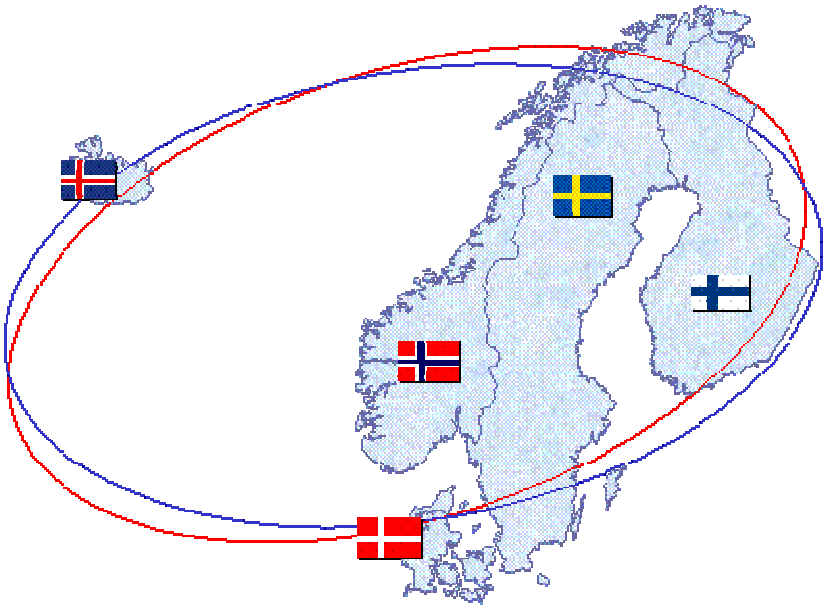
Principles for determining the transfer capacity in the Nordic power market



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1. Definitions of transfer capacities

The principles for determining the capacities and margins are described in the System Operation Agreement between the Nordic TSOs. This is a part of the Nordic Grid Code, and can be found at www.nordel.org. The Nordic TSOs use definitions, which are in line with the definitions used in the association of European Transmission System Operators (www.etso-net.org).

1.1 Total Transfer Capacity - TTC

TTC is the maximum exchange program between two areas compatible with operational security standards applicable at each system if future network conditions, generation and load patterns were perfectly known in advance.

1.2 Transmission Reliability Margin - TRM

TRM is a security margin that copes with uncertainties on the computed TTC values arising from:

a) Unintended deviations of physical flows during operations due to physical functioning of load-frequency regulation,
b) Emergency exchanges between TSOs to cope with unexpected unbalanced situations in real time,
c) Inaccuracies, e.g. in data collection and measurements.

In practice, only the definition a) described above is used in the Nordic countries.

The present TRM values for each connection are agreed upon in the System Operation Agreement and given below.

Sweden - Southern Norway	150 MW
Sweden - Northern Norway	50 MW
Sweden - Finland	100 MW
Sweden - Eastern Denmark	50 MW
Sweden - Western Denmark	0 *)
Southern Norway - Northern Norway	50 MW
Southern Norway - Western Denmark	0 *)

*) HVDC-connection, no TRM is used.

1.3 Net Transfer Capacity - NTC

The Net Transfer Capacity NTC (trading capacity) is defined as:

$$NTC = TTC - TRM$$

NTC is the maximum exchange program between two areas compatible with security standards applicable in both areas and taking into account the technical uncertainties on future network conditions.

2. Security standards

The criteria for system security are based on the n-1 criterion. N-1 is an expression of a level of system security entailing that a power system can handle loss of any single component (production units, lines, transformers, bus bars, consumption etc.). For faults having the largest impact on the power system, the term dimensioning faults is used.

If the power system is not in normal state following an operational disturbance, the power system must have been restored to normal state within 15 minutes.

3. System protection

System protection is used to limit the consequences of faults in the power system. System protection can have as its purpose to increase the system security, the transfer capacity, or a combination of these.

System protection is composed of automatic system protection equipment for the power system. System protection can, for instance, be used to limit the impact of faults by shedding production in order to relieve the situation so that overloads do not arise.

4. Capacity calculation procedures

The TTC between two subsystems is jointly determined by the TSOs on both sides of the interconnection.

When determining the capacity on the interconnection between two subsystems, the capacity is calculated by the TSOs on each side of the connection by using computer programs based on coordinated network models. If the values differ, the lowest value is used.

The objective is to give the market as high capacity for energy trade as possible taking into account outages and faults in the network.

The ability to transmit power shall be calculated for each state of operation. This applies both to transmissions within each subsystem and to exchanges between subsystems. Most frequently, this is achieved by means of a transmission corridor being defined, and static and dynamic simulations determine how much power can be transmitted in any direction through the corridor before thermal overloads, voltage collapse and/or instability arise following a dimensioning fault. In the corridor, an arbitrary number of lines on different levels of voltage can be included.

The TTC is the maximum transmission of active power, which is permitted in transmission corridors between the subsystems or individual installations. If the transfer capacity is exceeded, measures must be taken. The transfer capacity is set, using a certain safety margin (stability, voltage etc), at the transmission levels, which will entail network collapse in the event of dimensioning faults.

The NTC values between all the subsystems are given to Nord Pool Spot for day-ahead trading (Elspot) in its entirety. The TSOs guarantee the NTC value given for Elspot trading. The remaining cross-border transmission capacity available under actual operational conditions after the Elspot notification of planned trading flow is offered to the intra-day market Elbas. Capacities are updated automatically when market trades between parties across borders are made. Market splitting separates the Elbas market areas dynamically when congestion occurs.

On the HVDC-connections, the thermal capacity (TTC) is normally used as NTC value in both directions and there is no need for any margin (TRM).

5. Practical implementation of NTC calculations

Sweden

The main principle for managing potential congestion in internal transmission corridors in the planning phase is to limit when necessary the available capacity allocated for import and export between Sweden and other Elspot areas. The distribution of capacity per relevant interconnector is usually made in proportion to its rated capacity. However Cut 2 is treated differently in this respect (see below):

The relevant internal transmission corridors are:

- Cut 1, north part of grid
- Cut 2, middle part of grid
- Cut 4, south part of grid
- West-coast corridor in the Gothenburg area

During predicted high power flow in Cut 1 there may be a need to reduce NTC for imports from Norway and Finland to Sweden.

Allocation principles in Elspot with regard to cut 2
General
The NTC for export on interconnectors in Elspot south of cut 2 (Hasle, Konti-Skan, Öresund, but not Fenno-Skan) is allocated with optimization with regard to price by NPS calculation.

The NTC for export on these interconnectors will be set to the same as maximum trade capacity if no other limitations exist e.g. cut 4. The optimization in the Elspot calculation is made on condition that the total trade on these interconnectors shall not exceed Elspot's total allocated share of cut 2.

The fact that Elspot is given a sum net export limit for all those interconnectors combined while the individual interconnectors are not constrained has the additional positive effect that import from any of those areas towards Sweden can be utilized for transit to any of the other areas in question. In cases when first the cut 2 net limit out of Sweden has been fully utilized (i.e. is congested) one outcome of such transits through Sweden is that it appears like the power flow goes from high to low price area, but the fact is that in those cases all imports from one of the Bid Areas south of cut 2 always represent a transit to one of the other Areas south of cut 2.

Strained situations
In critical power balance situations Svenska Kraftnät will, in order to maintain power system security, temporarily give up the Elspot optimization. In such situations the export capacity will be reduced in proportion to rated capacity for all interconnectors, Elspot and other, south of cut 2. When the temporary measure to give up the optimization is taken Svenska Kraftnät will send an UMM special information at the latest in the morning before delivery date and when procedures return to normal it will be notified by Svenska Kraftnät via a follow-up UMM.

When there is a need to limit cut 4 the export capacities to Poland, Germany and Eastern Denmark will be allocated as the sum of:

- Capacity allocated in proportion to the rated capacity on the interconnectors SwePol Link, Baltic Cable and Öresund

and

- Capacity contribution of installed system protection on DC-links allocated to respective link in proportion to the system protection's impact on cut 4

Interconnectors affecting the load flow through the West-coast corridor are:

- Southern Norway-Sweden (Hasle)
- Western Denmark-Sweden (KontiSkan 1)
- Western Denmark-Sweden (KontiSkan 2)
- Eastern Denmark-Sweden (Øresund)
- Germany-Sweden (Baltic Cable)
- Poland-Sweden (SwePol Link)

The West-coast corridor is different from other cuts in Sweden as it is not a cut across the whole country between national borders. When there is a need to limit the West-coast corridor import and export on all interconnectors affecting the load flow through the corridor will be reduced in proportion to their rated capacities.

Forecasts used when calculating NTC values in cuts:

- Physical capacity with regard to grid configuration and generation conditions.
- Demand south of cut with regard to temperature forecast.
- Export or import on interconnectors. The day before is used as reference.

This gives the prerequisites for calculation of NTC values on respective interconnector that will be given to Nord Pool Spot.

Norway

The Norwegian power grid is divided into elspot areas in order to handle large and long-term bottlenecks. New elspot areas can also be established in case of regional energy problems. Other bottlenecks shall under normal conditions be managed through the use of the regulating market as special regulations covered by Statnett. Large bottlenecks can arise on short notice, for example due to a fault or a planned outage of a critical transmission line. The market will be informed about new elspot area division at the latest on the Monday, one week before they are applied.

Norway is normally divided into three Elspot areas:

- A southern Norway Elspot area (NO1) limited by the 300kV Øvre Vinstra-Vågåmo line, the 132kV busbar at Litjfossen, and the 132kV busbar at Åskåra.
- A central Norway Elspot area (NO2) limited by the 300kV Øvre Vinstra-Vågåmo line, the 132kV busbar at Litjfossen, the 132 kV busbar at Åskåra, the 300kV Nea-Jerpstrømmen line, the 300 kV Tunnsjødal-Verdal line and the 300kV Tunnsjødal-Namsos line.
- A northern Norway Elspot area (NO3) north of the area defined above.

The NTC value between two Elspot areas may be reduced due to thermal restrictions or voltage and stability limits. The NTC value may also be affected by outages of major transmission lines in the Norwegian grid. This happens when the outage is close to cross-border connections and/or when it is impossible to relieve the congestion through counter-trade in the Norwegian system.

The calculated NTC value between southern Norway and Sweden is dependent on several factors. First, the calculated NTC value is dependent on the consumption in the Oslo-area, figure 1. In the wintertime the export capacity is reduced because of thermal capacity limits on a 300 kV cable with increasing load in the Oslo-area. During summer, the NTC value may be reduced because of thermal restrictions on the lines in the Hasle-cut due to high temperature.

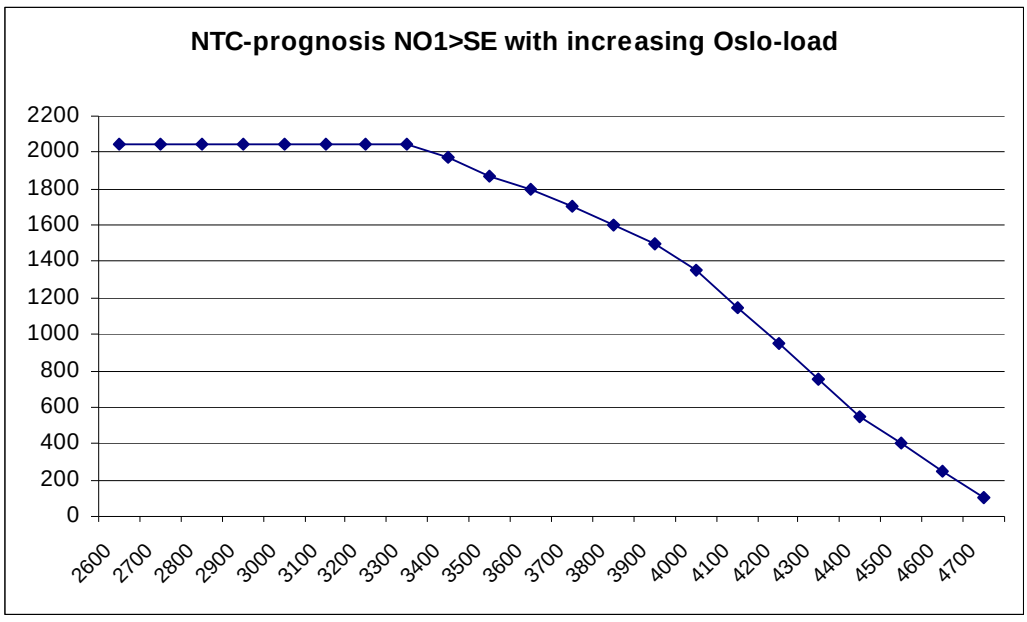

Figure 1. Prognosis of NTC (MW) between southern Norway and Sweden dependent of load in Oslo area.

The NTC value given to the market between southern and central Norway is a fixed value based on the expected flow on the connection the next day. The direction may deviate from normal direction of the flow between low and high price area. This is due to physical phenomena in the power system: A variation in the balance in South-Norway will hardly influence the flow between South- and Central-Norway because the impedance is high compared with the impedance between South-Norway and Sweden. Power may thus flow north from NO1 to NO2 even when there is full import to South-Norway from Sweden.

The capacity on the HVDC-cables between Norway and western Denmark refers to the measurement in Kristiansand in Norway. This means that because of the losses in the connection the NTC value is 1000 MW to Denmark and 950 MW to Norway.

The import capacity to central Norway will vary, depending on production in NO2, and the production volume and allocation in NO1, NO3 and Sweden. The lowest capacity to central Norway occurs in cases of low production in southern and northern Norway. Low production in southern and northern Norway could cause low transmission to central Norway from these areas. This will cause high transmission from Sweden to central Norway, and the connection NO2 – SE could reach its thermal limit.
During high transmission to NO2 from NO3 and SE, the congestion can appear as a sum of these two transmissions. During high transmission to NO2 from NO1 and SE, the congestion can appear as a sum of these two transmissions.
The above-mentioned expected congestions will lead to an estimated import capacity in the range 1100-1500 MW, depending on the allocation of production. The Elspot capacity is based on the expected physical congestions, and will be modified if the production and power flow changes.

Where NO2 in general is a deficit area, NO3 is a surplus area, confined by the total export to NO2 and Sweden.

Finland
When defining the NTC value between Finland and Sweden the forecasted regional power balance in southern and northern Finland is taken into consideration as well as the predicted connection of power plants having influence on the system stability. Typically due to winter temperatures the deficit in northern Finland increases and this will be taken into account when defining NTC from Finland to Sweden. During night time the NTC may be reduced according to the forecasted deficit volume to manage system stability during heavy transmission from south to north Finland.

The flow on radial 220 kV interconnection from Finland to Kalix in Sweden as well as transit flow to/from northern Norway through Sweden and Finland may affect the NTC values up to 150 MW.

The temperature dependence of Fenno-Skan cable will reduce the NTC between Finland and Sweden by 50 MW during summer time.

The Russian connection can only be used for import to Finland due to technical reasons in the HVDC system in Vyborg.

Estlink HVDC connection between Estonia and Finland has the capacity of 350 MW to both directions. During wintertime capacity may increase up to 365 MW due the temperature dependence of the cable. The connection is a merchant line owned by Nordic Energy Link AS.

Denmark
The NTC on the HVDC-connection between Eastern Denmark and Germany (Kontek) is the TTC deducted by 50 MW frequency controlled disturbance reserve in both directions.

In special situations the calculated NTC value between Western Denmark and southern Norway+ Sweden depends on the power production in the northern part of Jutland. In periods with high wind production the import capacity can be reduced. To handle these special situations an optimization limit is in place in Elspot for the so-called cut B in Western Denmark. It works as a limit both for the sum export allowed from Western Denmark to Sweden and Southern Norway and for the opposite i.e. the sum import.

The capacity on the HVDC-cables between Sweden and Western Denmark refers to the measurement in Vester Hassing in Denmark. This means that because of the losses in the connection the NTC value is 680 MW to Denmark and 740 MW to Sweden.

The HVDC-connection between Zealand and Germany (Kontek) is handled like the internal Nordic connections and the NTC is made available to Nord Pool Spot for day-ahead trading (Elspot) and intra-day trading (Elbas) between Eastern Denmark (price area DK2) and Germany (price area KT).

The capacity on the connection between Jutland and Germany is acquired by the market participants in explicit auctions. The market participants may forward their acquired capacity to Nord Pool Spot for day-ahead trading (Elspot) between Western Denmark (price area DK1) and Germany (price area KT). This so-called Cross Boarder Optimization (CBO) connects the power markets in the two parts of Denmark via Germany.

Constraint reasons and locations

To ensure a higher level of transparency of how capacities between the Elspot areas are determined, Nordel has decided to extend its information to the marked by using codes for capacity reduction. Each Elspot capacity will have one code every hour. The codes consist of four numbers, where the two first numbers informs about what type of capacity reduction it is, and the two last numbers informs about location of the constraint. The Capacity Reduction Codes can be studied at: http://www.nordpoolspot.com