

Overview of Nordpool

Introduction

In January 1996 a joint Norwegian-Swedish trading exchange was opened based on open access transmission networks and free competition between generators. This followed the initiation of electricity market reform in both countries in 1990-91. Open access was introduced to the Norwegian market first in 1991 following the 1990 Act. Both countries separated the grid from generation creating two new companies - Statnett in Norway was established in 1991 and Svenska Kraftnatt followed in Sweden in 1994. A new Swedish electricity Act was passed in 1995 allowing the market to be opened to competition in 1996.

Nordpool provides short-term physical markets and medium-term financial futures markets for trading electricity. These markets exist in addition to bi-lateral physical contracts between generators and distributors exchange outside Nordpool and which account for 85% of physical trade. Traded volumes in Nordpool are increasing and the experience so far has been generally positive. Further developments of the existing markets are being considered and it is hoped that the open market area will eventually also include Finland and Denmark.

This paper summarises some of the key components of Nordpool and provides a brief commentary on the markets' operations to date.

Market Structure

Norway and Sweden have fully committed their electricity industries to Nordpool - there is no other rival exchange though of course there are bi-lateral contracts exchange outside Nordpool. Additional imports/exports involve the industries in Finland, Denmark, Germany and Russia. Both.

Generation mix

Norway is 99.5% hydro with annual production of some 120 TWh. There is a small thermal capability of around 300 MW industrial co-generation plant. There is substantial hydro reservoir capacity of around 80 TWh that fills from May to August and allows water to be carried forward from wet years into dry years.

Sweden, in contrast, has a more mixed system comprising 50% hydro, 45% nuclear and about 5% conventional thermal in terms of share annual energy output of around 150 TWh. In capacity terms nuclear's share comprises 30%, hydro 50% and thermal 20%. Most of the thermal capacity is industrial co-generation. Sweden has less reservoir storage capacity than Norway and runs down its reservoirs during the period of peak winter demand.

The neighbouring system of Denmark has only thermal power plant which is mostly coal-fired. Finland is more like Sweden with a mix of hydro, nuclear and conventional thermal.

Market participants

Nordpool currently comprises 43 generators , 43 distributors, 16 brokers/traders, 14 industrial producers/consumers and 3 market makers. About 100 of these participants are Norwegian¹ where the open market system has been established for longer but Swedish participation is increasing.

The size of the market participants is far from equal. In Norway, about half of Norwegian output is accounted for by just four companies: Statkraft which at 30 TWh is around 25% of total output, Oslo Energi (6 TWh), Lysekraft (5 TWh) and Bergenshalvoens Kommunlaer Kraftselskap (4 TWh). Moreover, on the demand-side, the largest distributor - Oslo Energi (8 TWh) - is over double the size of the next largest distributor Nord-Trondelag Elecktsiteitsverk (4 TWh). About half of the 200 distributors also own power plant. .

Sweden has a similar structure with around 300 utilities in total. However Vattenfall alone accounts for just over 50% of generation capacity (17 GW) and output. The next largest generators are Sydkraft (5 GW) and Stockholm Energi (2 GW) which are substantially smaller. On the demand-side the largest utilities are more equal in size: Sydrakft (c.6 TWh) and Stockholm Energi (c.6 TWh) are the largest and Gottenburg (c.4 TWh) is only slightly smaller. These three distributors each have between 240,000 and 420,000 customers.

Ownership

Ownership is mixed. The largest generation companies in both Norway and Sweden - Statkraft and Vattenfall - and the grid companies are in state ownership. There are a few private companies, such as Gullspangs Kraft in Sweden and Norsk Hydro in Norway. But most companies are municipally owned reflecting the historical development of the industry from small scale townships. Some have mixed municipal and private ownership, others are wholly municipally owned such as Oslo Energi, while others are co-operatives.

¹ The Norwegian industry itself comprises around 250 separate utilities many of which are very small. the size of each participant is far from equal.

The Markets

Nordpool consists of a two main markets: the physical day-ahead spot market and the financial market for weekly contracts. The system operators Statnett and Svenska Kraftnatt are responsible for overall system stability and regulation and operate slightly different balancing markets. These are now briefly described.

Day-ahead spot market

Bidding

Each morning, players submit bids to buy or sell for each hour of the following day. The day runs midnight to midnight. Participants in Norway with generators or loads in different geographical locations will submit separate bids for the different locations. These locations are defined weekly by Statnett. Sweden is treated as a single region (see the section on Constraints below). At noon, the market closes and no further bids are accepted. The bids are firm and binding.

Bid format

Participants submit a price/quantity curve for each hour. This shows the quantities in MW that the participants is prepared to supply (a positive MW) or purchase (a negative MW) from the spot market at different prices. Prices are usually specified in Norwegian Kroner (NOK) per MWh (though there is provision for Swedish Kroner to be used).

Imports/Exports and bi-lateral contracts

Nordpool co-ordinates the bids and planned power exchanges with Finland, Denmark and Russia. Statkraft provides Nordpool with details of the power flows over the interconnector which it has contracted with Denmark. All distributors² provide Statnett and Svenska Kraftnatt with a schedule of bi-lateral contracts for the day ahead to assist in the management of constraints.

Price formation

Nordpool balances supply and demand by stacking up the supply and demand curves of the market participants. A price in NOK is calculated for each hour of the day ahead by 1300 hours at the latest of the prior day and the exchange notifies each player of the prices and quantities of their trades. If there any disputes to be resolved, these should be notified by 1430 - and prices and quantities recalculated if necessary.

² Distributors have the responsibility of informing Nordpool of contracted movements of electricity into and out of their control area. This is carried out on a weekly basis.

Treatment of constraints

In some circumstances there may be transmission constraints. These are relatively rare since both the Norwegian and Swedish systems are strong. However different approaches to dealing with the constraints are currently in use.

When the system spot price is calculated, potential load flows are compared with available transmission capacities. This allows the presence of constraints to be identified. In Norway, the market is split when there is a constraint and prices in different regions are calculated. Thus the net exporting region will benefit from a low price relative to the constrained, net importing region.

In Sweden, Svenska Kraftnatt takes full responsibility for constraints. In other words, Svenska Kraftnatt will buy power downstream of a constraint and sell it upstream. This effectively means that Svenska Kraftnatt 'subsidises' generators required to generate because of constraints so that they are in merit. This different approach is possible because such constraints do not occur often in Sweden. Moreover Svenska Kraftnatt was concerned that the Norwegian approach might result in excessively small regional markets being created that would be open to excessive manipulation. At the same time Svenska Kraftnatt is keen to see the market develop towards more continuous trading on the spot market that would mean that the Norwegian approach could not be applied.

Commitment and Dispatch

Each generator is responsible for his own commitment and dispatch to meet his contractual obligations under bi-lateral contracts and day-ahead spot market trades.

Balance Adjustment in Sweden

Sweden (but not Norway) operates a Balance Adjustment service. This provides players with the opportunity to make additional trades up to 2 hours before the due hour for delivery. The bids in the Balance Adjustment take the same format as in the day-ahead spot market. Balance Adjustment market is cleared and prices set 2 hours before the due hour .

This balance adjustment had been a part of the Swedish system prior to the establishment of Nordpool. In contrast to Norwegian generators, Swedish generators valued the flexibility of being able to alter their bids up the last minute to take account of unforeseen changes in the balance of supply and demand. It is arguable that the run-of-river hydro and system of dams in a cascade makes this particularly useful in Sweden, especially for small generators that cannot easily optimise their contractual commitments within a large portfolio of generating plant. In addition the thermal generation in Sweden demands flexibility to adjust its output - and hence its costs - at the margin (marginal output in Norway from hydro is arguably less costly). However volumes traded in this market have been small (and there is some possibility that it may be abandoned following the experience of Swedish participants with the Nordpool markets).

Balancing markets

Following the determination of spot market trades, each generator is able to finalise the planning of their generation schedules. These plans which include spot market and bilateral contract trades are submitted to the system operators in Sweden and Norway by around 19.30 hours of the prior day. At the same time, market participants can also submit bids to provide the system operators with access to regulating energy. This is dealt with slightly differently in Norway and Sweden.

Bidding

Bidding into the balancing markets is possible up to half an hour before the due hour in Sweden and up to three hours in Norway.

Bid format

In Norway and Sweden, participants offer bids to decrease production/consumption at given prices in each hour. A 'staircase' is then constructed of prices in NOK/MWh in Norway (and in Swedish Kroner per MWh, SEK/MWh, in Sweden) at which participants are prepared to regulate production/consumption. These bids are for increments/decrements at 15 minutes notice.

Price formation

In Norway, at the end of each hour, the most expensive bid on the 'up-regulation' side (or the least expensive bid on the 'down regulation' side) is paid to all players called upon to regulate up (and/or down).

In Sweden a distinction is made between active and passive regulation. Thus, Swedish generators/consumers that are called upon to regulate their production/consumption will be paid the balancing market marginal price. However generators/consumers that provide assistance to the system through deviations from their contracted production/consumption but which have not been called upon to do so, will be paid at the balance-adjustment price. This is intended to discourage over reliance on the balancing market. Deviations in prices between the balancing markets and the spot markets are larger in Sweden than in Norway due to the greater proportion of thermal generation.³

³ There are around 30 bidders into the Swedish balancing market as opposed to around 7 in Norway.

Financial market for weekly contracts

Contract-types

There are two types of contract that can be traded on the financial market:

- **base load power** covering 24 hours of each day for a full week; and
- **peak-load power** covering 0700-2200 hours Mondays to Fridays⁴.

These contracts can be trade as **single weeks** up to between 4 and 7 weeks in advance, as **blocks of four weeks** from between 5 and 8 weeks and up to 52 weeks in advance, and as **seasons of several blocks** 1-3 years in advance. The contracts are specified as forward contracts struck against the system spot market price (and not the regional price in the event of constraints).

Form of Trading

Since November 1996 trading is electronic (terminal-based) for both types of contract. This market is open each week-day from 1130 to 1500 hours. Nordpool has a help desk for participants not connected electronically. In practice, only the baseload contracts are traded in any significant volume and the peak-load contracts may be discontinued.

Settlement

Settlement is on a daily basis with the appropriate gains/losses being credited or debited to the a bank account that each player places at the disposal of the exchange. Players requiring physical delivery of power that hold a financial contract may simply submit a spot market bid without any price attached to it.

Ancillary services

Ancillary service markets are not included in Nordpool but are provided by the system operators. Secondary reserve is essentially provided through the balancing markets where response is required at 15 minutes notice. However reserve capacity is not contracted for since the hydro reservoirs are considered to be adequate for this function. Spinning reserve and reactive power are not currently paid for by the grid company in Norway but are simply required to be provided by each major generator. In Sweden Svenska Kraftnatt pays generators for spinning reserve.

⁴ The contract for off-load power (covering 2200-0700 hours Mondays to Fridays and 0000-2400 hours Saturdays and Sundays) has been discontinued due to lack of demand. .

Statnett and Svenska Kraftnatt are both in discussion with generators on suitable system of payment for frequency control and reactive power. It is possible that separate markets may be developed for these functions but there are no proposal to do so as yet.

Information release

The bid information of each market participant is held confidential by Nordpool and is not released to market participants. Nordpool only makes public aggregate information.

Transmission pricing

The transmission pricing systems in Norway and Sweden are slightly different. This follows from their different treatment of constraints described above.

Norwegian transmission pricing

There are four elements to the Statnett transmission charge:

- **connection charge** in NOK/kW of connected generation capacity (based on winter capacity when rivers may be low) or maximum load at time of system peak at grid supply point *plus* embedded generation;
- **power charge** in NOK/kW of connected generation capacity net of load or maximum load net of embedded generation capacity;
- **energy charge** based on estimated marginal energy losses estimated annually for 5 geographic areas and for three times of day calculated from loss factors multiplied by the system pool price. This recovers approximately twice the actual cost of average losses.
- **capacity charge** which comprises the excess revenue collected through the treatment of congestion described above. Statnett recovers the value of energy paid for on the low price side of a constraint and sold into the high price side of a constraint.

Swedish transmission pricing

There are three elements in the Svenska Kraftnatt transmission charge:

- **power fee** in SEK/kW per annum based on ex ante estimates of maximum input/output at point of grid connection. This charge varies by geographic location with inputs in the South being more expensive than inputs in the north.

- **energy fee** based on loss factors determined for each grid connection (150 nodes) by time period at the price Svenska Kraftnatt has negotiated with generators for supplying it with losses.
- **investment fee** to cover one-off investments in special circumstances such as new connections.

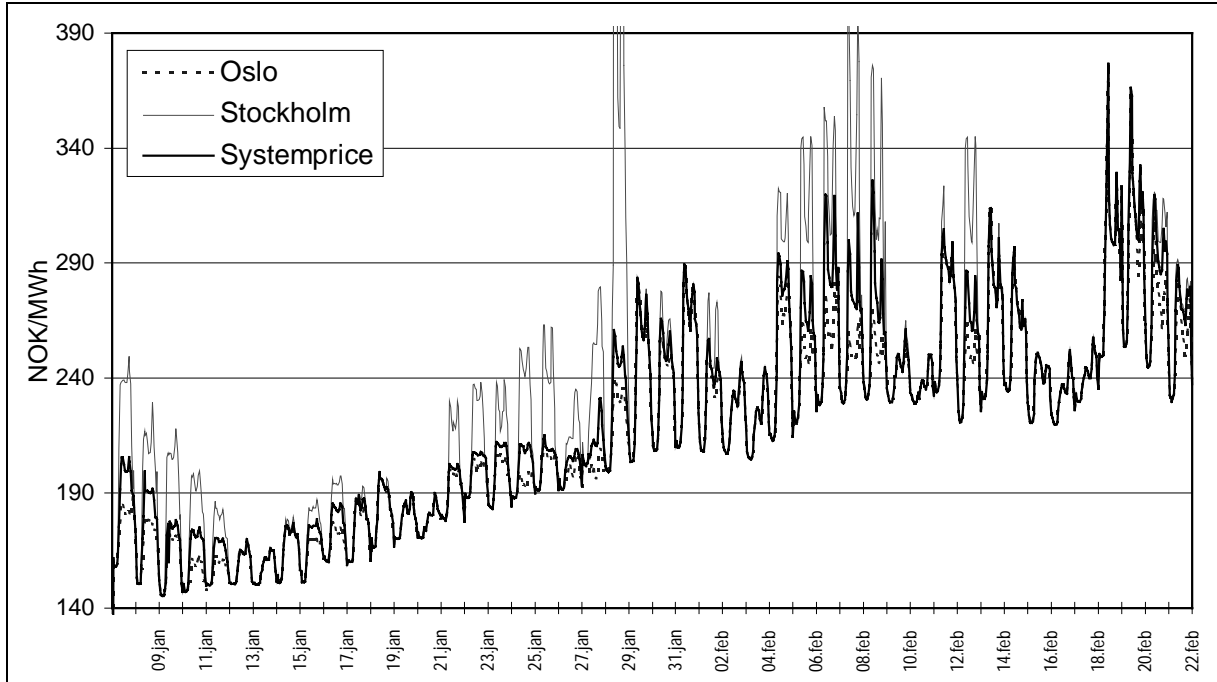
Market commentary

Traded volumes

The spot market accounts for around 15-20% of energy consumption. The balancing markets are then a small fraction of the spot market trades. The majority of electricity transactions are still under bi-lateral contract.

Norwegian-Swedish trade

At the beginning of 1996 the exceptionally cold weather caused the inter-country transfers to exceed transmission capability and the markets had to be split. Bi-laterally contracted transfers were around 1045 MW and additional net purchases from Nordpool exceeded limits set at 1,800-2,000 MW. The Swedish peak prices reached 450 NOK/MWh which caused some concern. Especially among consumers not covered by financial contracts that were struck against the system price. However from February to about June the system prices have been the same in Norway and Sweden except for a few isolated hours and one week-end. During the summer and autumn, the Norwegian price has frequently been higher than the Swedish price for several hours a day owing to the dry weather conditions.



Price volatility

Price volatility has increased significantly for Norwegian participants. Previously prices in Norway were remarkably stable showing a daily variation of 10-20 NOK/MWh. The introduction of Nordpool introduced price fluctuations of up to 100 NOK/MWh on a day. This follows from the introduction of Sweden's thermal capacity to the exchange and some cold, dry weather. Previous dry years in Norway have also led to price volatility -before the inclusion of Sweden.

Nordic Trade

During the first part of 1996, Sweden relied not just on Norway. Additional imports were made from Denmark, Finland and Germany. In the later months of 1996, Norway began to import significantly from Sweden to compensate for low reservoir levels.

Market manipulation

The rising prices in Nordpool during 1996 have prompted some concern about market manipulation. Some commentators have suggested that large generators have withheld water in order to drive up the spot price to ensure a favourable benchmark price against which bi-lateral contracts could be re-negotiated. However the rising prices can also be justified with respect to the cold and dray weather conditions.

There has also been some concern about pricing up bids behind transmission constraints in Norway. However such constraints are in any case relatively rare.

Sources:

Knut Fossdal (Nordpool) and Roger Kearsley (Svenska Kraftnatt) A Norwegian-Swedish Trading Exchange for Electricity, paper presented to UNIPEDE, November 1996

Jan Moen (Director of Regulation, NVE) A Common Electricity Market Norway and Sweden: Prerequisites, development and results so far, May 1996.

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