# The Norwegian Security of Supply Situation during the Winter 2002/-03

## Part I - Analysis

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Disclaimer: The authors as independent researchers prepared the study. The views expressed in this Working Paper are those of the authors and do not necessarily reflect the views of the Council of European Energy Regulators or the Norwegian Regulator.

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## 1. Introduction and background

Norway was one of the first countries in the world to open the electricity market to full competition, and has been stated as a successful example to follow for other countries wanting to liberalize their power market. During the winter 2002/03, however, the Scandinavian market design was put on a test with regard to how it would deal with situations of shortage of supply. Following the market problems in California in 2000, security of supply has been a much-discussed issue all over the world. The important question that is being asked is whether security of supply is sufficiently taken care of in electricity markets with full competition.

Being part of the Scandinavian power market, the Norwegian security of supply situation has to be considered in a Scandinavian context. However, due to the 99% dominance of hydro power generation, the dry winter 2002/03 particularly hit Norway hard. Focus will therefore be on Norway.

The European regulators, already having liberalized their energy markets or being in the process of doing so, have also put the subject of security of supply high on their agenda. The Council of European Energy Regulators (CEER), being concerned that deregulated electricity markets might, under specific circumstances not provide sufficient long-term investment signals, has established a Working Group dealing with this issue. As a consequence of the skyrocketing prices in the Scandinavian market due to the tight supply situation appearing this winter, and the heavy public discussions following it, the Working Group decided to investigate the apparent supply problems more thoroughly. A Task Force consisting of the Austrian and Portuguese regulators was established, and the Norwegian regulator provided background information and helped organize the necessary meetings in order to get a good picture of the situation.

The EU Commission has also dealt with Security of Supply issues in the draft version of the strategy paper on "Medium term vision for the internal electricity market" distributed for discussions in March 2003. The strategy paper particularly stresses the importance of:

- *Improved interconnection between the member states*: In order to achieve a well-functioning internal electricity market the level of interconnection should be increased. In order to promote this, the decision-making process for governments, regulators, and Transmission System Operators (TSOs) need to be clarified and the roles defined. Here a European view is necessary. Furthermore, investors have to be secured certainty with respect to regulatory treatment of profit and losses from interconnector projects.

- *Consistent approach to generation adequacy*: A few Member States, such as the Nordic system, Ireland and Greece, have faced a diminishing generation adequacy over the last years. A consistent approach, which does not have the potential to distort competition, is required to deal with this. So far this issue has been dealt with on a national level in the respective countries. From the point of view of economic efficiency, however, it is clearly of benefit if Member States can share reserve capacity since it means a lower level of reserve is needed in each Member State. The Commission furthermore points to the fact that the generation investment authorisation and planning process in some Member States are unnecessarily tough, and that this process should be streamlined and harmonised throughout the EU.

- *Market monitoring and reporting*: The operation of the electricity market is to be monitored, and an annual report on the overall functioning of the internal market is to be published. This report will include an examination of public service obligations and the supply-demand situation in every Member State every second year.

We would like to thank the following for their support and assistance related to this fact-finding mission to Norway:

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## 2. The supply situation

To understand the supply situation in Norway it is necessary to survey the Scandinavian area situation (Denmark, Finland, Norway and Sweden). These four countries have had strong commercial relations for a long time and operate a common electricity market (Nordpool ASA). This chapter analyses both the supply situation in Norway as well as in the other Scandinavian countries. It also describes the development of the total system over the last years, including both generation and transmission.

### 2.1. Generation

In Norway, 99% of the generation of electricity come from hydro power plants. In 2000, there were five companies generating more than 5% each of the domestic electricity output (Eurelectric, 2001). Statkraft, the biggest company is wholly state-owned and owns close to 30% of the Norway's electric power production resources (Statkraft, 2003).

The Norwegian hydro power generators have to pay a resource rent ("Richardian hydropower rent") for the use of the water. This resource rent depends on the generated output (kWh) and is indexed to the spot price of Nordpool.

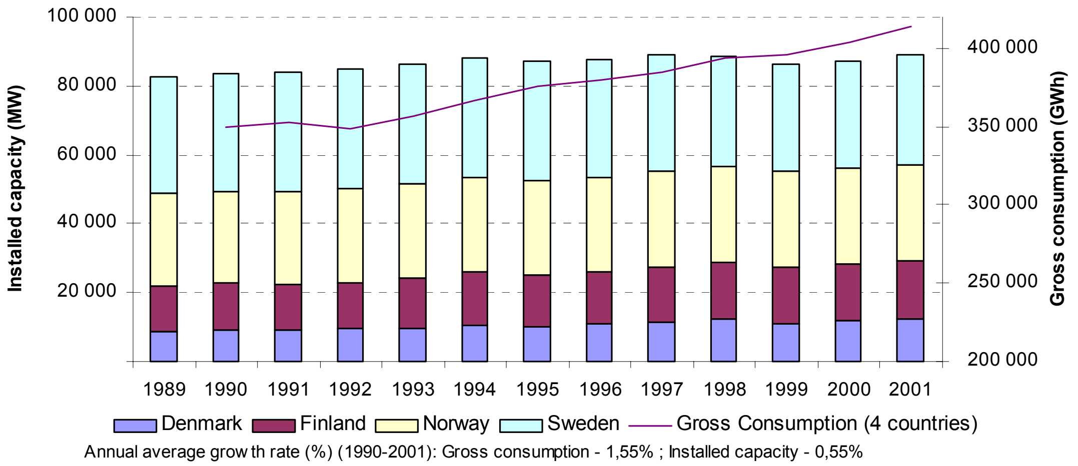
To achieve full insight into the Norwegian power situation it is important to survey the Scandinavian situation. Table 2.1 has information concerning the generation mix in the Scandinavian countries (2001).

**Table 2.1:** Generation mix in the Scandinavian countries (2001) (%).

| | Denmark | Finland | Norway | Sweden |
|---|---|---|---|---|
| Hydropower | 0 | 19 | 99 | 50 |
| Nuclear power | 0 | 31 | 0 | 44 |
| Other thermal power | 88 | 50 | 1 | 6 |
| Other renewable power | 12 | 0 | 0 | 0 |

Source: Nordel, 2003.

Figure 2.1 shows the evolution of the installed capacity (MW) in Scandinavia as well as the development of the gross consumption (GWh).




Source: Nordel, 2003.

**Figure 2.1:** Installed capacity and gross consumption in Scandinavia.

The installed capacity has remained almost constant over the last 12 years, with addition of very little new capacity combined with decommissioning of old power plant capacity (Nordel, 2002). The gross consumption[1] has increased at an annual average growth rate[2] of 1,55%, significantly higher than the annual average growth rate of the installed capacity (0,55%). Therefore, the security reserve margin has decreased.

Figure 2.2 shows the development of the installed capacity and the peak load in Norway as well as the margin over the peak load[3].

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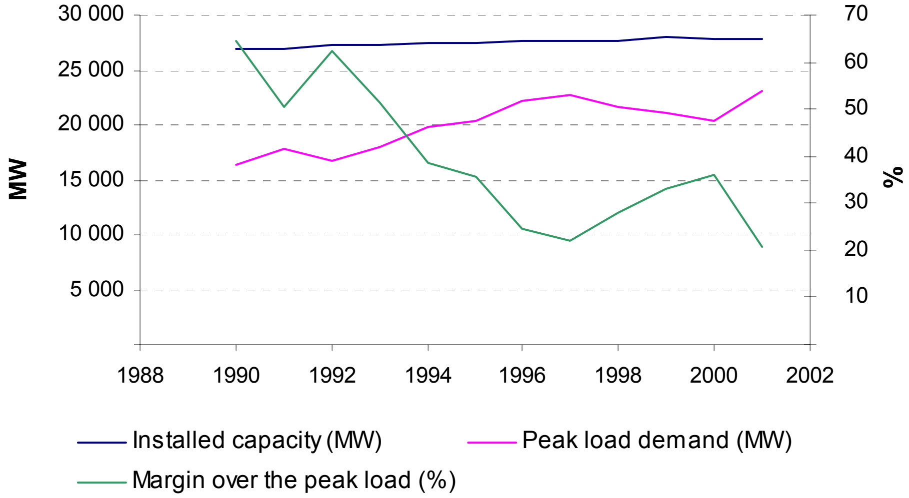
[1] Including losses

[2] $V_{2001} = V_{1990} \times (1+r)^{11}$ , r – annual average growth rate

[3] Margin (%) = (Installed capacity – Peak load) / Peak load x 100




Source: Nordel, 2003

**Figure 2.2:** The development of the installed capacity, the peak load and the security of supply margin.

In a hydro power based system the margin can not be analysed alone, because the installed capacity will not be useful if there is no water available. However, it is interesting to note the verified reduction of this margin over the years.

In Sweden there is a political will to reduce nuclear power plants. The power station Barsebäck 1 (615 MW) was closed on November 30, 1999 (Bassebackkraft, 2003). The decommissioning of the Barsebäck 2 power station has been delayed the last years, but the discussions have been renewed lately. Due to the fact that this power plant is situated near to an important consumption load this would increase the grid congestions.

Finland recently decided to build a new nuclear power plant until 2008, with a capacity of between 1.000 and 1.500 MW.

In order to understand the supply chain it is important to get a picture of the hydrological cycle in the Scandinavian countries[4]. Figure 2.3 shows the reservoir content in Scandinavia depending on the hydrological year.

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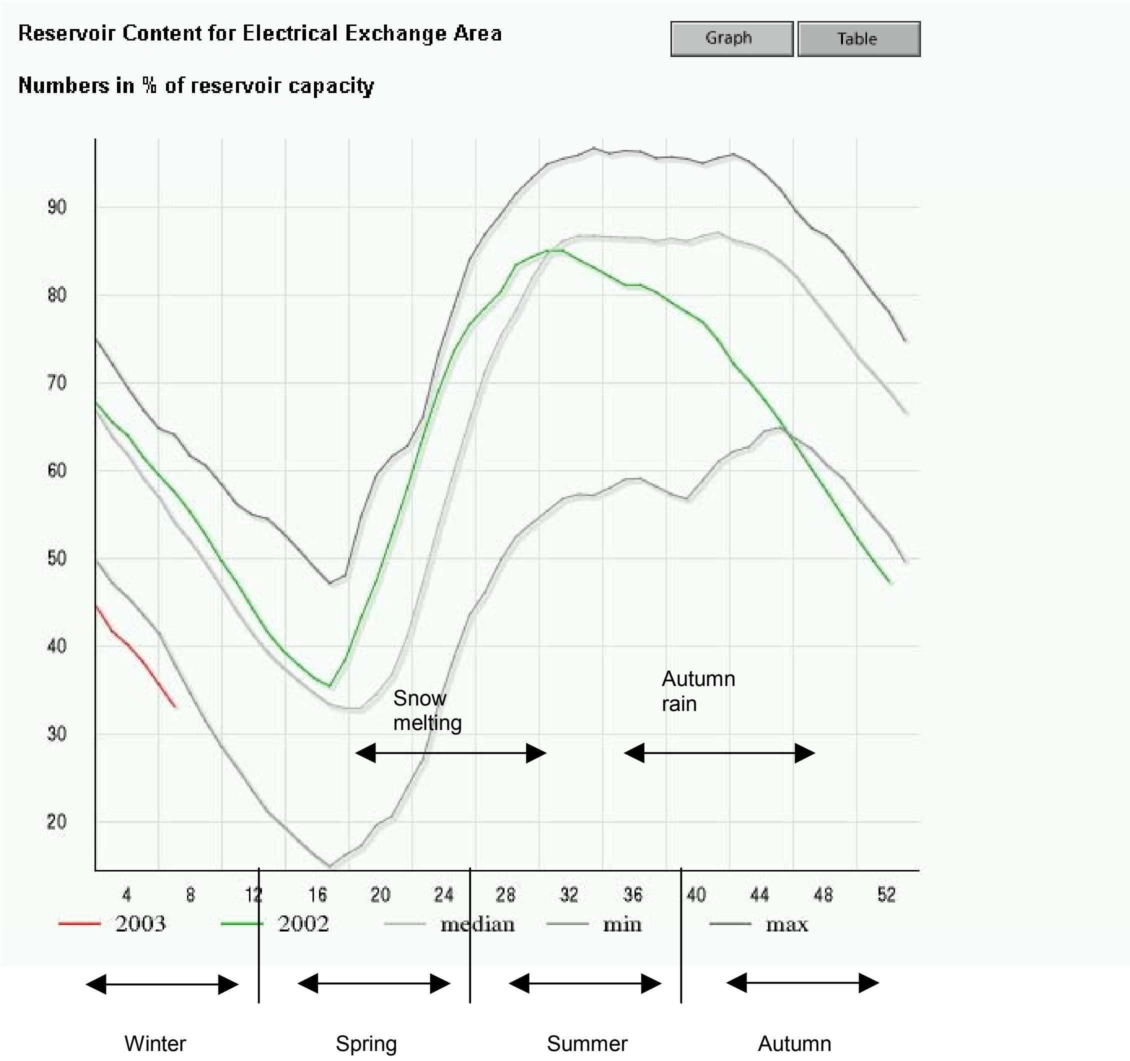
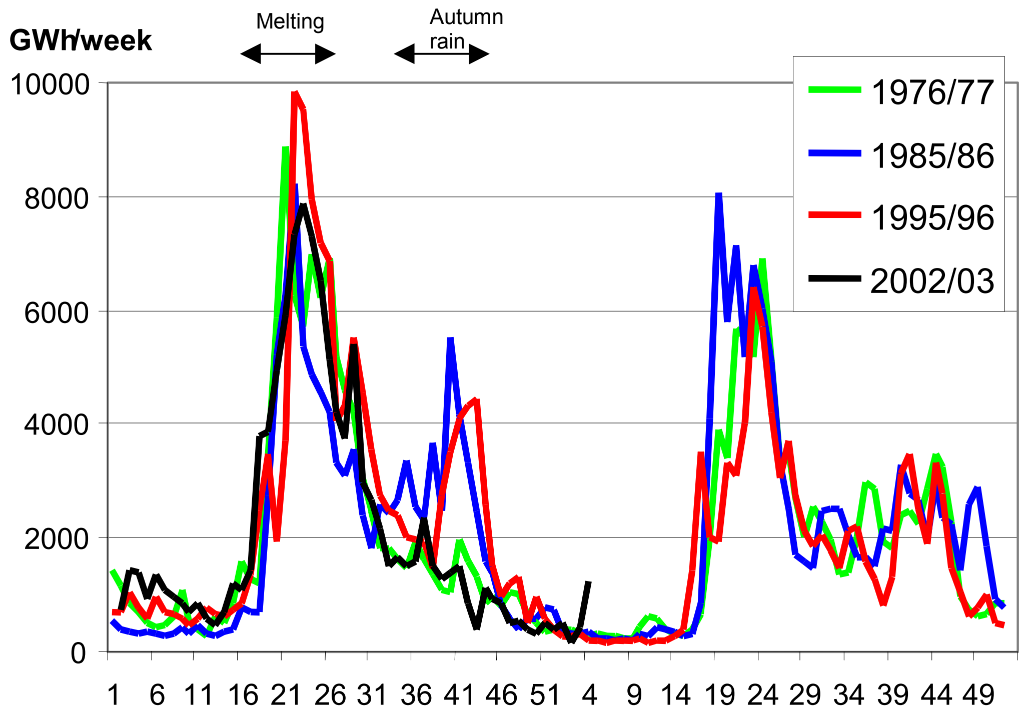
[4] It is interesting to note that the hydrological cycle is different from other European countries, namely the Southern European countries.




Source: Nordpool, 2003

**Figure 2.3:** Hydrological cycle in Scandinavia and impact on reservoir levels.

The reservoir levels increase due to the snow melting during Spring and early Summer. The Autumn rains contribute to the reservoir filling. The outflow of the reservoirs depends on the consumption, which is higher in the winter due to the strong consumption level (lower temperatures) caused by electric heating. Figure 2.4 shows how the inflow into the reservoirs is distributed over the year.




Source: NVE, 2003b

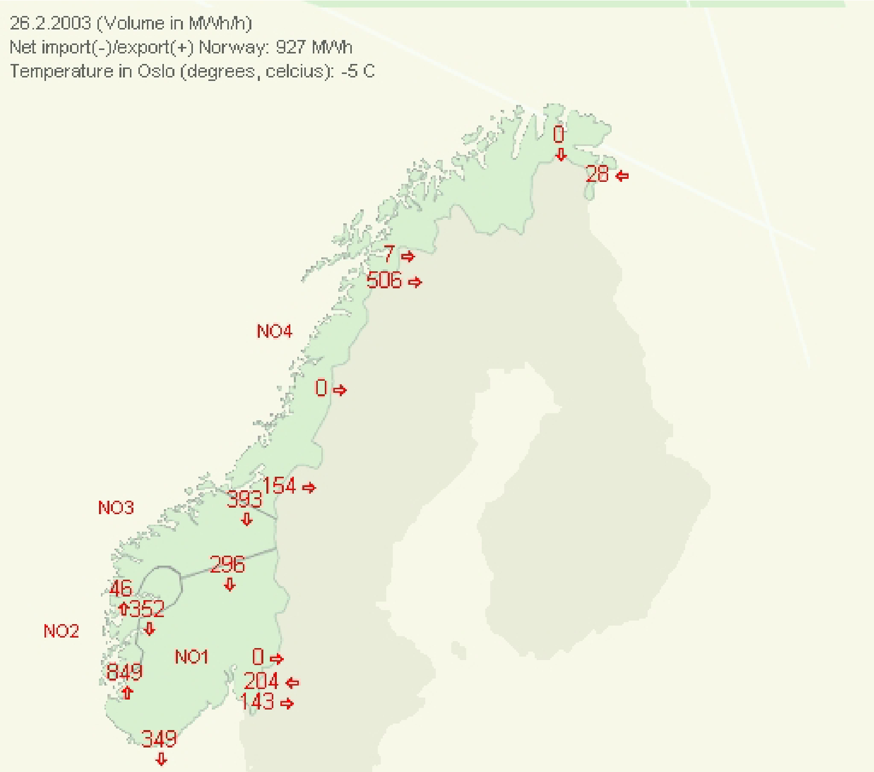
**Figure 2.4:** Inflow of water into the Norwegian reservoirs.

## 2.2. Transmission and Interconnections

Norway had one Transmission System Operator – Statnett - and 195 distribution companies as of 2000 (Eurelectric, 2001).

Worth mentioning is the location of the hydro power plants in the North and the load centres in the South in Norway. However, the power in Norway flows mainly in a West-East direction. Typical for Norway is furthermore that the power flow varies between night and day, between seasons as well as between years.

Norway is divided into four control areas (NO1, NO2, NO3 and NO4), as shown in Figure 2.5.




Source: Statnett, 2003a

**Figure 2.5:** Control areas in Norway.

Since the four Scandinavian countries form one electricity market the exchange between them is relevant. Therefore it is important to study the interconnections between the four countries. Table 2.2 shows the capacity of existing interconnections between the Scandinavian countries.

**Table 2.2:** Existing interconnections in Scandinavia, 2001 [MW]

| From/To | Denmark | Finland | Norway | (MW) Sweden |
|---|---|---|---|---|
| Denmark | - | - | 1040 | 2640 |
| Finland | - | - | 100 | 1830 |
| Norway | 1040 | 70 | - | 4755 |
| Sweden | 2680 | 2230 | 4055 | - |

Source: Nordel, 2003.

Table 2.3 shows the net export and the net import to/from Norway to the neighbouring countries from 1991 to 2001.

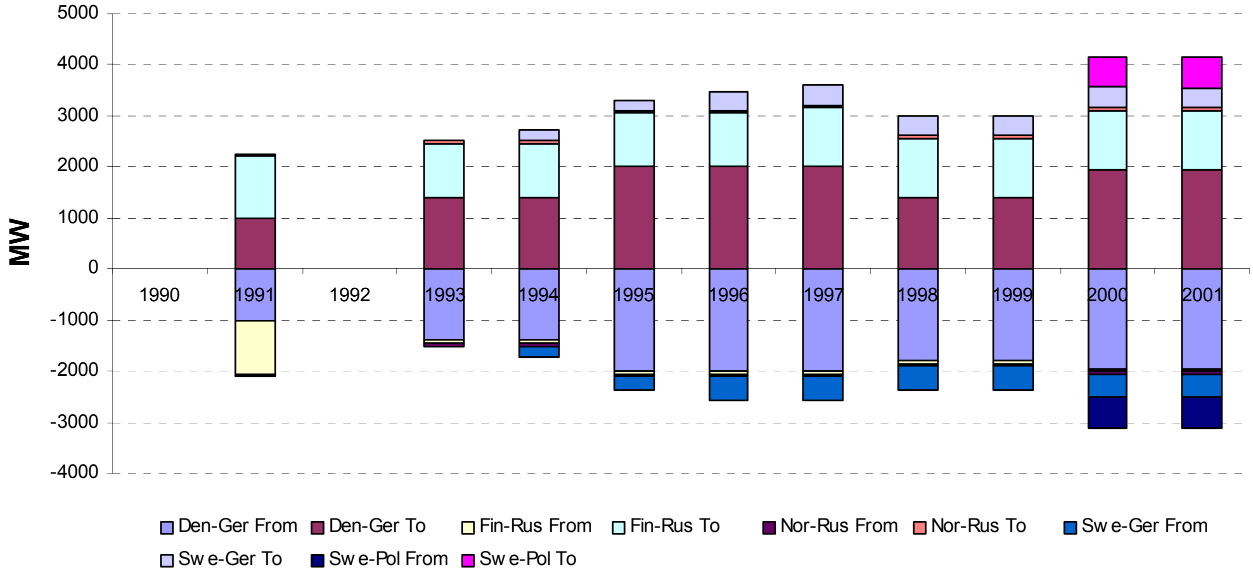
**Table 2.3:** Net exports (-) and net imports (+) from 1991-2001 [GWh].

| *Year* | *Sweden* | *Denmark* | *Russia* | *Finland* | *Total* |
|---|---|---|---|---|---|
| *1991* | *-1.832* | *-1.018* | *9* | *-79* | *-2.910* |
| *1992* | *-5.709* | *-3.047* | *31* | *-99* | *-8.824* |
| *1993* | *-5.810* | *-1.952* | *0* | *-26* | *-7.788* |
| *1994* | *-1.561* | *1.194* | *0* | *292* | *-75* |
| *1995* | *-6.143* | *-1.017* | *80* | *11* | *-7.069* |
| *1996* | *3.939* | *4.680* | *176* | *252* | *9.047* |
| *1997* | *3.148* | *639* | *50* | *180* | *4.017* |
| *1998* | *4.375* | *-909* | *193* | *19* | *3.678* |
| *1999* | *25* | *-2.137* | *232* | *-3* | *1.883* |
| *2000* | *-14.808* | *-4.488* | *231* | *42* | *-19.023* |
| *2001* | *2.341* | *845* | *207* | *199* | *3.592* |

Source: Nordel, 2003.

The Scandinavian countries currently have interconnections to Germany, Russia and Poland.

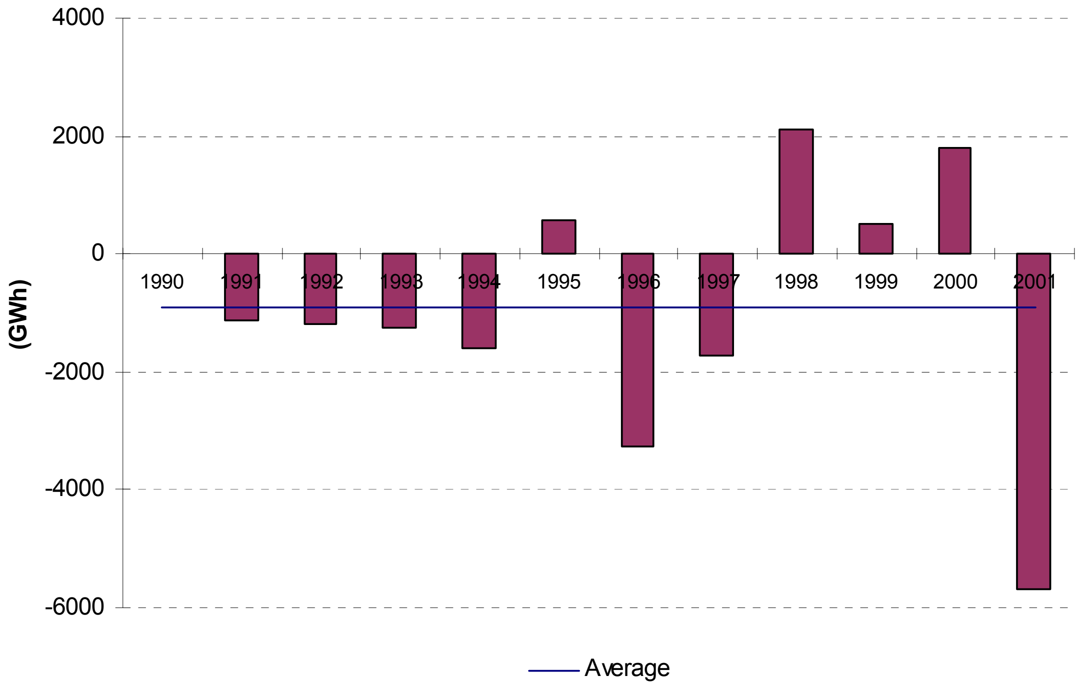
Figure 2.6 shows the development of the transmission capacity (MW) between the Scandinavian countries and other countries.




Source: Nordel, 2003.

**Figure 2.6:** Transmission capacity between Scandinavian countries and other countries.

The utilisation of the interconnections, and the direction of the power flow, depends on the market price. The price in the Scandinavian market, and partly also in the different price zones, depends on the hydrological conditions as well as the consumption. Figure 2.7 shows the development of the net exchanges through the interconnections from/to Scandinavia. Import is reported with a negative denomination, and export with a positive denomination.




Source: Nordel, 2003.

**Figure 2.7:** Scandinavian net exchange (import (-); export (+)).

Several new interconnections to/from Norway have and are being considered:

- Norway – Germany: Two cables (600 MW each) were originally planned but have been cancelled. The German parties did not want to go through with the expansion, and bought themselves out of the contracts. Existing price differentials between Norway and Germany might have played a role in this decision.

- Norway – Netherlands: Since 1994, Nordel annual reports have referred to future interconnections between Norway and the Netherlands[5]. However, that interconnection was not yet built.

- Norway – United Kingdom: A possible interconnection of 1.200 MW between Norway and the United Kingdom is being discussed.

[5] Planned transmission capacity of 600 MW. Approximately 50% of a possible subsea cable are supposed to be owned by Statnett (Statnett, 2003a)

## 2.3. Transmission system operations

The TSOs co-ordinate their operations, among others through Nordel. However, legal obligations differ between the countries, for instance regarding security of supply duties. According to NVE (2003) and EBL (2003), a political discussion is needed to improve the cooperation between the TSOs.

Statnett (2003) does not regard the security of supply as its task, dealing only with the real time balance (short term). Statnett is currently not allowed to own any generation capacity due to the organisational unbundling. Real time balancing is dealt with entirely through market or contractual mechanisms. Svenska Kraftnät (the Swedish TSO), on the other hand, owns some backup capacity.

## 2.4. Future investments in generation and transmission

As was shown in Figures 2.1 and 2.6, little has been invested in new generation capacity or interconnection capacity the last years. Some explanations for this in Norway are:

- Environmental constraints to new hydro power plants. Since the 1960s there has been a growing conflict between the hydro power developers and environmental interests. Until 1980 almost all environmental concerns focused on hydro power development. Therefore, a water bed protection plan was established that defines protection measures for 341 river bed systems against further hydropower development (NVE, 2003a);

- Strong environmental constraints to new thermal power plants, namely NOx emission limits[6].

Norway has abundant natural gas resources. Therefore, gas fired power plants could be expected to prevail as an interesting investment alternative. Due to relative tight environmental constraints, generation companies currently consider the forward contract prices (prices of forwards and futures on Nordpool) too low to make the

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[6] Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone establishes that $NO_2$ emissions cap in Norway, in 2010, must be –28% of the 1990 levels. Norway ratified this Protocol on 30.01.2002 (UNECE, 2003).

investment profitable. Current forward prices are close to 180 NOK/MWh (≈23,9 €/MWh[7]) and investors require a stable market price of 220-250 NOK/MWh (≈29,3-33,2 €/MWh) to trigger such investments (EBL, 2003). Retrofitting old hydro power plants could be an alternative to increase the installed capacity. However, this is considered more expensive than the construction of new hydro power plants. A potential of 25 TWh in new hydro power capacity is being considered realistic (EBL, 2003).

The Norwegian Government, through ENOVA (the public authority for energy efficiency), is supporting Demand Side Management (DSM) and investments in renewables (heat pump installation, district heating, wind and biomass). The Government through pre-defined targets sets the prioritisations of ENOVA. Retrofitting of old hydro power plants is currently not covered through these support arrangements, but has been mentioned as an interesting alternative.

Concerning the possible new interconnections (UK and the Netherlands) the discussion is focused on who should cover the costs. On the other hand, an agreement between grid operators is needed. There are some difficulties in these negotiations. Statnett (2003) expect that a decision on the interconnection to the UK will be taken Spring 2003. The project finance plan imply that 20% of the capacity will have third party access while the remaining capacity will be negotiated and covered through long term contracts (Statnett, 2003).

A possible future interconnection between Finland and Russia is also currently being discussed. For Norway this will probably have low impacts due to constraints in the Swedish transmission grid.

The cancelled interconnector to Germany would have provided several advantages since the German generation mix is heavily base load biased (cool and nuclear) and this would open up a number of optimization potentials in connection with the high percentage of peak load generation capacity in Norway.

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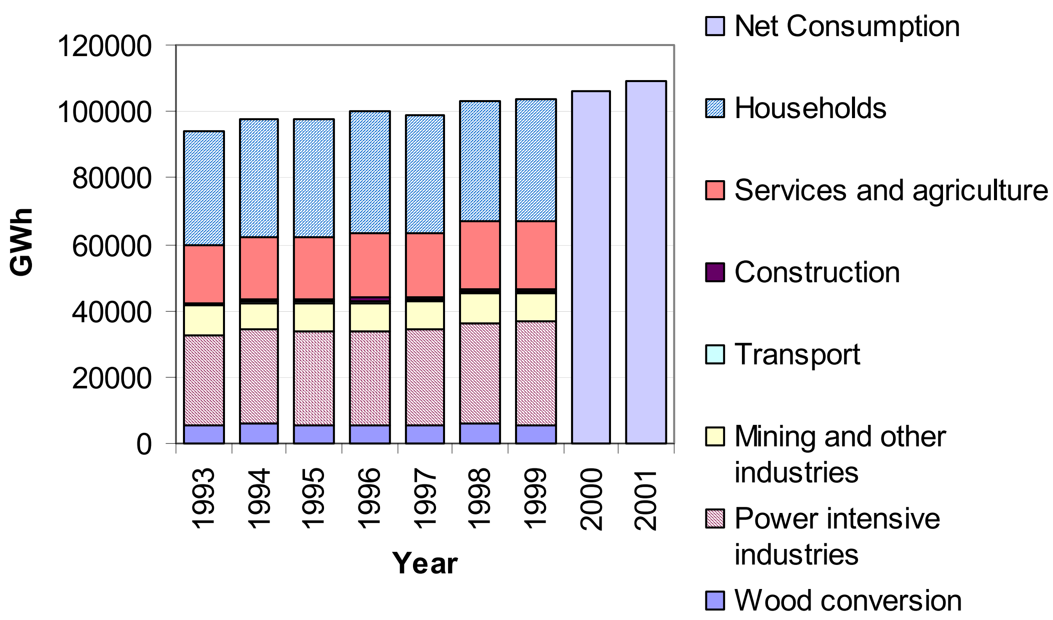
[7] Exchange rate: 1 Euro = 7,5 NOK

## 3. The demand situation

### 3.1. Electricity consumption

Electricity intensive industry consumes some 30% of total consumption in Norway, while residential customers use another 35%. Commercial customers consume the remainder of a total annual consumption of 108 934 GWh[8] in 2001. Figure 3.1 shows the consumption distribution for the period 1993-2001. The total number of household customers being served was 2 538 580 in 2000 (NVE, 2003d).

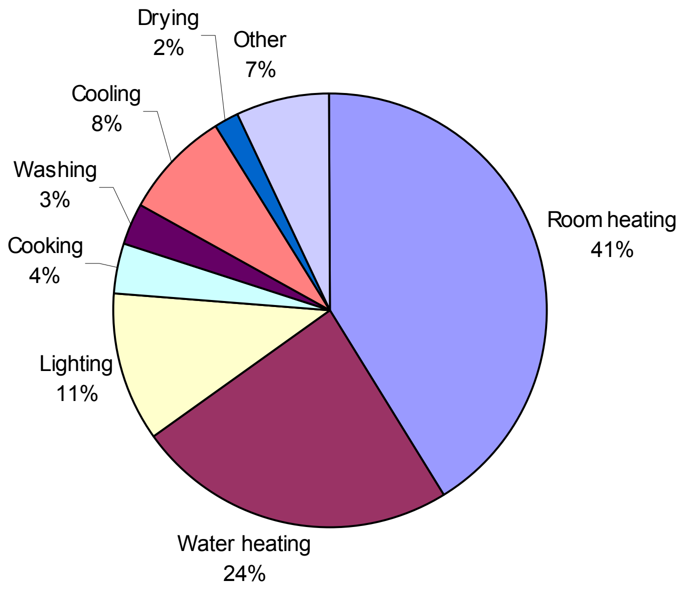



Source: Statistics Norway, 2002

**Figure 3.1:** Consumption distribution in Norway, 1993-2001.

The average household consumption was 17 650 kWh in 1999, which is rather high compared to other countries. The main reason for the high consumption is the fact that most Norwegian household customers have electric heating. Figure 3.2 shows the distribution of the electricity consumption by type of usage in Norway.

[8] Net consumption, meaning that grid losses are not included.



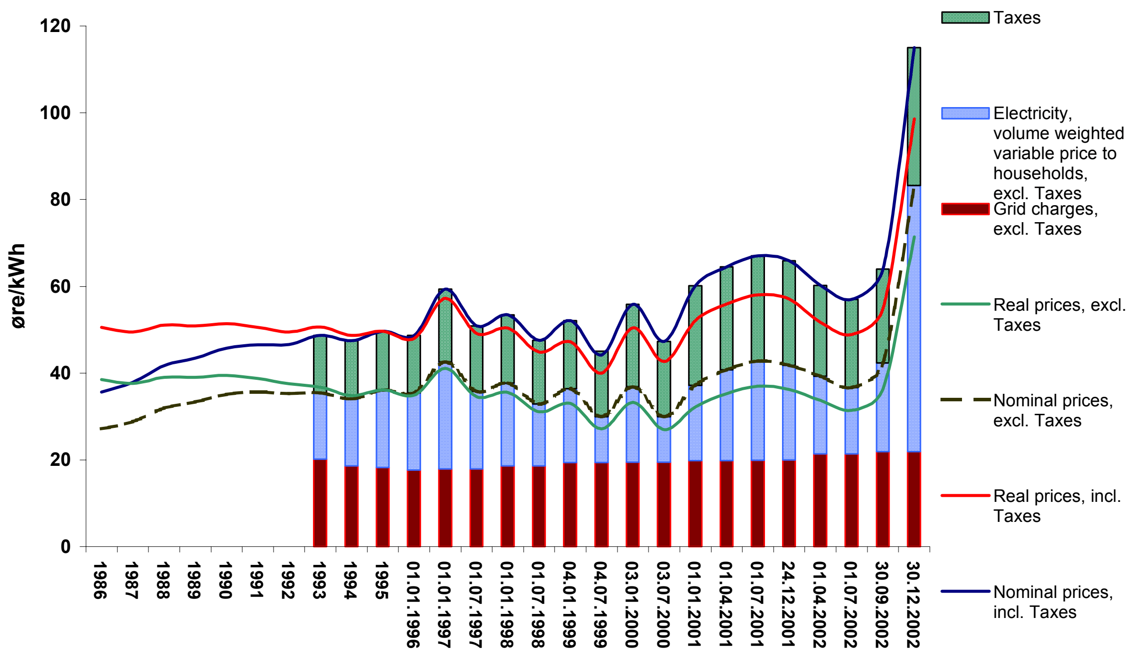

Source: Statistics Norway, 1992

**Figure 3.2:** Household electricity consumption divided by type of usage, 1992.

As can be seen from Figure 3.2, room heating covers approximately 41% of the household electricity consumption and water heating approximately 24%. The neighbouring countries do not have the same high share of electric heating as the Norwegian household customers.

## 3.2. Typical contracts to end-users

Despite the fact that the Norwegian household customers have relative high electricity consumption, the majority have electricity contracts linked to the spot price in one way or another. The customers normally can chose between the following standard pricing options: 1) fixed price contracts (1-2 years), 2) spot price contracts, or 3) variable price contract. The variable price contracts are contracts where the suppliers can change the price (on two weeks notice) whenever they see the need for it, for instance when the spot prices increase. This type of contract is the default when the customer does not actively choose, and is also the contract underlying the price comparisons prepared by the Competition Authority. In Sweden, on the other hand, the default contract is a fixed price contract. This also implies that the Norwegian household customers are exposed to the market price to a larger extent than the Swedish customers, also with the high spot prices of 2002/03. Figure 3.3 shows the development of the grid charges, electricity prices and taxes in Norway from 1986 to April 2001.




Source: NVE.

**Figure 3.3:** The development of the Norwegian household charges. 1986-2002.

As can be seen from Figure 3.3, the nominal grid charges have been rather stable since 1993. The nominal retail electricity prices, on the other hand, have varied from year to year as well as from quarter to quarter. What is also worth noticing is that the taxes have increased. The taxes are currently the Value Added Tax of 24% (also levied on the electricity tax) and the electricity tax of 9,3 öre/kWh (1,24 €-Cent). With the exception of the last quarter of 2002, the real electricity charges (without taxes) have had a downward trend since 1993.

The power intensive industries, on the other hand, mostly have long-term fixed price contracts. The consumption of the power intensive industries is furthermore rather stable over day and night, summer and winter.

## 3.3. Demand Side Bidding

The possibility of periodic tight peak power capacity has been discussed frequently the last years, and different alternatives for utilizing the customer side actively have been studied. Particularly the power intensive industry has been found interesting in this respect. The peak power reduction potential can be activated within 15 minutes notice, and can be utilised for periods exceeding 2 hours at a time, without causing large operational disturbances for the industrial production processes. As a consequence of recurring peak power capacity scarcity in the Norwegian system, the system operator Statnett opened the real-time (regulating) market to large industrial customers in 2000. Compensation is given for stand-by reserve as well as per MW available on demand. In 2001, 670 MW was made available from the large industrial customers to the regulating (balancing) market, although there was no need to utilize this potential.

## 4. Description of the 2002/-03 situation

### 4.1. Price developments

The market gave the first pre-warning signals as early as in 1996 that the Scandinavian power market could face tight electricity supply during dry hydrological years. 1996 faced a situation with a low spring filling of the reservoirs, and the prices increased accordingly. The prices remained high during the early autumn. However, normal autumn precipitation, as well as the extension of the Norwegian power market by including Sweden and Finland, helped ease the supply situation in the late autumn. The subsequent years precipitation remained plentiful and prices remained stable and low. The first public signals that there might be a tight supply for the winter 2002/-03 came in October when Statnett warned the market participants over the state of the reservoir filling. As opposed to 1996, the reservoir filling during the spring 2002 was somewhat better than normal. In order to prepare for the autumn rains the Norwegian generators produced electricity that was partly exported to Sweden[9]. However, the expected autumn rain did not appear, and the reservoirs continued to empty. In addition to the low autumn rains, temperatures were lower than normal from October 2002 on, meaning that any precipitation came as snow and that consumption was high. Figure 4.1 illustrates how the spot system prices have developed since Norway, Sweden and Finland formed one spot market in 1996, and Denmark joined in 1999.

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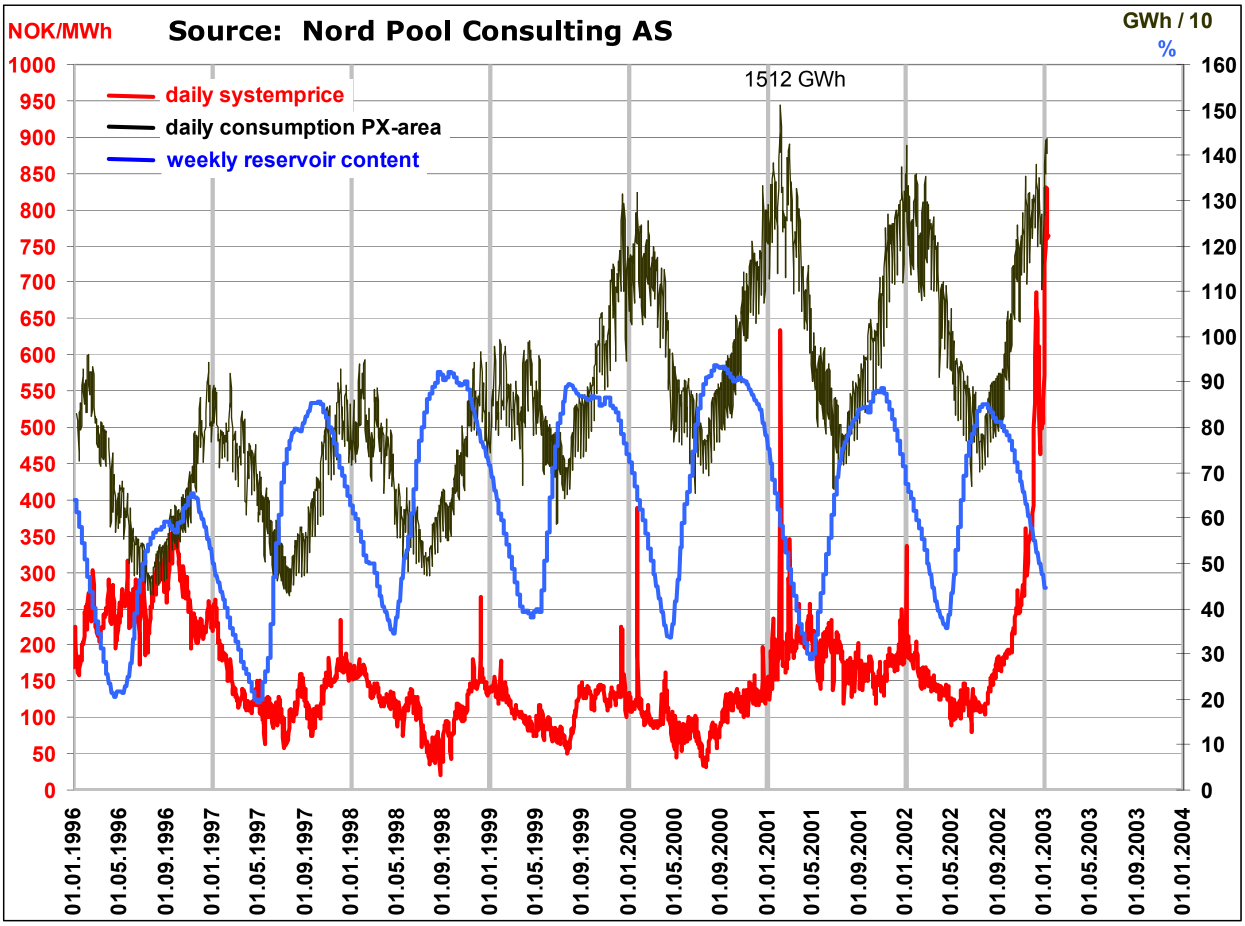
[9] The production planning in Scandinavia is to a large extent based on hydrological time series from 70 years. The hydro power generators compare the current spot price to their expected future price. In other words, the generators plan their production by evaluating the more or less certain current price to more uncertain future prices. Every generator does this evaluation depending on in which price area this generator produces electricity. The generation does not necessarily follow a certain pattern, but depend on the different generators evaluation of the current price compared to the expected future price.




Source: Nordpool Consulting.

**Figure 4.1:** Daily spot market prices compared to consumption and reservoir content. 1996-2003.

As can be seen from Figure 4.1, the prices in 1996 were rather high – up to a daily average of 350 NOK/MWh (47 €/MWh) - while the prices subsequent years were rather low. A few periods of high peak prices appeared also in the later periods of generally low prices. One reason was real time capacity constraints, for instance in February 2001 when the consumption reached the limits of the available capacity, when the price in one particular hour reached 1.000 NOK/MWh (133 €/MWh), but then went back to normal. During the winter 2002/-03 the daily average price reached a high of 850 NOK/MWh (113 €/MWh). One feature of the current high price period is that there were no big peak prices due to real time capacity scarcity or big price differences between the different market zones.

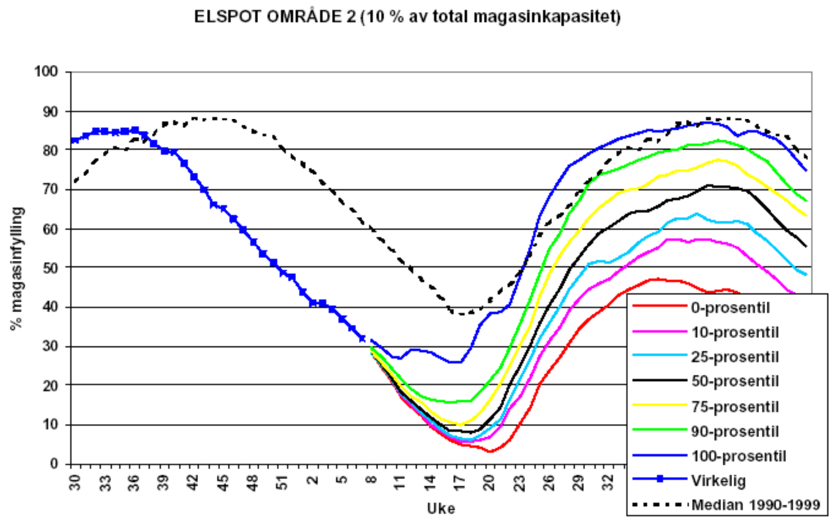
Although there are no signals that the power situation has changed much between December 2002 and February 2003, prices on the power exchange are considerably lower than in December. The question is, whether the prices in December were overstated, or whether the current market behaviour is really rational. One way of preventing irrational behaviour is to provide the market with more information, as NVE and Statnett have been trying to do.

Another possible explanation for the later price reductions that has been mentioned is the so-called resource rent that the Norwegian generators have to pay to the government. The resource rent is related to the spot price, meaning that the generators have to pay this tax in relation to the spot price independent of how much is actually sold on spot. When generators have a high share of long-term bilateral contracts, high spot prices mean that they have to pay a relatively high resource rent. Due to the high spot prices and consequently the high „Richardian hydropower rents“, the difference to the contracted prices are high, and the generators might have incentives to generate as much as possible in order to push the spot prices down.

## 4.2. Reservoir filling during 2002/-03

NVE has kept track of the continuous reservoir-filling situation in different regions of Norway over several years. A couple of years following the establishment of Nordpool (or the predecessor Statnett Market) the aggregated reservoir fillings were made public on a weekly basis. The reason for this was to provide the market participants with more information in order to facilitate rational decision-making. Before this information was made public the market participants had to gather this information on their own. The companies tried to estimate the reservoir filling for instance by using helicopters to map the reservoir fillings and the snow pack in different regions of Norway. Statkraft, the largest generator in Norway, had and still has an advantage in this respect. Statkraft possess power stations located all over the country and may therefore get a more accurate and timely overview of the total filling situation than other market participants. However, the fact that the Norwegian generators have to provide more information to the market than the other Scandinavian market participants has been criticised.

As the supply situation tightened during October and December 2002, NVE decided to prove more information on the current reservoir filling in Norway than had been formerly provided. Therefore, instead of publishing the aggregated reservoir levels for Norway, aggregated reservoir levels for 4 different regions were made public. Figure 4.2 shows the actual reservoir filling for Region 2 (West-Norway) until week 8, 2003 compared to the median of the years 1990-1999. Additionally, Figure 4.2 shows the prognosis of the reservoir filling for the following weeks depending on the hydrological development. The 0-Percentile, for instance, shows the forecasted reservoir filling given that the driest year of the historic time series of precipitation (from 1931) would repeat itself. Correspondingly, the 100-Percentile, shows the forecasted reservoir filling given that the wettest year of the historic time series of precipitation would repeat itself.



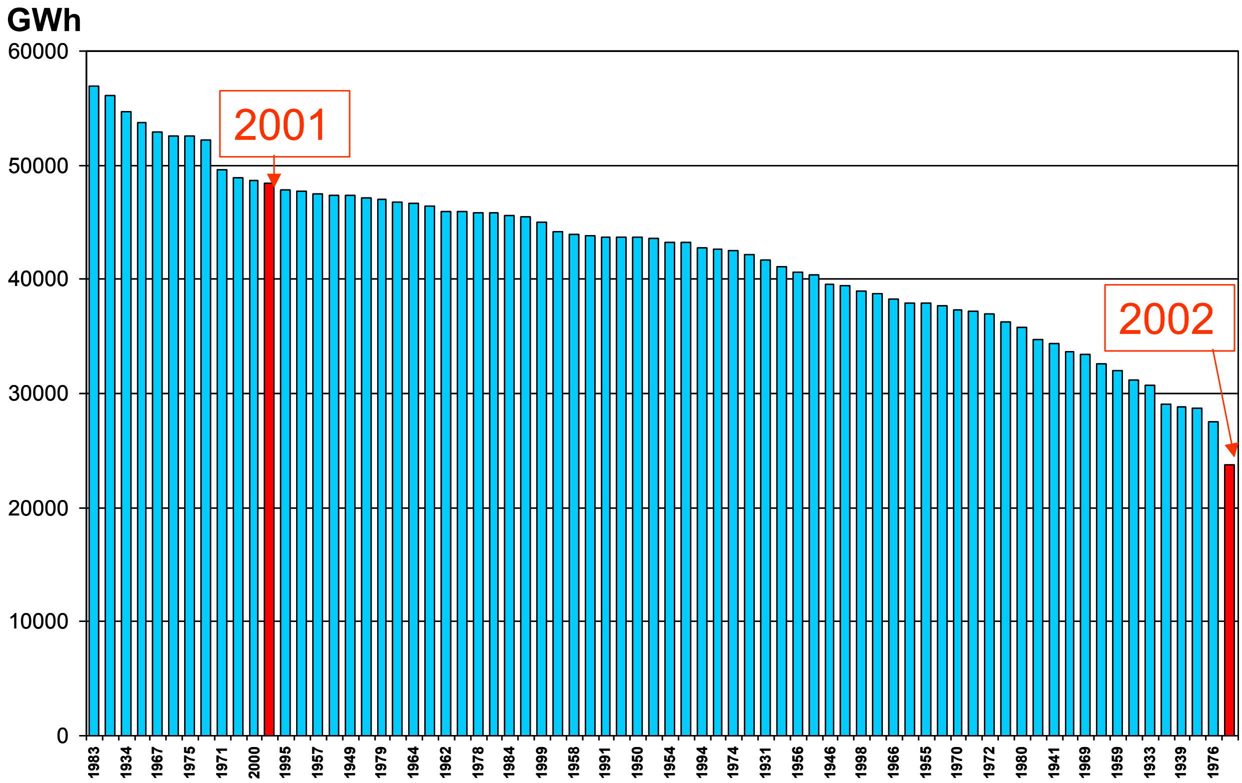

Source: NVE 2003d

**Figure 4.2:** Reservoir filling until week 8, 2003 for West-Norway.

As can be seen from Figure 4.2, the reservoir levels reached its peak some 10 weeks earlier as the median of the last 10 years due to low precipitation during autumn 2002. As a consequence, from around week 48, 2002 until week 8, 2003 the reservoir filling in this particular region was up to 30 percentage points below “normal”. Based on historic data on precipitation since 1931, a prognosis for the reservoir filling in region 2 has been prepared, as illustrated in Figure 4.2. With an exceptionally wet spring, and a high snow pack melting early, the reservoir filling would not fall below 26%. However, an exceptionally dry year could result in reservoir fillings down to 2-3% in this region.

The reservoir filling was 33,7% in Norway at the beginning of week 7, 2003. Particularly problematic is the southern parts of Norway. The reason for this is that the main consumption is located in the South, while quite a large part of the generation is located in the North. In addition to the level of the reservoir filling, the transmission capacity into the southern part of Norway is important. Statnett together with NVE have started publishing information not only on the reservoir levels of the four regions, but also on the transmission situation. Forecasts could be important in this respect, in order to promote "rational" water household[10] to deal with possible severe situations in the spring. However, one should be aware to cross the line of providing extra information that influence on the prices. These forecasts show that the capacity of the transmission lines into southern Norway may be too low in order to secure balance between generation and consumption in April and May 2003. The timing of the snow smelting, and the precipitation for the following weeks, is critical in this respect. According to Statnett a reservoir filling of minimum 7-8% is necessary in order to maintain a stable system.

Figure 4.3 shows the electricity equivalent of the autumn precipitation of the last 71 years.




Source: NVE, 2003

**Figure 4.3:** The current electricity content of the usable precipitation of weeks 31-47, 1931-2002, Norway.

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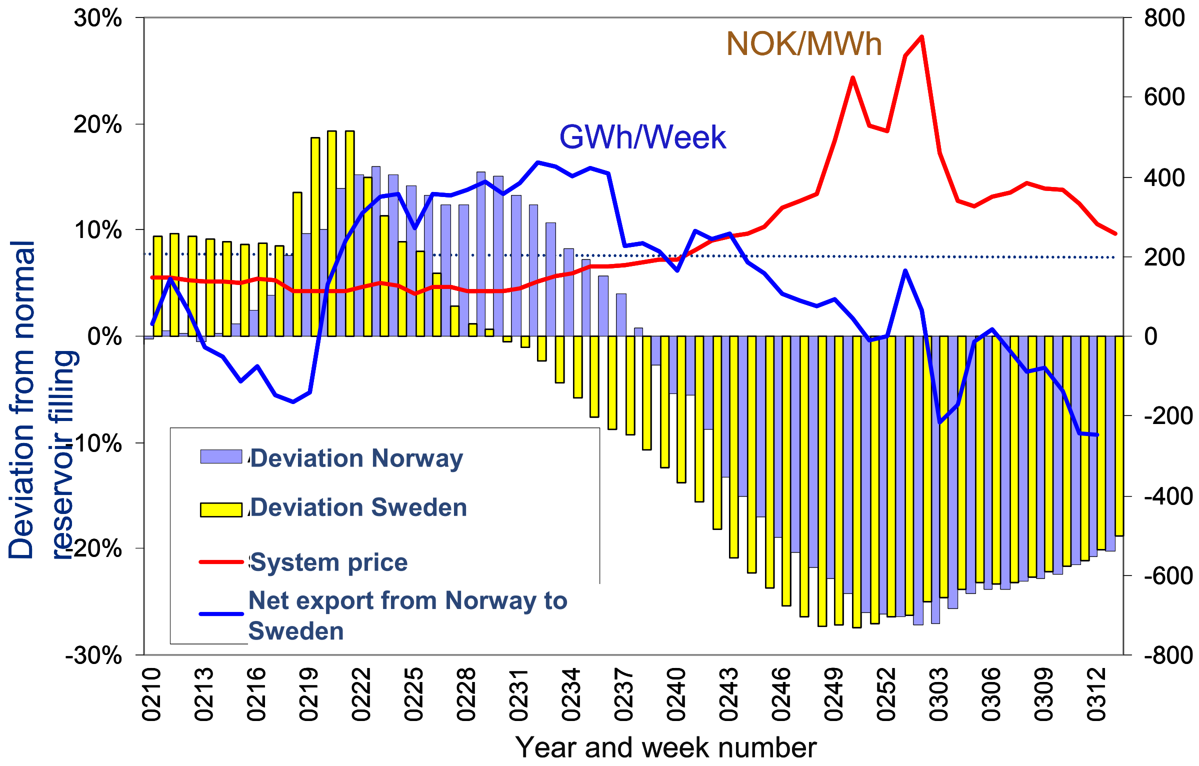
[10] When the market participants are well informed regarding the reservoir filling and the transmission constraints they are in a better position to plan a reasonable use of their reservoirs.

Figure 4.3 shows how much electricity (GWh) could be generated through the existing power system with the precipitation over the weeks 31-47 for the years 1931-2002 in Norway. The figure illustrates the large range of generating volume depending on whether it is a dry or a wet year. As can be seen from Figure 4.3, the usable precipitation of the weeks 31-47 was the lowest in more than 70 years in 2002. This is approximately 50% compared to 2001, when precipitation was relatively plentiful. Worth mentioning is that many of the generators in Norway use this type of time series in their generation planning. Planning for extreme dry or wet years is rather rare.

## 4.3. The flow on the interconnections

The precipitation situation in Sweden and Finland was similar to the Norwegian during the autumn 2002. There have, however, been few congestion problems within the Scandinavian power system. Figure 4.4 illustrates the daily power flow between Norway and Sweden compared with the deviation from normal reservoir filling in the two countries.




Source: Bråten, 2003a

**Figure 4.4:** Deviation from normal reservoir filling in Norway and Sweden compared to the system price and the net export from Norway to Sweden.

As can be seen from figure 4.4, the reservoir filling in Sweden fell under the normal filling level some 9 weeks earlier than in Norway. The deviation from the normal reservoir filling was larger in Sweden than in Norway until the end of 2002. During this period there was a net export from Norway to Sweden. The market made sure, that the power flow went in the direction to the system with the largest supply shortage. When the situation changed in the beginning of January 2003, and the deviation from normal reservoir filling started being larger in Norway than in Sweden, the direction of the power flow changed.

On the interconnections between Scandinavia and the continent, on the other hand, there has been limited transmission capacity during the winter 2002/-03 (Bråten, Jenssen and Tennbakk, 2003). The trade towards the continent has been reduced due to technical problems on the cable Sweden-Poland as well as the cable Zealand[11]-Germany. The Sweden-Poland cable has normally been used for export to Poland, also when the prices were higher in Scandinavia. However, after clearing the technical problems and putting the cable back into operations in December 2003, it has been used for import to Sweden.

## 4.4. Demand response

Due to the fact that most Norwegian household customers are exposed to the spot price in one way or another, the high power prices resulted in a public uproar, and heavy criticism of the industry in the media. In general, the electricity bills of the household customers were approximately twice as high in January 2003 compared to January 2002. The consumers have, however, reduced their consumption compared to previous years:

- The total temperature corrected consumption was 5,3% lower over the first 5 weeks of 2003 than in 2002 (NVE, 2003c).

- The power intensive industries consumed approximately 15% less power over the weeks 40-54, 2003, and 10% less over the first 5 weeks of 2003 (PIL, 2003 and NVE, 2003c).

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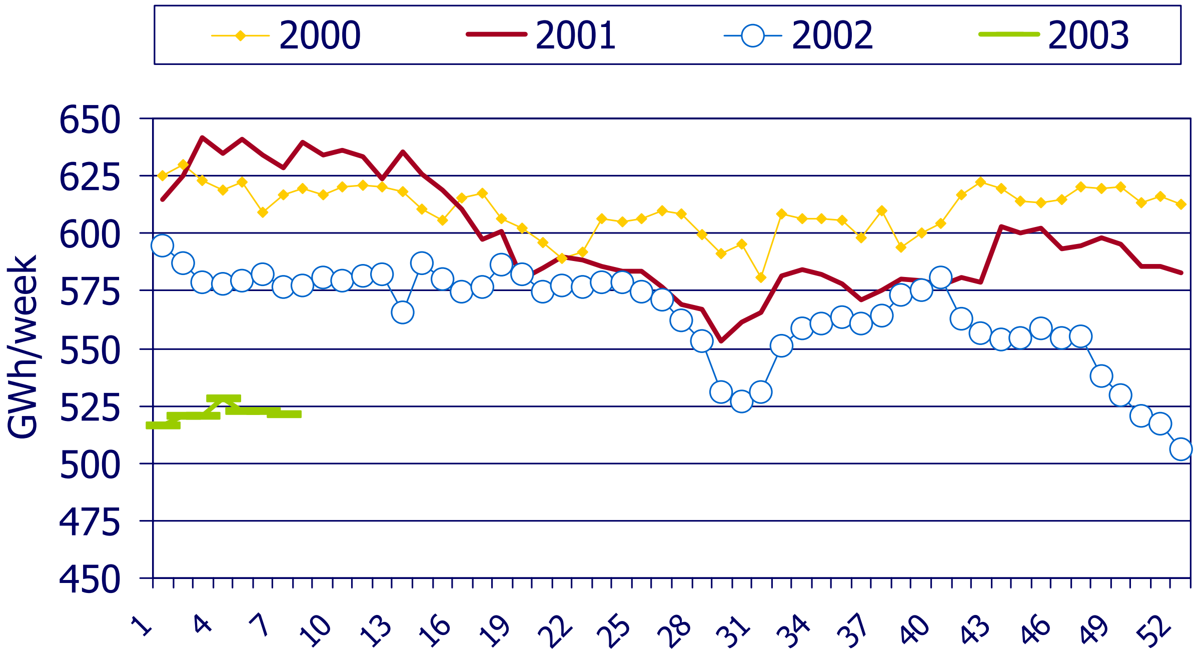
[11] Denmark

Figure 4.4 compares the consumption of the power intensive industries for the years 2000 to 2003.




Source: PIL 2003

**Figure 4.4:** Weekly electricity consumption of the Norwegian power intensive industries, 2000-2003.

As can be seen from Figure 4.4, the power intensive industries started reducing their consumption gradually around week 40, 2002. Generally, the power intensive industries have bilateral long-term contracts in order to reduce price and volume risk. As a consequence, the power intensive industries were not directly affected by the high spot prices over the winter 2002/-03. However, the power intensive industries started selling their contracted power back into the market, hence earning money on reducing their consumption. The power intensive industries have certain flexibility in their consumption that can be exploited, particularly in pulp and paper as well as in iron and steel. These industries have the possibility of producing for storage as well as buying their products on the world market in order to fulfill their commitments.

The power intensive industry is requesting a rationing plan. In a situation of rationing the power intensive industry would be the first to be closed down. As the winter

2002/03 have shown, the power intensive industries have the flexibility and willingness to adapt to prices through selling power from their contracts back to the market. The power intensive industries furthermore have shown interest in investing in gas power plants in order to secure supply.

## 4.5. Solutions discussed on the supply and demand side

Different solutions to the tight supply have been discussed, particularly the possibility of utilizing movable gas power stations on the West coast of Norway. On January 15, 2003, the consortium Statoil, BKK and Statnett received a concession from NVE to put movable gas power stations of up to 150 MW into operation. These movable gas power stations would generate approximately 400 GWh over the concession period of 4 months. However, 4 days later, the consortium informed that they would not go through with the project for financial reasons. An aspect was probably the financial risk involved, which the three parties would have to deal with on their own. Environmental pressure has been mentioned as another reason why the project was cancelled. Some generating units in Sweden and Finland, which had been decommissioned for several years, were put back into operations.

Different short and long term solutions in response to the tight supply situation of 2002/-03 have been discussed and partly implemented (Olje- og Energidepartementet, 2003):

- Subsidies for heat pumps, biomass and automatic regulation systems through the public authority for energy efficiency - ENOVA. Up to 50 Mio NOK (≈6,67 Mio €) has been allocated for these supports in 2003. However, as of March 2003 these subsidy allocations seem to fall short of demand, and additional subsidies have been estimated to 120 Mio NOK (≈16 Mio €) (Source: Platts, 2003).

- A majority of the Energy and Environment Committee of the Norwegian parliament have voted in favour of asking the Government to investigate different models regarding differentiated taxes on electricity. This system would imply, that people having a “luxurious” electricity consumption beyond a certain limit should pay more for the electricity than “average household” through a higher electricity tax. The suggestion from the Committee is, that such a system should be investigated so that it could be implemented in the autumn of 2003.

- A low-income subsidy, paid by the Government, in order to cover the 2002/-03 bills will be introduced.

- NVE received 20 Mio NOK (≈2,66 Mio €) from the Government in order to run information campaigns to promote energy saving.

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