVE or unit in KBO. Tendering processes may be limited in order to prevent sensitive information in bidding documents to become public.

All installations above specified ratings and capacities must be protected against unwanted events or actions. All installations are thus classified according to their importance for the national power system. The owner shall, based on classification of installations, perform a risk and vulnerability analysis, and plan and construct installations and systems according to the regulations. The level of security is based on the classification mentioned above. The regulations describe the functionality required from installations for each classification level.

All units in KBO shall perform a continuing and holistic assessment of information security, including confidentiality, integrity and access to information and resources. These areas shall be covered:

1. Sensitive information about the power supply system which can be used to obstruct or harm its functionality.
2. All systems and units maintaining important operational control.
3. Administrative and mercantile systems handling sensitive information or having importance for the operations of the power supply system.

A computer literate information technology security manager shall be appointed. She shall assist the unit's manager with issued related to information security.

The regulation lists several sensitive systems, installations and information about which information at all times must be protected from persons not concerned.

There are special requirements related to dispatch centres, communication facilities and other components maintaining functions of operational control. Also there are withstanding requirements against electromagnetic pulse and interference for control equipment and communication installations of certain security classifications.

There is a requirement that all units in KBO shall have independent and reliable mobile communication systems, with adequate coverage and long term capacity during emergency situations.

NVE has developed a comprehensive guideline to the regulations for emergency and preparedness. These guidelines further describe the KBO, requirements of allocations of resources, safety, protection and administrative routines.

Security provisions for the power supply

The regulations of the security in the power supply deals with actions aimed at preventing damage during wartime or sabotage on existing plants, plants under construction or planned plants that have or will have importance for the national power supply. The security provisions shall contribute to avoid intruders access to information and plants with the purpose of inflicting damage. The provisions apply to plants above specified capacities similar to those specified in §6 in the energy act. The provisions state that the manager of each licensee has the responsibility to ensure that the provisions are adhered to. There are provisions on the following issues:

- **Classified information.** A list of areas normally classified consists of military defence or police security actions, command quarters, important communication systems, flood calculations, analysis of harmful effect of electricity outages, spare parts and possibility of repairs, detailed maps of the power system, security measures at power supply plants and the classification of these.
- **License applications.** Regulations on how to obtain classified information used in license applications.
- **Limited tendering.** The Ministry or authorised authority may decide that tendering process shall be limited and that the bidding companies must declare binding commitment to safe treatment of sensitive information.
- **Instructions for visits.**
- **Employment of foreigners.** With reference to a directive about security control of foreigners used in the civil administration.
- **Physical securing of energy supply plants.**

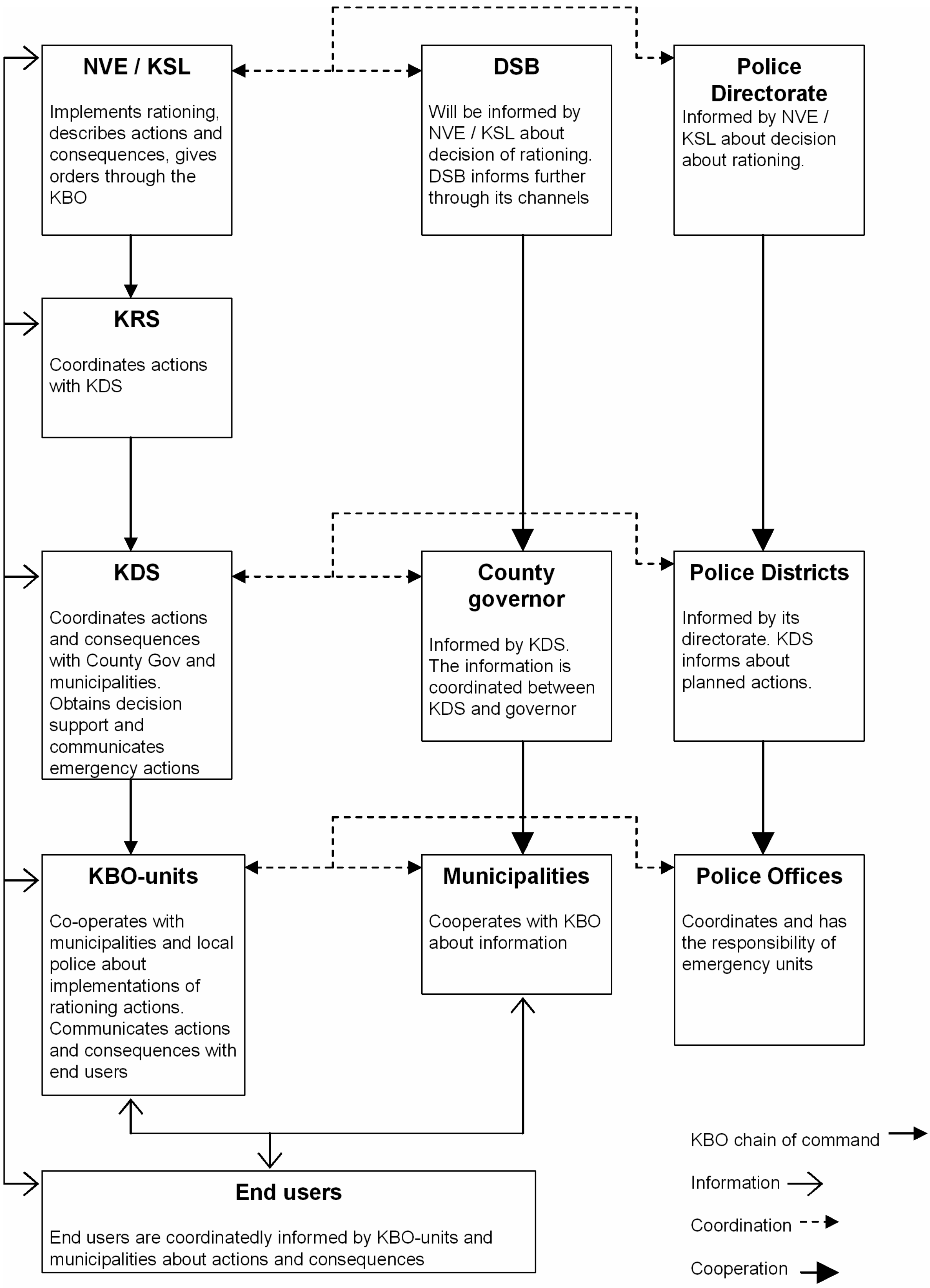
Other acts and regulations

There are several other acts, regulations and resolutions that have some relevance for the emergency preparedness in the energy supply sector. Some of them are:

- **The public administration act** applies for public bodies such as municipality, county and governmental institutions. The act has decisions about professional secrecy and storing of confidential information.
- **The personal records act** has decisions about handling of information which can identify individuals, foundations etc. Storing such information depends on having a license from the Data Inspectorate.
- **The act about military defence secrets** authorises prohibition if photographing and collection of information about energy supply facilities. The act also warrants visiting restrictions to such facilities.

- **The publicity act** states that all documents issued by or presented to municipality, county or state shall be public. Some information related to “security of the kingdom” may be exempted. This is done in the security provisions for the power supply.
- **The civil defence act** gives the Ministry of Justice the right to enforce renouncement of all properties, rights and electrical power in order to prevent harm or to do penance to harm inflicted on civilians. The MoJ can also determine rates payable for inter alia electrical power.

In addition there are acts regarding fire, explosives, inspections of electrical installations, hazardous waste etc. These are relevant both in emergency situations and during normal work and will not be commented further.


NVE / KSL
Implements rationing, describes actions and consequences, gives orders through the KBO
DSB
Will be informed by NVE / KSL about decision of rationing. DSB informs further through its channels
Police Directorate
Informed by NVE / KSL about decision about rationing.
KRS
Coordinates actions with KDS
KDS
Coordinates actions and consequences with County Gov and municipalities. Obtains decision support and communicates emergency actions
County governor
Informed by KDS. The information is coordinated between KDS and governor
Police Districts
Informed by its directorate. KDS informs about planned actions.
KBO-units
Co-operates with municipalities and local police about implementations of rationing actions. Communicates actions and consequences with end users
Municipalities
Cooperates with KBO about information
Police Offices
Coordinates and has the responsibility of emergency units
End users
End users are coordinatedly informed by KBO-units and municipalities about actions and consequences
KBO chain of command
Information
Coordination
Cooperation

Appendix 4: Sweden

Summary

The Swedish electricity system is a robust system where the generation is dominated by hydro and nuclear power plants. Renewable energy in the form of bio-fuelled CHP and wind power are increasing. The energy balance is positive during normal and wet years while there is a need for net import during less wet years.

The transmission network is well dimensioned for Swedish needs. Transit flows sometimes lead to bottlenecks. This is especially the case when the hydrological situation calls for extreme international flows. This can happen during wet as well as dry years.

The production capacity margin has decreased during the last 10 years. According to the Capacity Reserve Act, Svenska Kraftnät has the responsibility to purchase a capacity reserve of maximum 2000 MW of production and demand reductions in order to maintain an adequate balance between peak demand and supply. This Act will expire by the end of the winter 2007/2008. After that the market players are expected to take responsibility for the provision of adequate capacity.

The Electricity Markets Inspectorate within the Swedish Energy Agency (EMI) has no specific responsibility for extreme situations. On the other hand, increased emphasis on security of supply has led to a proposal of a new law that will put more emphasis on the security of supply of the distribution network. This new emphasis will also affect how the regulation model is applied.

The Energy Agency (STEM) has the overall responsibility for the coordination of energy emergency planning and for the coordination of technical infrastructure in this aspect. This is carried out within the framework set by and the financing provided by the Krisberedskapsmyndigheten (KBM).

The operative responsibility to secure the electricity system, and, in the extreme event of a war-like crisis, the operative responsibility to secure the most important societal needs, are entrusted to the system operator, Svenska Kraftnät (SvK). Several studies, and lately the hurricane “Gudrun” have pointed at the need to prioritize deliveries of electricity to the most important needs even in peacetime crises. Today this is has no legal ground.

Old emergency laws like the rationing Act and the price regulation Act were created during the post war period, and are not adapted to the modern view of crisis management. These acts are under scrutiny to be revised.

The electricity system

Electricity, as opposed to many other products, cannot be stored, and must therefore be produced as it is used, which means that production and use must always be in balance.

Electricity production

Swedish electricity production is based mainly on nuclear power and hydro power. In 2004, these two power sources provided over 90 % of the country's total electricity production, with the remaining 10 % being supplied by fossil-fuelled and bio fuelled production and a small quantity of wind power. Total electricity production amounted to 148.2 TWh. Table 1 shows production in Sweden since 1990.

Table 1: Electricity production in Sweden, TWh

	1990	1997	1998	1999	2000	2001	2002	2003[2]	2004[2]
Production[1]	141,7	145,3	154,7	151,0	142,0	157,7	143,2	132,3	148,2
Hydro power	71,4	68,2	73,8	70,9	77,8	78,4	65,8	52,8	59,5
Wind power	0,0	0,2	0,3	0,4	0,5	0,5	0,6	0,6	0,8
Nuclear power	65,2	66,9	70,5	70,2	54,8	69,2	65,6	65,5	75,0
Conv. thermal power	5,1	10,0	10,1	9,4	8,9	9,6	11,3	13,2	12,9
- Industrial CHP	*2,6*	*4,2*	*4,0*	*3,9*	*4,2*	*3,9*	*4,6*	*4,7*	*5,4*
- CHP in district heating systems	*2,4*	*5,6*	*6,0*	*5,6*	*4,7*	*5,6*	*6,3*	*7,9*	*7,5*
- Cold condensing, including gas turbines	*0,0*	*0,2*	*0,1*	*0,0*	*0,1*	*0,1*	*0,4*	*0,6*	*0,0*
Use	139,9	142,6	144,0	143,5	146,6	150,4	148,6	145,1	146,1
Of which distribution losses	*9,1*	*10,7*	*10,9*	*10,6*	*11,1*	*11,9*	*11,8*	*10,6*	*11,2*
Import / export	-1,8	-2,7	-10,7	-7,5	4,7	-7,3	5,4	12,8	-2,1

Source: SCB

[1] Net production, excluding own use.

[2] Figures for 2003 and 2004 are based on preliminary statistics.

Electricity production varies in parallel with electricity use, which means that production is higher during the winter than during the summer. Maintenance of the nuclear power stations is therefore planned for the summer, when the demand for electricity is at its lowest. The reservoirs for hydro power production fill during the spring and summer, with the stored water then being used during the winter until the next spring flood from melting snow occurs.

Installed capacity

Table 2 shows the changes in installed capacity in Sweden since 1996. It can be seen that it has fallen considerably since deregulation of the market, with most of the reduction occurring in conventional thermal power production capacity. Bearing in mind that, over the same period, electricity production has increased the reduction in installed capacity has led to that there is less standby capacity in the Swedish electricity production system. Since the winter of 2000/2001, available installed capacity in cold condensing power stations and gas turbine power stations has increased as result of Svenska Kraftnät purchasing standby capacity.

Table 2: Available installed capacity in Sweden, MW

	1996 31 Dec	1997 31 Dec	1998 31 Dec	1999 31 Dec	2000 31 Dec	2001 31 Dec	2002 31 Dec	2003 31 Dec
Total installed capacity[1]	34 158	34 044	31 994	30 885	30 894	31 721	32 234	33 361
Hydro power[2]	16 203	16 246	16 204	16 192	16 229	16 239	16 097	16 143
Nuclear power	10 055	10 056	10 052	9 452	9 439	9 436	9 424	9 441
Conventional thermal power	7 795	7 620	5 564	5 026	4 985	5 753	6 374	7 378
Cold condensing	*2 842*	*2 777*	*846*	*452*	*448*	*1 023*[3]	*1 356*[3]	*2 108*[3]
CHP, district heating	*2 464*	*2 354*	*2 246*	*2 248*	*2 264*	*2 340*	*2 462*	*2 572*
Industrial CHP	*776*	*776*	*841*	*841*	*932*	*929*	*957*	*979*
Gas turbines etc.	*1 713*	*1 713*	*1 631*	*1 485*	*1 341*	*1 461*[3]	*1 599*[3]	*1 719*[3]
Wind power	105	122	174	215	241	293	339	399

Source: Nordel, with further processing by the Energy Markets Inspectorate

1 Installed capacity represents the simple arithmetical total of all individual units' net power available to the grid, and is not the same as the total available capacity at any particular point in time.

2 Including the Norwegian proportion of Linnvasselv (25 MW).

3 Including capacity in stations in Sweden covered by standby power capacity agreements.

Electricity use

Electricity use in Sweden varies with the ambient temperature, as space heating of residential buildings and commercial premises accounts for a considerable proportion of electricity use. In 2004, total electricity use in Sweden amounted to 146.1 TWh, with the residential and service sector accounting for about half of this, and industry for about 40 %. Table 3 shows the changes in the pattern of electricity use from 1990.

Table 3: Electricity use in Sweden, TWh

	1990	1997	1998	1999	2000	2001	2002	2003[1]	2004[1]
Industry	53	52,7	53,9	54,5	56,9	56,2	55,7	54,5	56
Residential, service etc.	65	69,6	69,9	69,1	69	73,1	72,5	72,1	72,3
of which electric heating	*25,8*	*26,1*	*23,9*	*21,5*	*21,4*	*22,2*	*22,1*	*21,8*	*21,8*
Domestic electricity	*17,9*	*18,6*	*19,4*	*16,9*	*17,7*	*19,2*	*19,5*	*20,1*	*20,1*
Building services systems	*21,3*	*24,9*	*26,6*	*30,7*	*29,9*	*31,7*	*31*	*30,2*	*30,4*
Transport	2,5	3	2,8	3	3,2	2,9	2,9	2,8	2,8
District heating, refineries	10,3	6,8	6,6	6,3	6,5	6,3	5,7	5,1	3,8
Distribution losses	9,1	10,7	10,9	10,6	11,1	11,9	11,8	10,6	11,2
Total use	139,9	142,6	144	143,5	146,6	150,4	148,6	145,1	146,1
Total use, temperature-corrected	143,1	143,3	145	144,8	149,5	151,3	149,7	145,6	146,1

Source: SCB

1 *Figures for 2003 and 2004 are based on preliminary statistics..*

Note: Domestic electricity and electric heating in 2004 have been assumed to be the same as for 2003, as statistics for detached houses, apartment buildings and commercial premises will not be available until the summer of 2005.

The capacity problem in Sweden

The power balance of an electricity system describes its ability to balance demand with supply. In recent years, demand in Sweden has reached very high levels, with maximum demand occurring during severe winter weather. Maximum demand hitherto in Sweden occurred in February 2001, amounting to about 27 000 MW.

During the years before the reform of the electricity market in 1996, the major power utilities had reached agreement on the amount of peak load capacity each would hold. However, as a result of the reform of the market, these agreements ceased to apply, leading to the producers decommissioning a considerable amount of their peak load capacity, as the plants were seldom used and did not therefore justify their costs. However, electricity demand has continued to increase, with the result that there is a risk of insufficient generating capacity being available. If this occurs, it is necessary temporarily to disconnect supplies to parts of the country.

The Standby Power Capacity Act[5] came into force on 1st July 2003. Under the Act, the Swedish transmission system operator, Svenska Kraftnät, is responsible until year 2008 for purchasing standby power capacity not exceeding 2000 MW per year. This is done by Svenska Kraftnät through agreements with producers to

5 The Standby Power Capacity Act (2003:436).

make additional production capacity available, or with users to reduce their demand. The Act applies until the end of February 2008, at which time Svenska Kraftnät's responsibility for standby power capacity will cease and be replaced by a market-based arrangement. In 2004, the negotiated standby capacity amounted to 1970 MW.

Transmission of electricity

Electricity is transmitted from power stations to users over transmission and distribution networks. In Sweden, these are divided into three levels: the national grid, regional networks and local networks (distribution networks). The *national grid* consists of 220 kV and 400 kV lines, and is owned by Svenska Kraftnät. The *regional networks* connect to the national grid, and operate at a lower voltage, usually 70-130 kV. They carry electricity from the national grid to the *local networks* and in some cases directly to large electricity users. Most of the regional networks are owned by the major electricity producers. The local networks are connected to the regional networks, and supply electricity to domestic users and to most industries. These networks normally operate at 20 kV, with power being transformed down to the normal domestic voltage of 400/230 V. The local networks are owned primarily by the major electricity producers and by local authorities. There are about 180 distribution grids.

Security of supply in transmission and distribution

Security of supply has become increasingly important in Sweden. One way of obtaining an overview of security of supply is to look at the relationship between the length of overhead lines and the length of buried cables. Table 4 shows how this proportion has changed over the period 2000-2003. It can be seen from the table that it is mainly in the local networks that the proportion of buried cable has increased. However, it should be pointed out that burying cables is not done only in order to increase the security of supply, but also for environmental, space and aesthetic reasons.

Table 4: Lengths of overhead lines and buried cables in the Swedish electricity system, km

	2000	2001	2002	2003
Regional networks				
Overhead lines	30 519	30 229	30 026	30 638
Buried cables	478	396	473	691
Proportion of cables in proportion to total network length	1,5 %	1,3 %	1,6 %	2,2 %
Local networks				
Overhead lines[1]	225 267	227 698	217 933	211 153
Buried cables[1]	249 500	255 597	259 285	263 803
Proportion of cables in proportion to total network length	53 %	53 %	54 %	56 %

Source: The Energy Markets Inspectorate and Svenska Kraftnät

[1] HV and LV cables.

Another way of obtaining a picture of security of supply and efficiency of electricity transmission and distribution is to look at developments in interruptions to supply. Table 5 shows statistics for supply failures and their average durations over the period 1999-2003. A supply failure is defined as partial or total loss of supply to a subscriber for more than three minutes. However, on the basis of the material available to the Inspectorate, it is difficult to draw any detailed conclusions concerning trends in security of supply in respect of transmission and distribution of electricity.

Table 5: Interruptions to supply at local network level in Sweden.

	1999	2000	2001	2002	2003
No. of interruptions per customer					
Notified	0,47	0,26	0,24	0,26	0,21
Not notified	1,43	0,93	1,13	0,92	0,93
Average duration of interruption, minutes					
Notified	64	37	34	37	25
Not notified	142	81	143	86	98

Source: SCB, with additional processing by the Energy Markets Inspectorate.

Note: The values for the number and duration of interruptions are average values for all local networks throughout the country.

Svenska Kraftnät maintains the country's power balance

Every country has a body that is responsible for maintaining the country's power balance, in Sweden, this is Svenska Kraftnät.

By what is known as balance regulation, Svenska Kraftnät deals with any imbalance between production and demand in real time. Balance regulation is done by two means: primary control and secondary control. Primary control refers to automatic adjustment and restoration of balance in the system by automatically increasing or decreasing output. A Nordic agreement specifies the amount of frequency control capacity each country must hold in reserve for primary control. Secondary control is a manual upward or downward adjustment of control plants, in the form of power transactions with the frequency-holding plants with access to production facilities, and who have signed agreements with Svenska Kraftnät to participate in the balance regulation.

The costs for dealing with the imbalance are accounted for between the balance providing companies. Those companies having an imbalance have to pay for the power that Svenska Kraftnät purchased or sold in order to achieve a balance.

Bottlenecks

Demand for cross-border transfer of electricity within the Nordic electricity market varies, depending on such factors as the weather and variations in production and use. The transmission grid does not have the capacity to deal with all possible variations, and so restrictions on capacity, known as bottlenecks, can occur. Various methods are used on the Nordic electricity market to deal with bottlenecks (see the panel). Bottlenecks that occur during the planning phase are dealt with by splitting the market into different geographical areas. This is employed internally in Norway, and also between the Nordic countries. Import and export capacity limitations are applied to varying extents in order to deal with foreseen bottlenecks within or between the Nordic countries, while bottlenecks that occur during operation in real time are dealt with by counter trading.

In a report to the Government in November 2004, the Swedish Energy Agency has described the effects of present methods of dealing with transmission limitations in Sweden and the Nordic countries.[6]

Participants in handling extreme situations

New Swedish system for handling of crises[7]

Like most other European countries, Sweden has traditionally had an emergency preparedness planning that comprises the whole society. This preparedness has been focusing on the risk of war.

During recent years, the philosophy has changed. A new category of contingencies has emerged from a more peacetime perspective. The interesting question is to what extent a contingency can threaten the functioning of society as a whole, not the specific cause of the crisis. Irrespectively of their causes, these crises call for competent leadership and coordinated action both inside the country and across the borders. They also have in common that they demand priorities that are hard to do with the peacetime legal framework of today. Incidents that have affected the thinking are the Estonia catastrophe, the tsunami and the hurricane "Gudrun".

A concept that is used in connection with these crises is "hard strain on the society[8]" (HSC). Whether a crisis shall be characterized as HSC does not depend on the causes but on the consequences on the society of the crisis.

Since 2002 a new crisis management system is being built up in Sweden. Three principles are central in the new system:

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[6] *Hantering av begränsningar i det svenska överföringssystemet för el – Ett nordiskt perspektiv* [Handling of limitations in the Swedish Electricity Transmission s System – A Nordic perspective], Swedish Energy Agency 2004.

[7] Bygger på PM av Mikael Toll 2005-05-30

[8] Svår påfrestning på samhället

- *The principle of responsibility*, which means that the entity that is responsible for a certain activity during normal conditions has the corresponding responsibility during crisis and in the event of war.

- *The principle of similarity,* which means that an operation as far as possible should be located in the same place irrespectively of the situation.

- *The principle of vicinity,* which means that a crisis shall be handled by those that are normally concerned and responsible.

The system for crisis management builds on responsibility in two dimensions: *area* and *sector*.

The geographic *area* responsibility has three levels: local (municipalities), regional (county administrative boards) and national (the government). The area responsibility points out a coordinating public actor for the common actions that are necessary in order to handle a crisis. It does not mean that these entities take over responsibility from anybody else. Contingency planning and the capacity to handle them, is mainly a task for the municipality, the authority or the company where the crisis happens.

The *sector* responsibility is every authority's and organisation's responsibility within its own sphere.

STEM has, according to the ordinance (2002:472) on measures for peacetime contingencies and military preparedness, a special responsibility regarding technical infra structure (SO TI). The activities within SO TI are to be conducted such that the risk for disturbances in the technical infra structure are minimised and such that the basic needs of society can be met during HSC during peace or armed assault. In addition to STEM, Krisberedskapsmyndigheten[9] and Svenska Kraftnät have responsibilities regarding the electricity sector.

Coordination and financing of the new crisis management system

Krisberedskapsmyndigheten has a national responsibility across sectors and is to further coordination. Proposals for emergency measures in order to reach the preparedness goals are worked out by the sector responsible authorities in cooperation with among others the companies that are affected. These proposals also contain requests for funding that can be supplied from Krisberedskapsmyndigheten. Krisberedskapsmyndigheten has about SEK 2 billion at its disposal.

[9] Krisberedskapsmyndigheten

Krisberedskapsmyndigheten prepares a coordinated proposal of measures and financing for the government. After approval, there is a written agreement between Krisberedskapsmyndigheten and the authorities concerned. The emergency preparedness and crisis management program at STEM is financed through this agreement.

Every grid concessionary shall pay an electric emergency preparedness fee to the State which finances the emergency preparedness within STEM and Svenska Kraftnät. The fee correlates to the number of customers in the grid.

While the purpose of this system is still war-like situations, the resources provided under this system is to be used during HSC as well.

Roles and responsibilities within the electricity sector

The primary authority responsibilities are divided between STEM, Svenska Kraftnät and Elsäkerhetsverket as shown in table 6. In addition to this there are several other authorities that have responsibility for granting money for emergency generators.

Table 6: Authorities and roles for crisis management

Authority	Production/supply	Distribution/grid	Consumption	Totality
STEM	Long run further production/supply	N/A	User perspective. Rationing	Further a total view
EMI	N/A	Monitoring, sanctions	User perspective in monitoring	Broad studies of demand and supply
SvK	Momentary safeguard balance between demand and supply	System responsibility, prevent and operative handle blackouts	Balancing function; load shedding if necessary to safeguard the system	N/A
Elsäk	Safe and functional components	Safe and functional components	Safe electric products	N/A

The government has given STEM the over all responsibility for rationing and for the coordination of contingency planning regarding both the electricity system and the customers. In addition to that, STEM has the same responsibility for other kinds of energy. STEM has the sector responsibility for preparedness regarding oil and petrol.

EMI is the regulator for electricity (and gas) and gives concessions, has a legal responsibility and monitors the electricity networks. EMI is also responsible for over all analyses of supply and demand of energy.

Svenska Kraftnät is the system responsible authority in the Swedish electricity system and has an operative responsibility for the national transmission grid. The system responsibility also comprises operative security of the electricity system and to procure adequate reserves for balancing and disturbances according to the Nordic Grid Code. Svenska Kraftnät has the legal right to shed load if that is necessary for operational security.

In war or when the government decides, Svenska Kraftnät has the responsibility to plan, lead and coordinate the resources of the electricity system. Svenska Kraftnät is also responsible for the peacetime preparations for this responsibility. Svenska Kraftnät is the electricity preparedness authority according to the Electricity Preparedness Act, and can issue regulations in this area. Svenska Kraftnät is also responsible for dam security.

Elsäkerhetsverket is responsible for the preventive work in order to protect people and property against electric damage. In crises and war they have the duty to oversee the emergency repairs that may be necessary in case of widespread damage in the electricity networks.

A functional responsibility for crisis management

According to the Electricity Preparedness Act, Svenska Kraftnät has the overall responsibility for the preparedness of the electricity system as regards to production, transmission and trade in case of war.

EMI has no responsibility for security and emergency preparedness. But the inspection has a responsibility for clarifying the concept of quality of supply according to the Electricity Act.

As a result of the hurricane “Gudrun”, the Government instructed the Inspectorate to put forward proposals for improving the reliability of electricity transmission. The terms of reference for the investigation, which were announced in April 2005, included the preparation of suggestions for requirements to ensure that electricity transmission grids were reliable, as well as proposals for regulations governing compensation for loss of power supplies to customers suffering long failures. The work also included consideration of, and proposals for, how the act concerning compulsory administration of grid companies could be tightened up.

Svenska Kraftnät has been commissioned to propose amendments to the Electricity Preparedness Act that reflect the modern view of crisis management.

Crisis and emergency measures

Prioritising

STEM has been given the task to study the possibility to guide scarce electricity to prioritised customers. There are several legal, organisational and technical barriers that have to be removed before this will be a possible tool for peacetime crisis management. The Electricity Act is normally interpreted in such a way that no prioritising can be done in peacetime, for instance when a capacity shortage calls for load shedding. Another situation when prioritising would be called for is during restoration after a long blackout. Apart from the legal barriers, there are technical barriers inherent in the structure of the network, but remote control is increasing, which would facilitate the process.

Rationing

STEM has commissioned a study with the aim of making the legal framework regarding rationing of electricity more up to date. According to section 3 of the ordinance (2004:1200) with instruction to STEM, the authority shall plan, coordinate and to the extent regulated by the Government carry out rationings and other regulations regarding the use of energy in close contact with Krisberedskapsmyndigheten and Svenska Kraftnät. Figure 1 shows an idea of a future system.

Legal framework

The Electricity Act

The Electricity Act (1997:857) provides regulations concerning power plants, concerning trade in electricity in certain cases and concerning quality of supply.

Following the hurricane “Gudrun” the Energy Markets Inspectorate has submitted a report to the government containing proposals for a more strict definition of quality of electricity. In the fall of 2005, the government has submitted a proposal to the parliament for a new regulation on these questions.

The Electricity Preparedness Act

This Act (1997:288) provides regulations regarding emergency for production, transmission and trade with electricity in situations when the Total Defence and High Preparedness Act (1992:1403) applies.

Svenska Kraftnät is the responsible authority for the electricity preparedness. The goal of this preparedness is to secure resources such that the prioritized needs for electricity, as stated by regional authorities, can be met. The resources that are being built up for this purpose shall also be used for crisis management during peacetime emergencies in Sweden and abroad.

Regulations regarding rationing

The Rationing Act (1978:268) and the Price Regulation Act (1989:978) are acts originating from the war years. These acts need modernizing.

Regulations regarding systems operations

The Electricity Act and the ordinance regarding systems responsibility give the legal framework regarding system operations, and points out that Svenska Kraftnät is the system responsible authority. In order to secure peak load capacity in all situations, a temporary law has charged Svenska Kraftnät with the task to procure maximum 2000 MW of reserve capacity for extreme winter peaks. The temporary law expires after the winter 2007/2008.

Other acts and ordinances

STEM and Svk have, according to ordinance (2002:472) regarding the responsibility for peacetime crisis management and high preparedness a special responsibility for the cooperation area technical infra structure (SO TI).

Appendix 5: EU legislation

This appendix presents the relevant parts of EU legislation dealing with security and quality of supply issues which are relevant when handling the extreme situations are discussed.

Directive 2003/54/EC concerning common rules for the internal market in electricity

Monitoring of security of supply

Member States shall ensure the monitoring of security of supply issues. Where Member States consider it appropriate they may delegate this task to the regulatory authorities referred to in Article 23(1) in the Directive. This monitoring shall, in particular, cover the supply/demand balance on the national market, the level of expected future demand and envisaged additional capacity being planned or under construction, and the quality and level of maintenance of the networks, as well as measures to cover peak demand and to deal with shortfalls of one or more suppliers. The competent authorities shall publish every two years, by 31 July at the latest, a report outlining the findings resulting from the monitoring of these issues, as well as any measures taken or envisaged to address them and shall forward this report to the Commission forthwith.

Tendering for new capacity

With regard to tendering for new capacity the Directive 2003/54/EC states that Member States shall ensure the possibility, in the interests of security of supply, of providing for new capacity or energy efficiency/demand-side management measures through a tendering procedure or any procedure equivalent in terms of transparency and non-discrimination, on the basis of published criteria. These procedures can, however, only be launched if on the basis of the authorisation procedure the generating capacity being built or the energy efficiency/demand-side management measures being taken are not sufficient to ensure security of supply.

Member States may ensure the possibility, in the interests of environmental protection and the promotion of infant new technologies, of tendering for new capacity on the basis of published criteria. This tender may relate to new capacity or energy efficiency/demand-side management measures. A tendering procedure can, however, only be launched if on the basis of the authorisation procedure the generating capacity being built or the measures being taken are not sufficient to achieve these objectives.

The Directive states that details of the tendering procedure for means of generating capacity and energy efficiency/demand-side management measures shall be published in the Official Journal of the European Union at least six months prior to the closing date for tenders. The tender specifications shall be made available to any interested undertaking established in the territory of a Member State so that it has sufficient time in which to submit a tender. With a view to ensuring transparency and non-discrimination the tender specifications shall contain a detailed description of the contract specifications and of the procedure to be followed by all tenderers and an exhaustive list of criteria governing the selection of tenderers and the award of the contract, including incentives, such as subsidies, which are covered by the tender.

In invitations to tender for the requisite generating capacity, consideration must also be given to electricity supply offers with long term guarantees from existing generating units, provided that additional requirements can be met in this way.

Member States shall designate an authority or a public body or a private body independent from electricity generation, transmission, distribution and supply activities to be responsible for the organisation, monitoring and control of the tendering procedure. Where a transmission system operator is fully independent from other activities not relating to the transmission system in ownership terms, the transmission system operator may be designated as the body responsible for organising, monitoring and controlling the tendering procedure. This authority or body shall take all necessary steps to ensure confidentiality of the information contained in the tenders.

Authorisation procedure for new capacity

According the Article 6 of the Directive for the construction of new generating capacity, Member States shall adopt an authorisation procedure, which shall be conducted in accordance with objective, transparent and non discriminatory criteria. Member States shall lay down the criteria for the grant of authorisations for the construction of generating capacity in their territory. These criteria may relate to e.g.:

- the safety and security of the electricity system, installations and associated equipment;
- protection of public health and safety;
- protection of the environment;
- land use and siting;
- use of public ground;
- energy efficiency;
- the nature of the primary sources;
- characteristics particular to the applicant, such as technical, economic and financial capabilities;
- compliance with measures adopted pursuant to public service and customer protection according to the Article 3 of the Directive.

Member States shall also ensure that authorisation procedures for small and/or distributed generation take into account their limited size and potential impact. Besides, the authorisation procedures and criteria shall be made public. Applicants shall be informed of the reasons for any refusal to grant an authorisation. The reasons must be objective, non discriminatory, well founded and duly substantiated. Appeal procedures shall be made available to the applicant.

Directive concerning measures to safeguard security of electricity supply and infrastructure investments

In general the Directive establishes measures aimed at safeguarding security of electricity supply so as to ensure the proper functioning of the internal market for electricity and to ensure:

- an adequate level of generation capacity;
- an adequate balance between supply and demand; and
- an appropriate level of interconnection between Member States for the development of the internal market.

It establishes a framework within which Member States are to define transparent, stable and non-discriminatory policies on security of electricity supply compatible with the requirements of a competitive internal market for electricity.

According to general provisions of the Directive Member States shall ensure a high level of security of electricity supply by taking the necessary measures to facilitate a stable investment climate and by defining the roles and responsibilities of competent authorities, including regulatory authorities where relevant, and all relevant market actors and publishing information thereon. The relevant market actors include, inter alia, transmission and distribution system operators, electricity generators, suppliers and final customers.

In implementing the measures, Member States shall take account of e.g.:

- the importance of ensuring continuity of electricity supplies;
- the importance of a transparent and stable regulatory framework;
- the internal market and the possibilities for cross-border cooperation in relation to security of electricity supply;
- the need for regular maintenance and, where necessary, renewal of the transmission and distribution networks to maintain the performance of the network;
- the need to ensure sufficient transmission and generation reserve capacity for stable operation; and
- the importance of encouraging the establishment of liquid wholesale markets.

Member States shall ensure that any measures adopted in accordance with this Directive are non-discriminatory and do not place an unreasonable burden on the market actors, including market entrants and companies with small market shares. Member States shall also take into account, before their adoption, the impact of the measures on the cost of electricity to final customers.

In ensuring an appropriate level of interconnection between Member States, special consideration shall be given:

- each Member State's specific geographical situation;
- maintaining a reasonable balance between the costs of building new interconnectors and the benefit to final customers; and
- ensuring that existing interconnectors are used as efficiently as possible.

With regard to the operational network security Article 4 of the Directive states:

- Member States or the competent authorities shall ensure that transmission system operators set the minimum operational rules and obligations on network security. Before setting such rules and obligations, they shall consult with the relevant actors in the countries with which interconnection exists. Member States may require transmission system operators to submit such rules and obligations to the competent authority for approval;
- Member States shall ensure that transmission and, where appropriate, distribution system operators comply with the minimum operational rules and obligations on network security;
- Member States shall require transmission system operators to maintain an appropriate level of operational network security. To that effect, transmission system operators shall maintain an appropriate level of technical transmission reserve capacity for operational network security and cooperate with the transmission system operators concerned to which they are interconnected. The level of foreseeable circumstances in which security shall be maintained is defined in the operational network security rules;
- Member States shall, in particular, ensure that interconnected transmission and, where appropriate, distribution system operators exchange information relating to the operation of networks in a timely and effective fashion in line with the minimum operational requirements. The same requirements shall, where appropriate, apply to transmission and distribution system operators that are interconnected with system operators outside the Community.
- Member States or the competent authorities shall ensure that transmission and, where appropriate, distribution system operators set and meet quality of supply and network security performance objectives. These objectives shall be subject to approval by the Member States or competent authorities and their implementation shall be monitored by them. They shall be objective, transparent and non-discriminatory and shall be published.

- In taking the measures referred to in Article 24 of Directive 2003/54/EC and in Article 6 of Regulation (EC) No 1228/2003, Member States shall not discriminate between cross-border contracts and national contracts.
- Member States shall ensure that curtailment of supply in emergency situations shall be based on predefined criteria relating to the management of imbalances by transmission system operators. Any safeguard measures shall be taken in close consultation with other relevant transmission system operators, respecting relevant bilateral agreements, including agreements on the exchange of information.

With regard to maintaining balance between supply and demand Article 5 of the Directive states that Member States shall take appropriate measures to maintain a balance between the demand for electricity and the availability of generation capacity. In particular, they shall:

- without prejudice to the particular requirements of small isolated systems, encourage the establishment of a wholesale market framework that provides suitable price signals for generation and consumption;
- require transmission system operators to ensure that an appropriate level of generation reserve capacity is available for balancing purposes and/or to adopt equivalent market based measures.

Member States shall publish the measures to be taken pursuant to the Article 5 and shall ensure the widest possible dissemination thereof.

Article 6 of the Directives deals with network investments, stating that Member States shall establish a regulatory framework that:

- provides investment signals for both the transmission and distribution system network operators to develop their networks in order to meet foreseeable demand from the market; and
- facilitates maintenance and, where necessary, renewal of their networks.

Without prejudice to Regulation (EC) No 1228/2003, Member States may allow for merchant investments in interconnection.

Member States shall ensure that decisions on investments in interconnection are taken in close cooperation between relevant transmission system operators.

Appendix 6: Acquisition and use of capacity reserves in extreme situations

Definition of capacity shortage according to Nordel:

"Capacity shortage in the moment of operation is when a part of a system no longer can maintain the need for manual active reserve that can be activated within 15 minutes"

"Manual active reserve is active reserve that is activated manually in the momentary situation of operation. This is divided in to fast active prognosis reserve, fast active disturbance reserve, fast active counter trade reserve and slow active disturbance reserve."

The Nordic countries have through the Nordel-cooperation established joint guidelines for power balance and disturbance reserves to ensure that by working together they can keep the system in balance.

There are different purposes and principles for the reserves in the different Nordic countries:

1. Frequency control and operational disturbances (There is an agreed level within Nordel, each country decide how acquisition/ensurance will be taken care of)

2. Power balance market/-purchasing (each country decide how acquisition/ensurance will be taken care of) The TSOs activate the power market bids in the momentary operation to keep the balance/frequency and to handle bottlenecks in the system.

3. a) Fast, active prognosis reserve and counter trade reserve and responsibility for momentary balance between market and demand. (Norway and Denmark)

b) Power reserves or high load reserves (the Swedish TSO buy reserves after being given special responsibility for power reserves from the government during a limited period, 2003-2008, the TSO in Denmark is preparing for the same)

None of the Nordic countries finance energy reserves, price signals from the market are meant to give investment incentives.

The Nordic countries have partly different ways in handling capacity shortage. Finland has a market based solution also for long term capacity reserves. Sweden are aiming at the same, but the Swedish TSO has until 2008 been given responsibility for the security of capacity reserves. Denmark and Norway have chosen a centralized model where the TSOs are responsible for enough capacity.

According to the report "*Effekttilgång vid höglast*" by SvK in maj 2004, [6] and the report "*Utveckling av effekt- och energireserver i Norden*" by EME Analys [9], the Nordic countries deal with capacity shortage in the following ways:

Denmark
On a public level, Denmark has a proclaimed and long term achievement in ensuring enough generation reserves to cover demand in any given moment. What are bought centrally are reserves to keep the system in balance under an operational 24 h in the form of power balance resources in the power balance market. Within this capacity the fast, active prognosis reserves are taken, as is to an extent the fast, active counter trade reserve.

The TSO has long term deals with the dominating producers that they will make capacity/reserves available. The costs for these deals are covered by the central grid fees. Denmark is also discussing with Statnett about joining their RKOM market (effect options).

Norway
The TSO purchase capacity (mostly disconnectable load) that can be activated when needed. The reserve is today 2000 MW but there is no law that keep it from being larger. The cost for this capacity is financed through the central grid fees.

Statnett (the Norwegian TSO) has responsibility that there is always enough regulating reserves in the Norwegian system and that there in every situation is enough high load capacity available (which is bought as options and bid to the power balance market). There is a market based power market where there are contracts of different lengths (days to months). From October 2004 Statnett has a regulating power market with effect options (RKOM) which is a weekly market where it's possible so buy both consumption and production of effect power week by week based on the varying needs, to ensure enough capacity at the balance market. This market is fully internet based.

Finland
The market is assumed to cover the need for capacity. The TSO is responsible for keeping the momentary balance, but has no obligations to take responsibility for the long term power balance.

The market it self is responsible for power and energy reserves. Fingrid is responsible for hourly balance and also operation during disturbance situations. These reserves are automatically from frequency activated normal operation reserves, automatically from frequency activated disturbance reserves and fast, active disturbance reserves which are partly owned by Fingrid (about 515 MW fast disturbance reserves) an partly bought by bilateral contracts (reserves can be ordered to the reserve bank maintained by Fingrid) and regulating (balancing) power is bought from the (Nordic) regulating market to maintain balance.

Sweden
The TSO has responsibility to ensure the momentary balance. The goal is that the market will have enough reasons for keeping a good enough power capacity, but during a

transition period (2003 – 2008) the Swedish government have given Svenska Kraftnät the responsibility to secure resources for power balance.

The effect reserve is made of both free generation capacity and possible power reductions in for example industry. Plant owners give their bid with price for available capacity and are compensated in respect to what is available during the winter season. Variable compensation is then given for the actual time of operation during winter for actual marginal cost for generation in respective plant.

The buying of power reserve is made side by side with the responsibility of ensuring reserves for disturbances and frequency regulation of which the Nordic countries have come to an agreement.

Nordel

The aim for Nordel is that responsibility for capacity is limited to the daily operation for the system operator, while the market is responsible for keeping enough capacity even during (very) cold periods.

To secure the balance between supply and demand in a market based way is a key question for the continued development of the electricity power market. A system where requirements, compensation and financing vary between different countries may lead to a distortion of the competitive conditions between the actors/parties. (*Effekttillgång vid høglast*)

According to "Systemdriftavtalet"dated 1.4.2004 by Nordel, there is a structure to follow depending on the situation when there is a general capacity shortage. There are also some basic conditions that apply for the parties in the system. These are:

- Every part system is responsible for its own balance
- The TSOs have continuous information to each other
- A past of a system with a surplus doesn't have to disconnect load to the gain of a system part with a shortage
- Automatic active reserve shall be maintained to an extent as given in app. 2 in "Systemdriftavtalet"
- The need for manual active reserve in every part system is normally equally or larger than the dimensioning fault in every part system
- When there is a capacity shortage or critical capacity shortage the manual active reserve is reduces to under the normal level. The manual active reserve cannot undergo 600 MW in the synchronous system.
- Physical transmission capacities in the grid shall be maintained and the frequency shouldn't undergo 50.0 Hz.
- Every TSO develop instructions that fulfil the regulations, and the content is coordinated among the TSOs.

Risk for capacity shortage

When there is a danger for capacity shortage, the TSO shall inform the other parties as soon as possible and if needed the market parties will be informed as well via Nord Pool Spot. 600 MW or more of the most expensive bids are earmarked as a manual active reserve for every hour. If there is a risk for bottlenecks, the reserve is divided / distributed in consultation with the parties.

Capacity shortage

When there is an actual capacity shortage and a part of the system cannot fulfil the need for manual active reserves, the other parties are informed as soon as possible. Already established trades cannot be changed. Svenska Kraftnät och Fingrid may demand that Elbas is closed. In the need of up regulation, bids in the regulating list are used in price order. Marked based bids are used before fast, active disturbance reserve and the manual active reserve isn't used before the entire remaining regulating list is activated.

Critical capacity shortage

When critical capacity shortage is approaching, a manual disconnection of consumption in deficit areas is ordered. If no grid problems arise, bids in the regulating list are used until only 600 MW of manual active reserve is left in the synchronous system. At the same time disconnection of consumption without market deals are ordered and the disconnection is made in that part of the system that has the major deficit / shortage.

Capacity shortage due to bottleneck (congestion) or disturbance

Actual part system is responsible for measures when there is a capacity shortage which is caused by a bottleneck or a disturbance in the grid, as long as there are regulating reserves available. If time allows it, manual disconnection of load in deficit areas are ordered. If a bottleneck arises towards a part of a system with capacity shortage and all bids in the regulating list are activated, disconnection of load beside the regulating list is ordered. Parts of a system that can regulate itself into balance do not have to start disconnection of loads. Manual active reserve shall never be below 600 MW in the synchronous system.

When the capacity balance within the deficit area is improving, the load is connected in small steps. Usually the power is exchanged as balance power and the price is according to this.

Despite this common framework, there is of yet no common rules between the TSOs as how forced load shedding shall occur.

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