

The Norwegian Electricity Market

**Overview on
industry and market structure**

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By
Dr.-Ing. Jens Büchner
D. Alan Kidd

KEMA-ECC Europe
Management Consulting Services
Maastricht, NL
Tel: +31 43 258 296
Fax: +31 43 258 297

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Jens Büchner, D. Alan Kidd

1. The Norwegian Electricity Supply Industry

1.1 The Electricity Supply System

Norway is Europe's largest producer of hydro-electric power. It has an installed capacity of some 27.000 MW and a present average annual production capability of 110 TWh. Another 10 TWh are planned, licensed or already under construction, 21 TWh are technically and environmentally available and 35 TWh are protected from technical exploitation. The peak load is about 19.000 MW and the annual average demand amounts to 108 TWh. Practically all Norwegian natural gas is exported, as is more than 90% of the Norwegian oil production. The energy production per capita in Norway is about 15 times the European average. The electricity consumption per capita is the highest in the world (in 1992: 25.500 kWh per capita).

The Norwegian power system is energy dimensioned. This means, that the installed capacity necessary to cover the total demand of energy results in an installed capacity higher than required to cover peak load. Additionally, Norway's total storage capacity is 80 TWh and thus more than 70% of its average annual production capability. These technical features provide the Norwegian power system with the capability to export electricity at any time even during Norwegian peak-load periods. But as an energy dimensioned system, Norway's ESI is depending on the annual inflow of water. Over the last 50 years, an inflow deviation of ± 15 TWh could be observed. Thus, several dry years in a row may require Norway to import electricity.

The Norwegian power system consists of about 80 production companies, of which 34 provide 96% of the generating capacity. Statkraft is the largest generating company and alone provides some 27%. More than 200 companies distribute the electricity to the customer. 60% of these companies are vertically integrated, i.e. primary production and distribution are integrated in one single company. The state owned grid company, Statnett SF owns about 80% of the transmission grid and leases the remaining 20%. Statnett is responsible for the expansion and operation of the whole transmission grid. The generic structure of the Norwegian ESI can be taken from Figure 1. The bulk Power Market is operated by Statnett Market, which is formally a separate entity, but fully owned by Statnett.

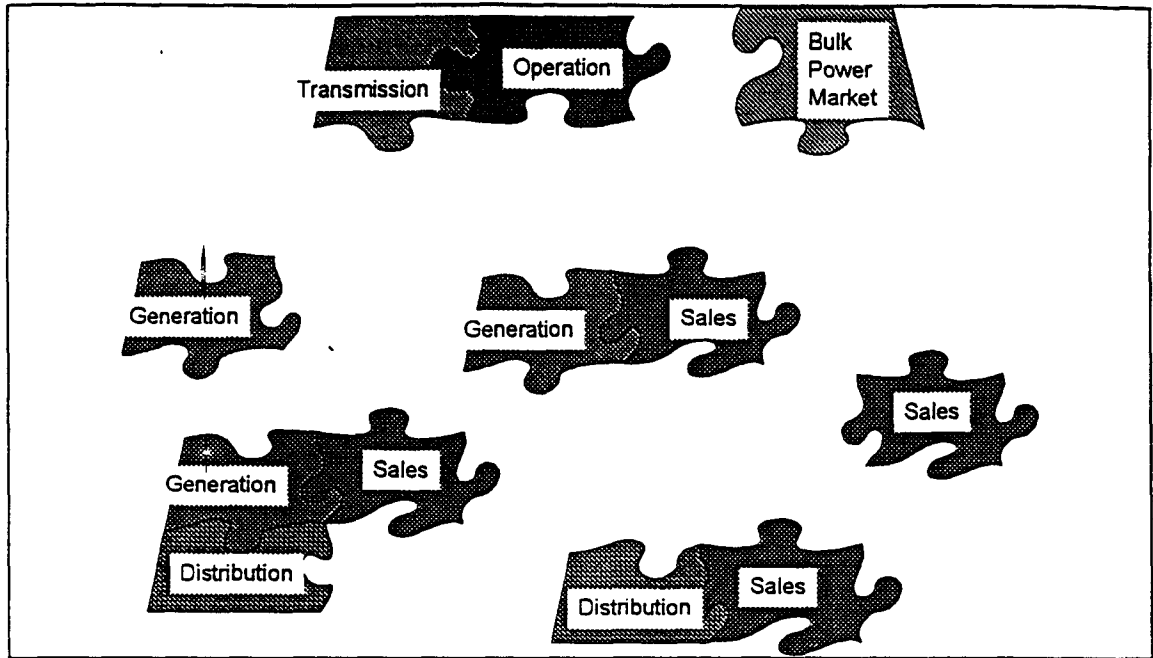


Figure 1: The structure of the Norwegian ESI

The Norwegian ESI was deregulated in 1991. The Energy Act provides Third Party Access on equal terms and conditions to everyone seeking access to the transmission grid. Distribution companies have an obligation to connect all customers, but have no exclusive right to supply power, but the obligation to supply captive customers. Transmission and distribution business is regulated by a regulatory authority, which is the Norwegian Water Resources and Energy Administration (NVE).

1.2 The Market

In Norway, in contrast to the electricity market in England & Wales, only 25% of the electric energy is traded through the pool (Statnett Marked). This summed up to some £ 500 million in 1994. The remaining 75% is contracted bilaterally, i.e. most of the bilateral contracts determine the schedule and dispatch of the power plants. Financial hedging contracts like those in England & Wales are currently being developed.

Statnett Marked is responsible for the power exchange via the pool. There are three different markets currently established:

- **The weekly market**

Prices for this market are stipulated once a week for the next 3 to 7 weeks and for another 5 blocks of 4 weeks, i.e. for weeks 23 of 27 ahead. Two different products can be traded. First, constant energy to be delivered 168 hours a week.

Second, constant energy to be delivered during daytime on working days (75 hours per week). In 1994, about 7 TWh were traded through the weekly market.

- **The spot market**

Prices are set every day for the next 24 hours. The significant difference between the Norwegian and the English spot market is that all market participants, seller as well as buyer, bid to sell or purchase power. The balance price of sale and purchase bids determines the System Marginal Price (SMP). This is demonstrated in Figure 2. Some 15 TWh went through the Spot Market in 1994.

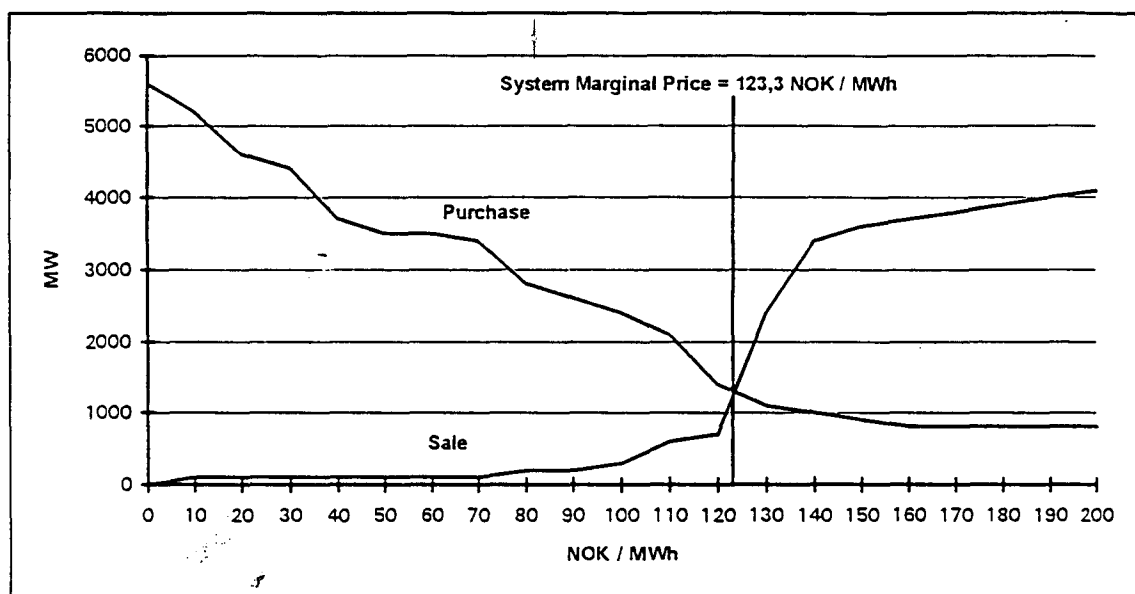


Figure 2: The pricing mechanism in Norway

By explicitly considering the demand side, the Norwegian market, in contrast to the England & Wales market, perfectly sets price incentives for demand reduction during high price periods. This mechanism is valid for the weekly and the spot market.

The second decisive distinction between the Norwegian and English market is that the offered capacity in Norway is only used to calculate the SMP. Generators are required to keep only that amount of generating capacity available that is actually necessary to meet their obligations, i.e. that is scheduled to be dispatched. Thus, the schedule according to the merit order determines the available capacity while the available capacity in England & Wales is determined by the Generator's bid.

- **The Regulating Power Market**

When prices and quantities of the spot market are fixed, Statnett Market invites offers for regulating power. It is a requirement that this regulating power can be delivered at short notice. It is, therefore, similar to the 5-minute-reserves in England & Wales. However, the market mechanism is completely different. Regulating power is offered in a procedure similar to that of the spot market. Regulating power bids are submitted once a day for the next 24 h. The price paid for regulating power is the bid price of the most expensive regulating unit that is actually dispatched. Finally, generation as well as load are considered equally in the regulating power market. The System Operator uses the regulating power market merit order to dispatch plant/demand to control the net effect of bilateral and spot market miss-matches, i.e. frequency and interconnection power flows. He used 6,0 TWh of this regulating power in 1994.

Some remarks should be added concerning system operation, particularly with regard to the utilization of regulating power. The Norwegian ESI is part of the Nordel, which is association of Nordic utilities. Primary goals of Nordel are to promote the secure and economic operation of the whole Nordic supply system. Thus, the total need for primary response in all Nordic countries is allocated among the different industries. The required frequency-load characteristic in the whole Nordel system is about 6000 MW/Hz with a required reserve margin of 600 MW. Norway's share is some 2.000 MW/Hz with a margin of 200 MW. This is provided by Norwegian generators without any commercial compensation. Secondary response, as it exists in England & Wales and most UCPT systems, does not exist in Norway, i.e. frequency is not automatically brought back to its rated value. This is done by manual dispatch instructions from the operator, using the Regulating Power Market.

This is a very brief and simplified description of the major market mechanisms in Norway. It can be seen that the trading possibilities of generators as well as of customers are higher in Norway than in England & Wales. First, there are three different centrally organized markets where market participants can bid in. Second, the generators, distributors and customers in Norway do not have to trade via the pool at all, they can conclude bilateral physical contracts to meet their needs.

When describing the electricity market in Norway, at least two more issues should be covered. The treatment of ancillary services and the treatment of transmission constraints.

In contrast to England & Wales, no really relevant payment mechanisms are defined yet for the provision of primary response and for reactive energy. There is no doubt that hydro stations are very effective frequency control units and can easily provide fast response. Thus, frequency control in Norway is easier than in England & Wales. This may be one reason for the absence of payments for frequency responses. Nevertheless it should be noted that, although the problems of voltage control seem

similar in both countries, no payments are associated with the provision of reactive energy in Norway either. This pragmatic approach simplifies the pool settlement significantly and avoids the possibilities for gaming.

Also the transmission constraint problem is solved simply, but unfortunately it sets the wrong incentives. When Statnett identifies overloading in the transmission system when considering the unconstrained dispatch schedule, it divides the market and asks the market participants on each side of the constraint to make separate bids for each of the areas, assuming there are no internal bottlenecks. Utilities which have a need for transmission through the bottleneck will have to make a bid for sale on one side of the bottleneck and for purchase on the other side. The price in each area is then determined which ensures the flow through the bottleneck meets the transmission constraint capability. Statnett will recover the difference of the spot prices times the transferred energy via the bottleneck. These revenues to Statnett reach a maximum at a certain transmission capability of the bottleneck. These pricing procedures, therefore, set no incentives to reduce the bottlenecks completely.

2. Relationship with Foreign Countries

2.1 Trade with Foreign Countries

The trade with foreign countries has changed dramatically since the deregulation of the Norwegian electricity market. Before deregulation the common Nordel rule was valid that short-term power exchanges between two Nordel countries are settled according to the split savings method, i.e. the average of the marginal power price of the two countries. According to the Norwegian power industry, Norway - as a net exporting country - received prices which were considered too low during periods of large power surpluses.

After deregulation, short-term exports were supposed to be based on actual spot prices, or on the prices in the weekly and regulating power market respectively. These prices are much higher than the Swedish power industry was used to paying. Additionally, a temporary procedure was introduced to adjust for the differences of the power markets in Norway and Sweden. The issue was that Swedish utilities could trade in the open Norwegian Market, while Norway's utilities could not equally enter the Swedish system. This put the Norwegian industry at a disadvantage. Thus, it was decided that foreign utilities were permitted to enter the power pool, but with a slightly different price mechanism. The difference was assumed to compensate for the advantage Swedish utilities could take from the differences of the electricity market structures.

The interconnection lines which are in operation, under construction, planned or in consideration are illustrated in **Figure 3**.

Due to the tremendous transmission capability of the tie lines and the energy limitation of the Norwegian power system, large export contracts need governmental approval. Usually, power exports pursuant to agreements that are not valid for more than a maximum of six months ahead require no special export approval. Power exports under long-term contracts, however, presuppose concession by the State. In total, concession-free exports are allowed for a maximum of 5 TWh/a for up to 5 years validity. The export quota is shared between the producers and quotas may be sold to other producers through Statnett Marked.

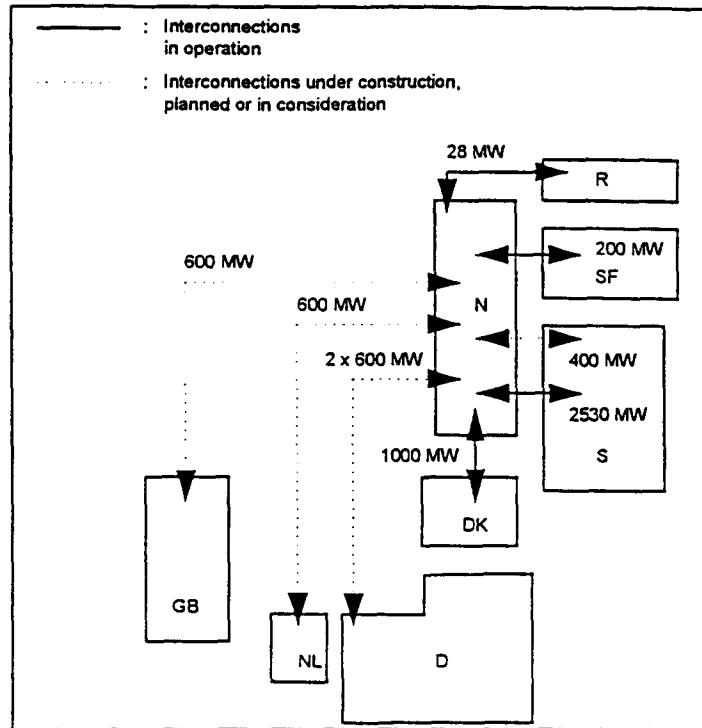


Figure 3 The integration of the Norwegian grid into Nordel and UCPTE

2.2 The future Nordic market

Norway is integrated into Nordel, the association of electric utilities of Norway, Sweden, Finland and Denmark. In all of these countries liberalization of the electric industries is in progress. The Norwegian ESI is certainly the most advanced, being already deregulated in 1991. The Swedish and Finnish ESI's will probably implement liberalized markets in 1995. Only minor developments towards a more open electricity sector can be observed in Denmark. However, there are serious considerations taking place to develop and establish a common Nordic electricity market.

Statnett and Svenska Kraftnät have developed a proposal for a common Norwegian-Swedish electricity market and submitted this proposal to the respective ministries for consideration. Also within Nordel, a structure of a common market is being developed. It is expected that the ministries will not comment on the proposals before June 1995. However, it is still unknown, whether all politicians really support a liberalized electricity market. In Sweden, for example, the treatment of nuclear power is regarded critical and may delay the liberalization process.

The structure of a common Nordic market, as it may come into force, is not clear. However, both proposals submitted by the power industry promote the introduction of a spot market. Also the coexistence of a spot market and a physical bilateral market

seem broadly supported. The existence of a Regulating Power Market, probably in its main characteristics similar to the Norwegian one, is being considered.

However, at this point in time, the development of a joint market is mainly a political issue. The introduction of a single common market or the coexistence of different national markets will be decided at minister level. In any event, the electricity industry in Scandinavia will become more open and more competitive. At the end of the day, it remains to be seen, whether this is to the benefit of the customer.

3. Lessons to learn

3.1 Norway is very special

When we analyze and evaluate the ESI in Norway, we must also pose the question whether the experience gained can be transferred to other systems. This raises the issue how comparable different supply systems are. Without going into detail, we note at least two features that are very special in Norway.

The Norwegian supply system is 100% hydro based. This has a number of impacts:

- Capacity limitation at peak load periods are, at least at present, of minor importance. However, they may occur in extreme export situation.
- Energy limitation may influence export possibilities.
- Frequency control is significantly easier due to technical and financial characteristics of hydro stations.
- Operation planning is easier than in thermal systems due to the fast responds characteristic of hydro units.

These technical features are often stressed to emphasize the special characteristic of the Norwegian system. They are often miss-used to conclude that Norwegian experience cannot be used in most other thermal dominated supply systems.

Less emphasis is often put on a second significant distinction to most other ESI's, making the Norwegian solution very special - the Norwegian culture.

The Norwegians have a long tradition with power pools. They have operated a spot production market over the last 20 years or so. Most of the players in the market know how to deal with a spot market. Electricity trading is - even if this is probably a little exaggerated - part of their culture. This leads to important results:

- The Norwegian market works very effectively, without having every issue set out in rules and documentation.

- The Norwegian players take, of course, advantage of possibilities the market provides, but they do not overplay the system.
- The Norwegian market does not need commercial compensations, and associated sophisticated settlements, for every product (particularly ancillary services).

Thus, the market in Norway functions very well mainly due to the trading culture of the participants. This is a feature of the Norwegian ESI that is less often mentioned, but which must be taken into account when evaluating the experience in Norway.

3.2 Norway is very 'normal'

Despite on the distinction between the Norwegian ESI and other supply industries there are a number of attributes that could be taken into the design of other ESI's. This is particularly valid for the trading mechanisms, the parallel operation of bilateral markets and pool and, more specifically for the regulating power market.

The system marginal price in Norway represents the balance price between sales and purchases. This structure sets perfect incentives to the customers and is, thus, an efficient, market-orientated and economic way of Demand-Side Management (DSM). The discussion for or against such a bidding system is not related to the special characteristics of the Norwegian system. In principle, the market mechanism has proven successful and may be an option for other ESI's.

The parallel operation of bilateral market and a pool is a continuous issue in England & Wales and elsewhere. Without entering into the discussion in this paper and without intending to support proponents or opponents, we simply state that the Norwegian experience has shown that bilateral and multi-lateral markets can work in parallel successfully. We note that this market coexistence has also been demonstrated in wholesale markets in the U.S. It seems that the introduction of a pooling system additional to existing trading mechanisms is feasible and facilitates the introduction of competition. However, it should also be noted that the regulating power market is one important element of the pool and supports operation and control of a system, where self- and central scheduling is permitted.

The Regulating Power Market in Norway has probably developed due to the good control capabilities of hydro units. However, it can also function in other thermal dominated systems. This can be seen in the proposals for the new industry structures in Sweden, Finland and Australia (Victoria), where 'relatives' of the Regulating Power Market are developed. Thus, it seems that the Regulating Power Market has proven to be an efficient tool to promote competition in the provision of regulating power and simultaneously facilitates a secure operation of the system.

Summing up it may be said that most of the experience in Norway may be relevant for the power market structure in other ESI's, i.e. hydro, hydro-thermal and thermal systems. It should be also noted, however, that the 'relaxed' Norwegian trade culture is the major prerequisite for the success of the relatively transparent and straight forward market structure.