AGREEMENT (Translation)
regarding operation of the interconnected Nordic power system
(System Operation Agreement)

§ 1 The Parties etc

- Energinet.dk (Energinet.dk) corporate registration no. 28 98 06 71
- Fingrid Oyj (Fingrid) corporate registration no. 1072894-3
- Statnett SF (Statnett) corporate registration no. 962 986 633
- Affärsverket svenska kraftnät (Svenska Kraftnät) corporate registration no. 202100-4284

The terms and concepts occurring in this System Operation Agreement (the Agreement) and its appendices are defined in Appendix 1.

§ 2 Background

The *subsystems* of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected, forming the so called *synchronous system*. The *subsystem* of Western Denmark is connected to Norway and Sweden using DC interconnectors. The *synchronous system* and the *subsystem* of Western Denmark jointly constitute the *interconnected Nordic power system*.

The supervisory authorities of Denmark, Finland, Norway and Sweden have appointed special *system operators* who are comprehensively responsible for the satisfactory operation of each *subsystem*. These *system operators* are Energinet.dk for the Danish *subsystem*, including Bornholm, Fingrid for the Finnish *subsystem*, Statnett for the Norwegian *subsystem* and Svenska Kraftnät for the Swedish *subsystem*. Åland is not covered by this Agreement.

The background to entering into this Agreement is that operation of the *interconnected Nordic power system* entails operational collaboration and co-ordination taking place between the *system operators*. Effective collaboration between these will provide the technical prerequisites for trading in power on an open electricity market.

The Agreement and its Appendices regulate the operational collaboration between the *Parties*. Several of the Agreement's provisions are based upon recommendations issued by Nordel.

§ 3 Objective

The objective of the Agreement is to make use of the advantages arising from the interconnected operation of the Nordic power system. The *Parties* shall thus jointly uphold the interconnected operation of the Nordic power system on a satisfactory level of reliability and quality.

The *Parties* shall jointly uphold a supply quality that is appropriate to joint system operation, e.g. frequency, *time deviation*, system oscillations etc.

The *Parties* shall jointly operate the *interconnected Nordic power system* in a manner which promotes the efficient utilization of existing resources and power trading on the Nordic electricity market, as well as on an additional potential international market. The Agreement specifies in detail the commitments that the *Parties* undertake to honour during their operational collaboration.

The *Parties* are agreed that agreements regarding the operation of the *interconnected Nordic power system* shall only be entered into between the *system operators* concerned.

It is the *Parties'* intention that, as long as *transmission facilities* between the *subsystems* are in operation, there shall exist an agreement between the *Parties* regulating their operational collaboration, rights and commitments vis-à-vis system operation issues.

§ 4 Appendices

The following Appendices are attached to this Agreement.

Appendix	Content
1	Definitions
2	Operational security standards
3	Balance regulation standards
4	Exchanging information
5	System protection
6	System services
7.1	Joint operation between Norway - Sweden
7.2	Joint operation between Sweden - Finland
7.3	Joint operation between Norway - Finland - Sweden (Arctic Scandinavia)
7.4	Joint operation between Norway - Western Denmark
7.5	Joint operation between Sweden - Western Denmark
7.6	Joint operation between Sweden - Eastern Denmark
7.7	Joint triangular operation between the Norwegian, Swedish and Western Danish subsystems.
8	Management of transmission limitations between subsystems.
9	Power shortages
10	The Nordel system's joint operation with other systems

The Appendices constitute an integral part of the Agreement.

In the event of any variance between the contents of the Appendices and what is set forth in this, the main part of the Agreement, what is set forth in the main part shall take precedence.

§ 5 Decisions etc concerning own subsystems

The *Parties* will make their own decisions regarding the principles applicable to the *system security* of their own *subsystems*.

The *Parties* agree, however, when taking such decisions, to comply with the intentions and principles of the Agreement as far as is possible and appropriate.

The *Parties* are individually responsible for formulating their own agreements concerning system operation collaboration between their own *subsystems* and *subsystems* outside of the *interconnected Nordic power system*, with which there are physical transmission links, in such a way that these do not contravene the intentions of, or prevent compliance with, the Agreement.

It is the intention of the *Parties*, as far as is possible within the legal framework provided (terms and conditions of concessions etc) to co-ordinate the terms and conditions of such agreements with the provisions of this Agreement.

Each respective *Party* shall enter into such agreements with companies within its own *subsystem* as are necessary to comply with the Agreement.

Unless otherwise agreed, the *Parties* shall be responsible for ensuring that measures taken within their own *subsystems,* which impact upon the operation of the system, shall not burden the other *subsystems*.

§ 6 Operational security standards

The *Parties* shall, in the day-to-day operation of the system and in their operational collaboration with other *Parties*, comply with the standards set forth in Appendices 2 and 3.

§ 7 Operational terms and conditions for the links between the subsystems

7.1 Transmission facilities

The *transmission facilities* linking the *subsystems* are accounted for in the following Appendices.

Appendix 7.1 Norway - Sweden
Appendix 7.2 Sweden - Finland
Appendix 7.3 Norway - Finland - Sweden (Arctic Scandinavia)
Appendix 7.4 Norway - Western Denmark
Appendix 7.5 Sweden - Western Denmark
Appendix 7.6 Sweden - Eastern Denmark
Appendix 7.7 Norway - Sweden - Western Denmark
(subsystems in triangular operation)

The *Parties* are responsible, as and when required, for detailed *operating instructions* being drawn up for the links listed in the mentioned Appendices within their own *subsystems*. In parts where such *operating instructions* have a bearing upon the joint system operation, they are to be co-ordinated with the companies and *Parties* concerned.

7.2 Transmission capacity

The *transmission capacity* of the links between the *subsystems* shall be bilaterally determined on a routine basis by the *Parties* concerned. Decisions shall normally be based on the *operational security standards* set out in Appendix 2 and on such current technical and operative factors as are of significance to the *transmission capacity*. The *Parties* are individually responsible for assessing these circumstances within their own *subsystems* and will decide on the necessary measures.

The *Parties* agree to reserve a *regulating margin* between the *transmission* and *trading capacities* of the links. The *regulating margin* shall normally have the values specified in Appendices 7.1 -7.7.

7.3 Special operational terms and conditions

In certain cases, special rules are applied as regards using the *transmission capacity* of the links. Detailed terms and conditions, together with the companies concerned, are specified in the respective Appendices 7.1-7.7.

7.4 Transmission losses

Issues concerning transmission losses are governed by separate agreements – settlement agreements.

A *Party* shall not be responsible for transmission losses arising within another *Party's subsystem* in any operational situation, unless otherwise agreed.

The *settlement points* are specified in Appendices 7.1-7.6.

7.5 Voltage regulation

Voltage regulation in the *subsystems* shall be conducted in such a way that the *operational security standards* specified in 6 § are upheld and in such a way that the reactive flow of power between the *subsystems* does not entail operational problems. The *Parties'* rights and liabilities regarding reactive power flows on the AC interconnectors are limited to what corresponds, calculation-wise, to zero exchange at the national border, based on values measured at the terminals of the links.

7.6 System protection

System protection can be used to increase the *transmission capacity* and/or *system security* between and within the *subsystems*. The settings and operational status of *system protection* shall be decided upon and monitored by the respective *Party*. In cases when *system protection* has a bearing on two or more *subsystems*, co-ordination and communication of the operating status shall take place between the *Parties* concerned. The requirements relating to *system protection* are set out in Appendix 2. The forms of *system protection* used are set out in Appendix 5.

7.7 Relay protection and fault analysis

The *Parties* shall co-ordinate supportive data and plans for setting functional values for the relay protection of such *transmission facilities*. Following *operational disturbances*, information from registration equipment shall be exchanged between the *Parties* concerned to the extent necessary to enable investigation of the course of events.

§ 8 Operational planning

The *Parties* shall, as far as is possible, bilaterally co-ordinate operational outages and other measures which each and everyone of them has control over and which impact upon the joint system operation. In the event that *operational disturbances* and other measures occur during the *operational phase* and which have to be carried out at short notice, with no time for co-ordination, the *Parties* concerned shall be informed as quickly as possible.

Appendices 7.1- 7.6 contain certain rules regarding the co-ordination of operational outages on the respective links between the *subsystems*.

§ 9 System services

The *Parties* shall comply with the *operational security standards* specified in § 6 by ensuring the availability of *system services* within their own *subsystems*. When this is possible, the *Parties* can co-ordinate and exchange *system services* with each other. During the exchange of such *system services*, the pricing shall be based on the costs incurred by the respective *Party* when obtaining access to and utilizing the *system services* within its own *subsystem*.

The *Parties* shall work towards harmonisation of the terms and conditions in order to gain access to *system services* from companies within the respective *subsystem*.

System services are described in Appendix 6.

§ 10 Managing transmission limitations between the subsystems

The *Parties* shall be bilaterally responsible for transmissions on the respective links between the *subsystems* not exceeding the set *transmission capacity*. If a limit is exceeded, this shall be rectified within 15 minutes.

The *Parties* shall bilaterally co-ordinate terms and conditions and management routines in order to be able, as and when required, to restrict the commercial players' utilization of the links in cases when *transmission capacities* need to be reduced. The separate terms and conditions that apply, as and when appropriate, to each respective link are set out in Appendices 7.1 - 7.7. The *Parties* shall uphold the commercial players' planned trading, by means of *counter trading,* to the extent set out in Appendix 8.

It is incumbent upon the *Parties* to manage, within their own *subsystems*, such transmission problems that cannot be solved by restricting the commercial players' utilization of the links. The *Parties* are further responsible for implementing the necessary regulation on their own sides of the links, and for the costs thus arising, unless otherwise agreed between the *Parties* concerned.

§ 11 Managing operational disturbances

In the case of all *operational disturbances*, *normal state* shall be resumed without undue delay. The *Parties* shall assist one another in minimising the consequences of any *disturbances* that arise.

In the case of disturbances arising within its own *subsystem*, the affected *Party* will be responsible, at its own expense, for remedial measures. Whenever it is appropriate to carry out remedial measures in another *subsystem*, the affected *Party* shall be responsible for the costs of the agreed measures. For disturbances on a link between the *subsystems*, the *Parties* concerned shall, at their own expense, be responsible for the necessary measures on their own side of the link, unless otherwise agreed.

In the case of activation of the joint *frequency controlled disturbance reserve*, compensation shall normally be rendered via the settlement of *balance power*.

The *Parties* shall promptly inform one another of *system security* risks or disturbances arising.

§ 12 Balance regulation

Each *subsystem* is responsible for planning itself into balance hour by hour, as well as for upholding its own balance during the hour of operation.

The *Parties* shall collaborate towards minimising the cost of *balance regulation* by utilizing, to the greatest extent possible, one another's regulation resources when this is technically and financially appropriate.

The *balance regulation* of the Nordic system is divided up into two *balance areas*. One of these *balance areas* is the *synchronous system* while the other *balance area* is Western Denmark.

Energinet.dk manages the *balance regulation* of the Western Danish area, within its sphere of responsibility for the *UCTE* system, and in accordance with an agreement with EON Netz. Consequently, Energinet.dk has agreements with two *balance areas*; the *UCTE* system and the *synchronous system*.

The *balance regulation* of each *subsystem* within the *interconnected Nordic synchronous power system* shall be carried out in accordance with the principles set out in Appendix 3.

The basis of the *interconnected Nordic synchronous power system's balance regulation* is that regulation is carried out in respect of frequency. Regulation work is apportioned in accordance with the requirement for *frequency response* and a joint Nordic merit order *regulation list*. The entire Nordic power system shall constitute a single market for *regulation power*. In the event of *bottlenecks*, the *regulation market* can be split up.

The *Parties* shall pay attention to regulation problems within the hour of operation and especially at hour changes. Major changes to *exchange plans* should be managed via agreements concerning transitions.

§ 13 Power exchanges

13.1 Hourly exchange plans

Parties with adjacent *subsystems* shall jointly set routines for notifying hourly *exchange plans* and *trading plans* among the *subsystems*. Whenever transmission capacity is made available for other purposes than power trading, the relevant plans shall be bilaterally reported to each *player* individually. Trading must be reportable as a net trade between each *subsystem*.

13.2 Supportive power

Exchanges of *supportive power* between *Parties* with adjacent *subsystems* may be carried out in order to achieve efficient operation of the system. Such exchanges can come about as and when required during *normal state*, during *counter trading* or during *operational disturbances*. *Supportive power* can be agreed upon in advance, as well as commenced and terminated during the current hour of operation.

The principles for pricing *supportive power* are set out in Appendix 3.

13.3 Balance power

Balance power between the *subsystems* is calculated during settlement as the difference between the measured exchange of power and the sum of all forms of agreed exchange, including such exchanges as have been agreed between the *Parties*.

More detailed rules for managing and pricing *balance power* are set out in Appendix 3.

§ 14 Settlement

Settlement shall be based on the principles set out in § 12 - 13 for *balance regulation* and exchanges of power.

All settlement of exchanges of power between the *subsystems* shall take place at the *settlement points* specified in Appendices 7.1 - 7.6.

The settlement procedure is regulated bilaterally in separate agreements, settlement agreements, between the *Parties* concerned.

§ 15 Power shortages

When there is a risk of *power shortages*, the power trade within the power exchange area shall be given the opportunity, through price formation, to distribute risks and costs between the electricity market *players*. The *Parties* shall, as far as is possible and reasonable, work towards upholding such power trading and allocations of production capacity, which they do not contractually have the right to discontinue.

In the event of anticipated *power shortages* in one or more *subsystems*, the *Parties* shall collaborate in such a way that the resources available within the *interconnected Nordic power system* are utilized in order to minimise the extent of compulsory *load shedding*.

Acute situations such as general *power shortages* or *power shortages* resulting from *operational disturbances* on networks, or *bottleneck situations* when compulsory *load shedding* has to be carried out, are to be managed in accordance with Appendix 9.

System security shall be maintained on the level specified in Appendices 2 and 3 so that *dimensioning faults* do not lead to extensive follow-on disturbances in the *interconnected Nordic power system*.

§ 16 Exchanging information

Appendix 4 specifies the information that shall be exchanged between the *Parties* for system operation requirements.

If the information that the *Parties* are mutually exchanging has not been made public in the country the information relates to, the *Parties* pledge to keep this information confidential, as far as possible, in accordance with the legislation in force in the respective country.

§ 17 Liability

The *Parties* will only be liable to one another for damage resulting from gross negligence or malice aforethought.

None of the *Parties* will be able to hold any of the other *Parties* liable for lost revenues, consequential losses or other indirect losses, unless such damage has been caused by gross negligence or malice aforethought.

§ 18 Disputes

Should a dispute arise in connection with this Agreement, the *Parties* shall initially attempt to resolve their conflict through negotiation. If this does not succeed, the dispute shall, under Swedish law, conclusively be settled by arbitration in accordance with the Rules of the Arbitration Institute of the Stockholm Chamber of Commerce. The arbitration procedure shall take place in Stockholm.

§ 19 Alterations and supplements

Alterations and supplements to this Agreement shall, in order to be legally valid, be drawn up in writing and signed by all the *Parties*.

Appendices to this Agreement can be added to on a rolling basis. In doing so, Appendices which relate to all the *Parties* shall be updated jointly and approved by all the *Parties*. Appendices which deal with individual links shall be updated by the *Parties* that are affected by the Appendix in question. Any and all changes to Appendices shall be documented in writing and communicated to the *Parties*.

In the event of alterations to Appendices, the Appendices in question shall, by at the latest one month after the alteration has been made, be revised and sent out to all the *Parties*. An annual review of the Agreement shall be carried out in order to deal with any contractual revisions.

§ 20 Transfer

This Agreement may be transferred to another company which has been appointed as the *system operator* of a *subsystem* by the authorities of a country. Other transfers may not, wholly or in part, take place without the written consent of the other *Parties*.

In the event of the transfer of the *system responsibility* to another company, the *Parties* will be responsible for transferring their contractual commitments under this Agreement to the new *system operator*.

§ 21 Validity etc

This Agreement will come into force once it has been signed by all the *Parties* and will remain in force until further notice. The Agreement, which will apply from 1 July 2006, is conditional upon each respective *Party* receiving the necessary Board/Authority approvals.

If a *Party* deems the terms and conditions of this Agreement to entail unreasonable or inappropriate consequences, then this *Party* will be able to request, in writing, from the other *Parties* that negotiations be entered into as soon as possible with the aim of bringing about appropriate changes to the Agreement. Equivalent negotiations can also be entered into if the pre-conditions for the Agreement change significantly due to altered legislation or a decision made by an authority, or due to physical changes being made to the *interconnected Nordic power system*.

If a *Party* requests renegotiation, the other *Parties* will be obligated to actively take part in such negotiations within one month of receiving such a request.

If renegotiations do not, within six months of the request for renegotiation being made, lead to agreement being reached as regards such changes to the Agreement that the *Party* deems satisfactory, the *Party* shall have the right to terminate the Agreement. Termination, which must be in writing, shall occur by at the latest two weeks from the expiration of the renegotiation deadline. If such termination occurs, the Agreement shall be deemed to have ceased to be valid in respect of the terminating *Party*, once a period of six months has elapsed from the time when the notice of termination was communicated to all the other *Parties*.

This Agreement replaces the previous agreement dated 1 April 2004.
This Agreement has been drawn up and signed in four (4) identical copies, of which the *Parties* have received one copy each.

Fredericia 2006- -	Helsinki 2006- -
Energinet.dk	Fingrid Oyj
Peder Ø. Andreasen	Timo Toivonen
Oslo 2006- -	Stockholm 2006- -
Statnett SF	Affärsverket Svenska Kraftnät
Odd Håkon Hoelsæter	Jan Magnusson

Definitions

Terms defined in this Appendix are written in italics in the Agreement and its Appendices.

Most of the terms are Nordic and are not used in Continental Europe. Individual general terms correspond to terms used within UCTE. Terms concerning the capacity of the links between the subsystems are comparable to the corresponding terms within ETSO.

The **active reserve** is divided into *automatic active reserve* and *manual active reserve*.

Adjustment state is a transition from alert state to normal state, characterised in that consumption, production and transmissions in the network are adjusted so that the network can manage a (new) dimensioning fault. The adjustment takes place in 15 minutes from a fault which has involved the disconnection of components. See also *operational states*.

Alert state is an operational state which entails that all consumption is being met and that the frequency, voltage or transmissions are within acceptable limits. The reserve requirements are not fulfilled and faults in network components or in production components will lead to *disturbed state* or *emergency state*. Also see *operational states*.

Annual consumption is the sum of electricity production and net imports in a *subsystem*. Electricity production is the net production in a power plant, i.e. exclusive of the power plant's own consumption of electricity for electricity production.

An **area** is a part of the power system within a *subsystem*; an area can potentially comprise an entire *subsystem*. An area is bordered by *transmission constraints* in the national subsystems or by *cross-border links*.

Area prices are *Elspot prices* within an *Elspot area*.

The **automatic active reserve** is the active reserve which is automatically activated during the momentary operating situation. It is divided into *frequency controlled normal operation reserve*, *frequency controlled disturbance reserve* and *voltage controlled disturbance reserve*.

Balance areas are areas of the power system where there is continuous regulation in order to maintain the frequency and a physical balance in relation to adjacent areas. In the Nordic area, the *synchronous system* and Western Denmark are separate *balance areas*.

Balance power is the difference between the planned and measured transmissions between the *subsystems*.

Balance regulation is regulation in order to maintain the frequency and *time deviation* in accordance with the set quality requirements. Regulation is also carried out for network reasons.

A **bottleneck** is a capacity limitation on the *transmission network*. On the Elspot market, attention is paid to *bottlenecks* between the *Elspot areas*. During *operational planning* and *monitoring and control,* attention is paid to all physical *bottlenecks*.

Counter trading is the purchasing of upward regulation and the sale of downward regulation, on each side of a *bottleneck,* which the *system operators* carry out in order to maintain or increase the *trading capacity* of *Elspot trading* between two *Elspot areas,* or in order to eliminate a *bottleneck* during the *day of operation*.

Critical power shortage occurs during the hour of operation when consumption has to be reduced/disconnected without commercial agreements about this.

A **cross-border link** is a link between two *subsystems* including connecting line feeders on both sides of the link. For HVDC links, only the DC facility at stations on both sides of the link is included in the cross-border link.

The **day of operation** is the calendar day around the momentary operational situation.

A **deficit area** is a *subsystem* whose balance is negative, i.e. that power is physically flowing into the *subsystem* physically measured on the *cross-border links* between the *Parties*.

Dimensioning faults are faults which entail the loss of individual major components (production units, lines, transformers, bus bars, consumption etc.) and entail the greatest impact upon the power system from all fault events that have been taken into account.

Disturbed state is an operational state which entails that all consumption is being met, but that the frequency, voltage or transmissions are not within acceptable limits and that *normal state* cannot be achieved in 15 minutes. Also see *operational states*.

Elbas trading is power trading in Elbas at Nord Pool Spot. *Elbas trading* can take place in Sweden, Finland, Western Denmark and Eastern Denmark prior to and during the *day of operation* after *Elspot trading* has finished.

Elspot areas are the areas of the Elspot market which the *interconnected Nordic power system* is divided into in order to deal with potential capacity limitations (*bottlenecks*) on the *transmission network*. Potential *bottlenecks* give rise to different *Elspot prices* in *Elspot areas*. In Finland, Sweden, Western Denmark and Eastern Denmark, the *Elspot areas* correspond to the *subsystems*.
In Norway, there are several *Elspot areas* within the *subsystem.*

Elspot prices are prices in *Elspot trading* within an *Elspot area.*

Elspot trading is power trading on the spot market of Nord Pool Spot. *Elspot trading* can occur prior to the *day of operation* in all *subsystems*.

Emergency power is power regulation on HVDC links activated by automatic systems on both sides of the respective HVDC link.

Emergency state is an operational state entailing that compulsory load shedding has been applied and that production shedding and network divisions may occur. Also see *operational states.*

ETSO (European Transmission System Operators) is an organisation for *system operators in Europe.*

An **exchange plan** is a plan for the total agreed active power to be exchanged hour by hour between two *subsystems*. This can be a plan for a whole calendar day or a number of hours (energy plan) and, whenever *supportive power* occurs during a part of the hour, also a momentary plan during the hour (power plan).

The **fast active counter trading reserve** is the *manual active reserve* for carrying out *counter trading.*

The **fast active disturbance reserve** is the manual reserve available within 15 minutes in the event of the loss of an individual principal component (production unit, line, transformer, bus bar etc.). Restores the *frequency controlled disturbance reserve.*

The **fast active forecast reserve** is the *manual active reserve* for regulation of forecasting errors for consumption and production.

Faults are events which occur in the power system and lead to a reduced capacity or loss of a line, bus bar, transformer, production units or consumption. A fault causes an *operational disturbance* in the power system.

The **frequency controlled disturbance reserve** is the momentarily available active power available for frequency regulation in the range of 49.9 – 49.5 Hz and which is activated automatically by the system frequency. Previously called the momentary disturbance reserve.

The **frequency controlled normal operation reserve** is the momentarily available active power available for frequency regulation in the range of 49.9 – 50.1 Hz and which is activated automatically by the system frequency. Previously called the frequency regulation reserve.

The **frequency response** is the change ability in production dependent on the frequency of the network (MW/Hz).

The **interconnected Nordic power system** is the interconnected *subsystems* of Finland, Norway, Sweden, Western Denmark and Eastern Denmark for which the Nordic *system operators* have joint *system responsibility*.

Load following entails *players* with major production changes reporting their production plans with a time resolution of less than 1 hour.

Load shedding is the automatic or manual disconnection of consumption.

The **manual active reserve** is the active reserve which is activated manually during the momentary operational situation. This is divided into the *fast active forecast reserve,* the *fast active disturbance reserve,* the *fast active counter trading reserve* and the *slow active disturbance reserve*.

Manual emergency power is power regulation on the HVDC links which is activated manually.

A **momentary area control error** is the disparity (in MW) between the sum of the measured power and the sum of the agreed *exchange plan* on the links between the *subsystems* plus frequency correction, which is the *subsystem's* momentary *frequency response* multiplied by the deviation in the frequency away from 50 Hz. Also called the momentary imbalance.

N-1 criteria are a way of expressing a level of *system security* entailing that a power system can withstand the loss of an individual principal component (production unit, line, transformer, bus bar, consumption etc.). Correspondingly, n-2 entails two individual principal components being lost.

Network collapse is an operational state that entails that all loads in one or more areas are shed and that production shedding and network divisions can occur. Also see *operational states*.

Normal state is an operational state entailing that all consumption requirements are being met, that frequency, voltage and transmission lie within their limits and that reserve requirements are being met. The power system is prepared to deal with *dimensioning faults*. Also see *operational states*.

An **operational disturbance** is a disturbance to the power system. This can be the loss of a line, a bus bar, a transformer, a production unit or consumption.

An **operational instruction** is an instruction given to the control rooms of the *system operators* concerning how they are to behave in an operational situation.

Operational monitoring and control is the monitoring and control of the operation of the power system carried out by the control rooms.

The **operational phase** is the time from the momentary operational situation and the rest of the *day of operation* when trade on the Elspot market has already been determined.

Operational planning is the *system operators'* planning of the operation of the power system.

The **operational reserve** is the reserve that the *system operators* have access to during the *day of operation*. It is divided into the *active reserve* and the *reactive reserve*.

Operational security standards are criteria which the *system operators* use when conducting *operational planning* in order to uphold the reliable operation of the power system.

The **operational states** are *normal state, alert state, disturbed state, emergency state and network collapse*. See also *adjustment state* and *restoration*. These were earlier referred to as the power system's operational states. See Figure 1.

Outage planning is the planning done by each individual *system operator,* as well as between the *system operators,* of the necessary outages affecting *transmission capacities* between the *subsystems*.

A **Party** is one of the *system operators* entering into this Agreement regarding operation of the *interconnected Nordic power system*. The *Parties* are Energinet.dk, Fingrid, Statnett and Svenska Kraftnät.

The **peak load resource** is an *active reserve* which normally has a long readiness time. In the event of anticipated peak loads, the readiness time is reduced so that the *peak load resource* can be used prior to the *day of operation* on the Elspot market or during the *day of operation* on the *regulation market*.

The **planning phase** is the time until which bids submitted for the next calendar day's *Elspot trading* on the power exchange can no longer be changed.

A **Player** is a physical or legal persona active on the physical electricity market in the form of bilateral trading with other *players*, *Elspot trading*, *Elbas trading* or trading on other existing marketplaces.

The **power operation manager** is the person who has obtained, from the holder, the task of being responsible for managing the electrical facility.

The **power operation responsibility boundary** is the boundary of a well-defined area in the *transmission facilities* between two *power operation managers*.

Power shortage occurs during the hour of operation when a *subsystem* is no longer capable of maintaining the demand for a *manual active reserve* which can be activated within 15 minutes.

A **price area** is an *Elspot area* which, due to *bottlenecks* towards another *Elspot area,* has been given an *Elspot price* of its own.

Production shedding means the automatic or manual disconnection of a production facility.

Ramping means restricting changes in *Elspot trading* on one or more cross-border links individually and together from one hour to the next.

Ramp regulation means regulation of power based upon a specified ramp in order to even out the transition between two power levels, normally on HVDC cables at the changes of the hour.

The **reactive reserve** is the reactive power which is activated either automatically or manually during the momentary operational situation.

Redundancy is more than one independent opportunity for a piece of equipment to carry out a desired function.

Regulating bids are bids for upward or downward regulation at a specified output power at a specified price.

Regulating power is activated *regulating bids*, upward and downward regulations at power plants as well as the upward and downward regulation of consumption which producers or consumers offer in exchange for compensation. The *system operators* activate these bids during the momentary operational situation to maintain the balance/frequency within the *balance areas* and to deal with *bottlenecks* on the *transmission network*.

Regulation areas are the areas which the *regulation market* for the *interconnected Nordic power system* is divided into in order to manage possible capacity limitations (*bottlenecks*) on the *transmission network*. Potential *bottlenecks* will entail different *regulation prices* in the *regulation areas*. In

Sweden, Finland, Western Denmark and Eastern Denmark, *regulation areas* normally correspond to the *subsystems*. In Norway, there are several *regulation areas* within the *subsystem*.

The **regulation list** is the list of *regulation bids* in ascending and descending order sorted by the price for one hour.

The **regulation margin**, also called **TRM** (Transmission Reliability Margin), is the gap between the *transmission capacity* and the *trading capacity*. It constitutes the scope for the momentary regulation variations as a result of frequency regulation around the planned hourly value for transmission.

The **regulation market** is the market for *regulating power*.

The **regulation price** is the price resulting from implemented regulations during the hour of operation for a *regulation area*. Also called the RK price.

Regulation steps are steps in the *regulation list*.

Restoration is a transition between different operational states characterized by the network being restored, production being regulated upwards, and frequency, voltage and transmission being brought within acceptable limits. Consumption is connected at a pace which the network and production resources can take. Also see *operational states*.

A **risk of power shortage** occurs when forecasts show that a *subsystem* is no longer capable of maintaining the demand for a *manual active reserve* which can be activated within 15 minutes, for the planning period.

Scaling means restricting changes in the *trading capacity* (NTC) between two *Elspot areas* from one hour to the next.

Serious operational disturbances are *operational disturbances* entailing greater consequences than activation of the *frequency controlled disturbance reserve*.

Settlement points are reference points for financial settlement between the *subsystems* based on direct measurement.

The **slow active disturbance reserve** is the active power available after 15 minutes.

Special regulation is the activation of *regulating power* in order to deal with *bottlenecks* on the *transmission network*.

A **subsystem** is the power system for which a *system operator* is responsible. A *system operator* can be responsible for several *subsystems*.

Subsystem balance is calculated as the sum of the measured physical transmissions on the *cross-border links* between the *subsystems*. Thus, there is a deficit if this sum shows that power is flowing into a *subsystem* and a surplus if power is flowing out of a *subsystem*. (Exchanges on *cross-border links* like Finland-Russia, the SwePol Link, the Baltic Cable, Kontek and Western Denmark-Germany are not to be included in the calculation.)

Supportive power is power that adjacent *system operators* can exchange reciprocally as an element of the regulation of balance in the respective *subsystems*. Exchanges are made specifying the power, price, link and time to the exact minute of the start and finish of the exchange. *Supportive power* is settled as the hourly average value.

A **surplus area** is a *subsystem* whose *balance* is positive, i.e. that power is physically flowing out of the *subsystem* measured physically on the *cross-border links* between the *subsystems*.

The **synchronous system** is the synchronously interconnected power system consisting of the *subsystems* of Norway, Sweden, Finland and Eastern Denmark. Western Denmark is synchronously interconnected with the *UCTE* system.

The **system operator** has the *system responsibility* for a defined *subsystem*.

The **system price** is an estimated price for the entire Elspot market. The s*ystem price* is estimated as if there are no capacity limitations on the *transmission network* between the *Elspot areas*.

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 compensate for the defective component and so that overloads do not arise. *System protection* can also be used to increase the capacity of the *transmission network* without simultaneously increasing the risk of diminishing the *system security*. *System protection* requires a level of reliability in line with primary protection. Previously called network protection.

The **system responsibility** is the responsibility for co-ordinating the utilization of electrical facilities in the jointly operated power system, or a part of this, in order that the desired *system security* and network quality may be attained during operational service.

System security is the power system’s ability to withstand incidents such as the loss of lines, bus bars, transformers, production units or consumption.

System services is a generic term for services that *system operators* need for the technical operation of the power system. The availability of *system services* is agreed upon by the *system operator* and the other companies within the respective country. *System services* can be arranged into different forms of *system protection* and *operational reserves* for active and reactive power.

Time deviation is the difference between a synchronous clock driven by the frequency of a power system and planetary time.

The **trading capacity**, also called **NTC** (Net Transfer Capacity), is capacity made available to *Elspot trading* between the *Elspot areas* and the highest permitted sum of the *players'* planned trading on an hourly basis. The *trading capacity* is calculated as the *transmission capacity* less the *regulating margin.*

The **trading plan** is the sum of the *players'* electricity trading between the *Elspot areas* (Elspot, Elbas, hourly trading).

The **transmission capacity**, also called **TTC** (Total Transfer Capacity), is the maximum transmission of active power in accordance with the system security criteria which is permitted in *transmission constraints* between the *subsystems/ areas* or individual installations.

A **transmission constraint** is a constraint on the *transmission network* between the *subsystems* or between *areas* within a *subsystem.* Also referred to solely as constraints.

Transmission facilities are individual installations (lines, bus bars, transformers, cables, breakers, isolators etc) which form the *transmission network.* This includes protective, monitoring and control equipment.

A **transmission network** is the interconnected network containing the *transmission facilities.*

UCTE (Union for the Co-ordination of Transmission of Electricity) is an association of *system operators* in continental Europe.

The **voltage controlled disturbance reserve** is the momentarily available active power used for *operational disturbances* and which is activated automatically by the network voltage. Often established as *system protection.*

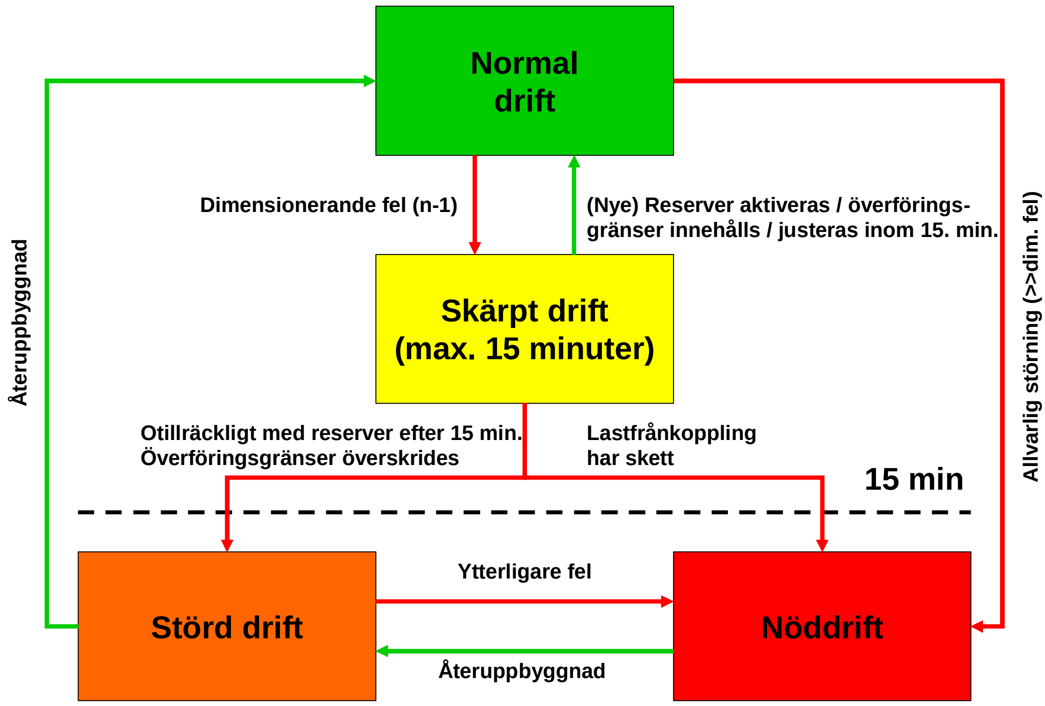

Figure 1
Operational states (network collapse is not specified in the figure).

Operational security standards

1. System security criteria

The following criteria for *system security* are to be applied in those respects that are of significance as regards enabling operation of the power system to be upheld with the *subsystems* interconnected with each other.

The criteria for *system security* shall be based on the *n-1 criterion*. This is an expression of a level of *system security* entailing that a power system is assumed to be intact apart from the loss of individual principal components (production units, lines, transformers, bus bars, consumption etc.). For faults having the largest impact on the power system, the term *dimensioning faults* is used.

It is not normally the same type of fault that is dimensioning during frequency disturbances as during disturbances to the transmission system. The loss of the power system's largest production unit is normally dimensioning as regards determining the *frequency controlled disturbance reserve.*

The definition of *serious operational disturbances* is *operational disturbances* having a greater impact than activation of the *frequency controlled disturbance reserve.*

The definition of *normal state* is an operational state entailing that all consumption is being met, that the frequency, voltage and transmission lie within normal limits and that the reserve requirements have been met. The power system has been prepared in order to deal with *dimensioning faults.*

For the *interconnected Nordic power system,* the above entails that:

- a *dimensioning fault* on a *subsystem* must not bring about *serious operational disturbances* in other *subsystems*. This places demands on the *frequency controlled disturbance reserve* and the *transmission capacity* within and between the *subsystems*
- if the power system is not in *normal state* following an *operational disturbance, the power* system must have been restored, within 15 minutes, to *normal state*. This places demands on the available *fast active disturbance reserve*. If there are exceptions from the time requirement, or if there is a departure from the above definition of *dimensioning faults*, then there must be consultation between the *system operators* concerned.

2 System protection

System protection is used to limit the consequences of faults over and above the disconnection of defective components. *System protection* can have as its purpose to increase the *system security*, the *transmission capacity,* or a combination of these. For *system protection* that is used to increase the *transmission capacity,* the following requirements have been set:

- An analysis must be implemented which shows the consequences for the power system in the event of a correct, unwarranted and missing function and simultaneously takes into account the other system protection
- In the event of a correct or unwarranted function, *serious operational disturbances* will not be accepted in other *subsystems*
- If the above consequence analysis shows that a missing function can entail *serious operational disturbances* for other *subsystems,* the following technical requirements shall apply to the *system protection* function:

    - **Redundant telecommunications shall exist in cases where system protection is dependent on telecommunications**
      Redundant telecommunications means that communications between the stations concerned shall be entirely duplicated. If the auxiliary power feed for one of the communications systems fails, then the other must not be affected. In practice, this means that batteries, telecom terminals, converters and communication paths must be duplicated. Communication paths may not, on any section, share connections, leads, opto cables or similar. They must take geographically separated routes.
      Multiplexed links can be used but communications shall use separated multiplexes that are not fed by the same battery. Having separate fuses on the same battery does not constitute full redundancy.

    - **There must be real time monitoring of telecommunications**

    - **There must be a redundant and independent ”triggering function”**
      A *redundant* triggering function, if this relates to breakers, means that the breaker has two trip magnets. Breaker fault protection shall be used to safeguard breaker operation if the ordinary breakers are not functioning correctly

    - **The control facility and telecommunications standard shall be on the same acceptable reliability level as the one applicable to primary relay protection**

- If a consequence analysis shows that a missing function will not entail *serious operational disturbances* for other *subsystems*, the relevant *subsystem's system operator* will decide which requirements apply to the *system protection* function.

- If a consequence analysis shows that a correct, unwarranted or missing function can lead to more extensive consequences than *dimensioning faults*, *system protection* must be accepted separately between the parties.

3 HVDC links

HVDC links shall be regarded as production facilities.
The *system operators* for the individual HVDC links are only responsible for restoring the operation to *normal state* in their own *subsystems* after the loss of the HVDC link or after *emergency power* regulation has been activated.

4 Operational reserves

4.1 Automatic active reserve

The *automatic active reserve* is divided up into the *frequency controlled normal operation reserve*, the *frequency controlled disturbance reserve* and the *voltage controlled disturbance reserve*.

4.1.1 Frequency controlled normal operation reserve

The *frequency controlled normal operation reserve* shall be at least 600 MW at 50.0 Hz for the synchronous system. It shall be completely activated at f = 49.9/50.1 Hz (Δf = +- 0.1 Hz).
In the event of a rapid change of frequency to 49.9/50.1 Hz, the reserve shall be regulated upwards/downwards within 2-3 minutes. The *frequency controlled normal operation reserve* is distributed between the *subsystems* of the *synchronous system* in accordance with the *annual consumption* (total consumption exclusive of power plant's own consumption) during the previous year.

The factual distribution of the *frequency-controlled normal operation reserve* between the *subsystems* shall be revised each year before 1 March on the basis of *annual consumption* in the previous year and rounded to the closest ten. *Annual consumption* shall be given in TWh with an accuracy of one decimal.

Each *subsystem* shall have at least 2/3 of the *frequency-controlled normal operation reserve* in its own system in the event of splitting up and island operation.

For 2008, the following distribution applied:

	Annual consumption 2007 (TWh)	Frequency controlled normal operation reserve (MW)
Eastern Denmark	*14.6*	*23*
Finland	*90.3*	*143*
Norway	*127.4*	*202*
Sweden	*145.9*	*231*
Synchronous system	*378.2*	*600*

4.1.2 Frequency controlled disturbance reserve

There shall be a *frequency controlled disturbance reserve* of such magnitude and composition that *dimensioning faults* will not entail a frequency of less than 49.5 Hz in the *synchronous system*.

Taking into account the frequency-dependence of consumption, the above requirements entail that the combined *frequency controlled disturbance reserve* shall amount to an output power equal to the *dimensioning faults* less 200 MW. The overall *frequency controlled disturbance reserve* must be able to be used until the *fast active disturbance reserve* has been activated.

Upward regulation of the *frequency controlled disturbance reserve* must not give rise to other problems in the power system. When setting the *transmission capacity*, localization of the *frequency controlled disturbance reserve* must be taken into account. Each *subsystem* shall have at least 2/3 of the *frequency controlled disturbance reserve* within its own system in the event of splitting up and island operation.

The *frequency controlled disturbance reserve* shall be activated at 49.9 Hz and be completely activated at 49.5 Hz. It must increase as good as linearly throughout the frequency range of 49.9-49.5 Hz.

The major part of both the *frequency controlled disturbance reserve* and the *frequency controlled normal operation reserve* will be achieved via automatic frequency regulation for production facilities. To meet the above requirements, the objective for each respective *system operator* must be to place demands on turbine regulator settings, e.g. in the form of demands regarding regulating time constants. There should also be the possibility of monitoring and checking.

Agreed automatic *load shedding,* e.g. industrial, district heating and electric boiler consumption in the event of frequency drops to 49.5 Hz can be counted as part of the *frequency controlled disturbance reserve*. The following requirements are applicable, however:

Load shedding can be used as *frequency controlled disturbance reserve* in the frequency range of 49.9 Hz to 49.5 Hz, when *load shedding* meets the same technical requirements set below for generators.

In the event of a frequency drop to 49.5 Hz caused by a momentary loss of production:

- 50 % of the *frequency controlled disturbance reserve* in each *subsystem* shall be regulated upwards within 5 seconds
- 100 % of the *frequency controlled disturbance reserve* shall be regulated upwards within 30 seconds.

Distribution of the requirement for the *frequency controlled disturbance reserve* between the *subsystems* of the *interconnected Nordic power system* shall be carried out in proportion to the *dimensioning fault* within the respective *subsystem*. Distribution of the requirement shall be updated once a week or more often if necessary.

The following example shows how distribution of the requirement for the *frequency controlled disturbance reserve* is achieved:

	Dimensioning faults (MW)	Frequency controlled disturbance reserve (MW)	Frequency controlled disturbance reserve (%)
Denmark	580	168	14.5
Finland	865	251	21.6
Norway	1,200	348	30.0
Sweden	1,360	394	34.0
Total		**1,160**	**100**

Energinet.dk's requirement of the *frequency controlled disturbance reserve* is distributed between Eastern and Western Denmark as follows:

- Western Denmark 75 MW (7.4%)
- Eastern Denmark 78 MW (7.6%)

Energinet.dk accepts this requirement as long as E.ON Netz and UCTE accept the emergency power setting on the HVDC Skagerrak and Konti-Skan links and as long as this entails no financial consequences for Energinet.dk. Energinet.dk will not reserve trading capacity in order to be able to deliver the reserve.

Energinet.dk's AC joint operation of Western Denmark within the *UCTE* system entails that Energinet.dk is required to maintain the frequency and *frequency controlled disturbance reserve* in accordance with *UCTE* rules. This is described in section 5 ”Special conditions for Energinet.dk as a member of UCTE”.

4.2 Fast active disturbance reserve

The *fast active disturbance reserve* shall exist in order to restore the *frequency controlled normal operation reserve* and the *frequency controlled disturbance* *reserve* when these reserves have been used or lost, and in order to restore transmissions within applicable limits following disturbances.

The *fast active disturbance reserve* shall be available within 15 minutes.

The *fast active disturbance reserve* shall exist and be localized to the extent that the system can be restored to *normal state* following faults.

The size of the *fast active disturbance reserve* is determined by the individual *subsystem's* assessment of local requirements. *Bottlenecks* on the network, *dimensioning faults* and similar are included when assessing this.

The *system operators* have secured, through agreement or ownership, a *fast active disturbance reserve*. This reserve consists of gas turbines, thermal power, hydropower and *load shedding*. In round figures, Fingrid has 1,000 MW, Svenska Kraftnät 1,200 MW, Energinet.dk 600 MW in Eastern Denmark (where 300 MW is *slow active disturbance reserve* which, on special occasions, can be made fast), Energinet.dk 680 MW in Western Denmark, and Statnett 1,200 MW.

Whenever required, a *subsystem* can hold a certain amount of *fast active disturbance reserve* for another *subsystem*, if there is idle *transmission capacity* for this purpose. The keeping of such reserves is to be agreed upon between the concerned *subsystems' system operators* upon each occasion, and all *system operators* shall be informed of this.

4.3 Slow active disturbance reserve

The *slow active disturbance reserve* is active power available after 15 minutes.

4.4 Reactive reserve

Within each *subsystem*, there must be a reserve of reactive power which is constituted in such a way with regard to size, regulation capability and localization that *dimensioning faults* will not entail a system collapse.

5 Special conditions for Energinet.dk as a member of UCTE

N-1 security

The *n-1 criterion* also applies to the *UCTE* area. If n-1 security is maintained with the help of adjacent systems (e.g. using *system protection*), this shall be approved by the adjacent system owners.

Primary regulation

For the entire *UCTE*, a *frequency response* of 18,000 MW/Hz is required. The *dimensioning production loss* is 3,000 MW. The different countries' share of the primary regulation reserve is distributed in proportion to the individual countries' production capacities. Energinet.dk shall thus, during 2008, be able to deliver 30 MW as *frequency controlled disturbance reserve* in Western

Denmark. This *frequency controlled disturbance reserve* shall be fully activated in the event of a momentary frequency change of ± 200 mHz.

Secondary reserve
Generally within *UCTE,* it is applicable that the delivery of secondary reserve shall be commenced 30 seconds after an imbalance has arisen between production and consumption and shall be fully regulated out after 15 minutes. There must be sufficient reserve to safeguard each area's own balance following a loss of production.

6 Principles for determining the transmission capacity

6.1 Introduction

The various *system operators'* 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 constraint* being defined, and static and dynamic simulations determine how much power can be transmitted in any direction through the constraint before thermal overloads, voltage collapse and/or instability arise following a *dimensioning fault* (for the constraint) being added. In the constraint, an arbitrary number of lines on different levels of voltage can be included.

The result of the calculations will be the maximum technical limitation for transmission. For the operational phase, this limit must be reduced as regards the calculatory inaccuracy and normal variations due to frequency controlled normal operation regulation.

6.2 Thermal limitation

In cases when thermal limitations on lines and/or equipment restrict the *transmission capacity* through a *transmission constraint*, the maximum transmission capability through a constraint, or for single lines following a simple fault, can be set at a given percentage over the nominal limit in cases when the constraint/line can be relieved within 15 minutes.

6.3 Voltage collapse

It is neither of interest nor possible to specify exactly at which voltage a voltage collapse occurs as this will vary with the state of operation and access to active and reactive synchronized production at the onset of the fault. Some events that low voltage can lead to are:

- Consumers being affected at a voltage of 0.5-0.7 p.u. (contactors open)
- Risk of overloading equipment at 0.8 p.u.
- Risk of production being shed due to low voltage on auxiliary power equipment (0.85 p.u.)
- Reactive resources being exhausted, i.e. generators are at their current limits for rotors and stators. Can appear at a voltage of 0.85-0.9 p.u.

Neither is it possible to specify a global value for the calculatory inaccuracy. This is different for each *system operator* and *transmission constraint* and primarily depends on the quality of data, representation of the underlying systems and the calculation technique used. The margin for primary voltage regulation is set by each *system operator* for internal constraints and bilaterally between the *system operators* for constraints between systems.

6.4 System dynamics

Dynamic simulation of a power system before, during and after a fault provides, as a typical result, how the different production facilities' generators oscillate against each other. These oscillations can either be attenuated after a while or accelerated. Today there is no accepted norm for how quickly the oscillations must be attenuated in order for the system to be assumed to be stable; rather this is a matter of judgement. In the same way as above, the calculated technical limit is reduced using a calculatory inaccuracy margin.

A fault scenario is to be simulated over a period so lengthy that all conceivable oscillation frequencies can be detected and that these are well attenuated.

Balance regulation standards

The work of *balance regulation* shall be conducted in such a way that regulations take place in the *subsystem* with the lowest regulation cost. *Parties* carrying out regulation shall be compensated for their costs.

1 Balance regulation within the synchronous system

Balance regulation within the *synchronous system* shall be conducted in such a way that the below specified quality standards regarding frequency and *time deviation* are integrated. Requirements regarding *frequency response* and frequency controlled reserves (see appendix 2) shall be maintained. Furthermore, *balance regulation* shall be conducted in such a way that the *transmission capacity* is not exceeded.

Sweden and Norway represent approx. 75% of the *annual consumption* of the *synchronous system*. The *Parties* agree that Svenska Kraftnät and Statnett will thus have the task of maintaining the frequency and *time deviation* within the set limits. Fingrid and Energinet.dk will normally only *balance-regulate* after contacting Svenska Kraftnät. Energinet.dk West will exchange *supportive power* with the *synchronous system* after contacting Statnett.

The distribution of work between Svenska Kraftnät and Statnett is regulated bilaterally and described in document “Frequency regulation in Nordel system” (Instruction for frequency regulation), which is distributed to all the *Parties*.

1.1 Quality standards

Frequency

The requirement of the highest permissible variation in the frequency during *normal state* is between 49.90 and 50.10 Hz. The goal is to maintain 50.00 Hz.

The number of minutes with frequency deviation shall be kept at a minimum. The goal figures for frequency deviation shall be established annually, and the number of deviations with underfrequency and overfrequency shall be recorded. With regard to *system security*, it is more important to fulfil the requirement for underfrequency than overfrequency.

In certain operational situations it may be necessary to deviate from the normal activation sequence and go over to *regulating bids* on the regulating list in order to maintain the frequency.

Time deviation

The *time deviation* is used as a tool for ensuring that the average value of the frequency is 50.00 Hz.

The *time deviation* ΔT shall be held within the time range of - 30 to + 30 seconds. At $\Delta T = 15$ seconds, Statnett and Svenska Kraftnät shall contact each other in order to plan further action.

The frequency target has a higher priority than the *time deviation* and the costs of frequency regulation.

The *time deviation* shall be corrected during quiet periods with high *frequency response* and with a moderate frequency deviation.

Joint operational planning

There shall active communications between Statnett and Svenska Kraftnät before each hour of operation and *day of operation* in order to jointly draw up a suitable strategy and to plan future action so that the above goals are achieved. Both parties are responsible for maintaining sufficiently active communications.

Information on planned and taken action in order to achieve the above goals shall be delivered to Fingrid and Energinet.dk.

1.2 Momentary area control error

Momentary area control errors are calculated for each *subsystem* and used as an instrument for measuring the *subsystem's* momentary imbalance. Momentary area control errors are not normally used as regulation criteria.

Area control errors (I) are calculated in accordance with the following formula:

$I = P_{mom} - P_{plan} + \Delta f \times R$

P_{mom} = the momentary reading on the links between the *subsystems*

P_{plan} = the exchange plan including *supportive power* between the *subsystems*

Δf = frequency deviation

R = momentary *frequency response*

2 Balance regulation in Western Denmark

Balance regulation in Western Denmark shall take place so that the requirements concerning Western Denmark as a “control block” in UCTE are met on the *cross-border links* between Germany and Jutland.

3 Regulation measures and principles of pricing

A joint list of *regulation bids* is compiled, in the order of price, containing bids from both the *synchronous system* and Western Denmark. During the hour of operation, regulation is initially carried out for network reasons and then, if necessary, to maintain the frequency in the *synchronous system* or the balance in Western Denmark. Regulation carried out for network reasons can take place on one or both sides of a bottleneck.

Power exchange between the *subsystems* in the *synchronous system* primarily takes place in the form of *balance power*. *Balance power* can be exchanged as long as this does not cause unacceptable conditions for the adjacent areas. Power exchange between the *synchronous system* and Western Denmark primarily takes place in the form of *supportive power*.

3.1 Regulation of frequency and balance

For the regulation of the frequency of the *synchronous system* and the balance in Western Denmark, the bids on the joint *regulation list* are used in the order of price, with the exception of bids confined behind a *bottleneck*. The activated bids are marked as *balance regulations* and are included when calculating the *regulation price* and regulation volume.

For each hour, the *regulation price* is determined in all *Elspot areas*. The *regulation price* is set at the margin price of activated bids in the joint *regulation list*. When *bottlenecks* do not arise during the hour of operation, the prices will be equal. The available capacity during the hour of operation can be utilised even there is a bottleneck in Elspot so that a joint *regulation price* is obtained. If there has been no regulation, the *regulation price* is set as the *area price* in Elspot.

When a *bottleneck* arises during the hour of operation between *Elspot areas* which entails that a bid in an area cannot be activated, the relevant area will obtain a *regulation price* of its own. This *regulation price* will be decided by the last bid activated in the joint *regulation list* prior to the *bottleneck* arising.

There is a *bottleneck* between the *Elspot areas* when it is not "possible" to carry out *balance regulation* on the basis of a joint *regulation list* without deviating from the normal price order of the list. The reason for this not being "possible" can be for example levels of transmission that are too high on the *cross-border link* itself or on other lines/*transmission constraints* or operational/trading rules which entail that it is not permitted to activate bids in the joint *regulation list*.

If the transmission between *Elspot areas* is greater than the *trading plan* and this creates *bottleneck problems* for other *Elspot areas*, the area(s) which caused this will regulate against the balance. The area(s) therefore obtain(s) its/their own *regulation price(s)*. This will be decided by *balance regulations* within the area or within several adjacent areas that are affecting the *bottleneck* in the same way.

During bidirectional regulation for an hour in the *synchronous system*, the net regulated energy will decide whether the *regulation price* will be the upward or downward regulation price. If no regulation has taken place or if the net volumes upwards and downwards are equal, the price will be set at the *Elspot price*. Regulation behind a *bottleneck* will only affect the net volume if the *bottleneck* has arisen through activated *balance regulations*. This also applies to Western Denmark.

Bottlenecks to/from an *Elspot area* which are caused by imbalances within an *Elspot area* are dealt with as *balance regulation* and give rise to a divided *regulation market*. *Bottlenecks* caused by a reduced *transmission capacity* to/from an *Elspot area,* after Elspot pricing, are managed using *counter trading* and *special regulations*.

A prerequisite for the *system operator* in the *synchronous system* to be able to set his own *regulation price* is that the *trading plan* is exceeded. In the opposite case, *counter trading* could be necessary between the *system operators*.

3.2 Regulation for network reasons

Regulations carried out for network reasons shall not, in the basic case, affect the r*egulation price* calculation, but they are carried out as *special regulations*.

For regulations for network reasons in internal constraints in an *Elspot area*, bids are used in the *subsystems* which rectify the network problem. When choosing a regulation object, attention must be paid to both the price and the effectiveness of the regulation.

For regulations carried out for network reasons on the border between *Elspot areas*, the cheapest bids are normally used in the *subsystems* which rectify the network problem. When such regulation is caused by an imbalance vis-à-vis the *trading plan* between *Elspot areas*, the *regulation price* will be affected in the subnetwork where the regulation was carried out.

4 Pricing of balance power

4.1 Balance power between the subsystems within the synchronous system

Balance power between two *subsystems* is priced at the average of the *regulation prices* in these *subsystems*.

4.2 Balance power between Western Denmark and Sweden

Swedish *regulation prices* apply to the pricing of *balance power* between Western Denmark and Sweden in accordance with the dual price model applied internally within Sweden.

4.3 Balance power between Western Denmark and Norway

Norwegian *regulation prices* apply to the pricing of *balance power* between Western Denmark and Norway.

5 Pricing of supportive power

5.1 Pricing within the synchronous system

When there is a need to *exchange supportive power* between two *Parties*, the price will be set at the regulating *Party's* cost, and conclusively set after the hour of operation. The price of *supportive power* shall not normally affect the *pricing of balance power* between the *subsystems*.

5.2 Pricing between Western Denmark and Norway, and Western Denmark and Sweden

The following applies to *supportive power* for *balance regulation* between the *synchronous system* and Western Denmark:

When the balance in the *synchronous system* and Western Denmark is regulated in the same direction, the price of *supportive power* is set to that *regulation price* – if they are different – which is closest to the *system price* in Elspot. The same rule applies when there is no regulation in any of the areas.

When the balance in the *synchronous system* and Western Denmark is regulated in different directions, the price of *supportive power* is set to the *system price* in Elspot.

In the event of *bottleneck situations,* it may be appropriate to carry out triangular *supportive power exchanges* between Sweden, Norway and Western Denmark. This will not affect the individual *subsystem's* balance and the price of the exchange will be set at 0 SEK. *Supportive power* for balance regulation has priority over triangular transit.

5.3 Pricing during operational disturbances on cross-border links

The price of *supportive power* during *counter trading* which is due to an *operational disturbance* on the *cross-border link* itself will be the average of the *area prices* in Elspot in the adjacent systems.

6 Operational/trading rules between the synchronous system and Western Denmark

Exchange of *supportive power* for *balance regulation* between the *synchronous system* and Western Denmark is carried out in accordance with a set model based on the below principles.

Energinet.dk West sends plans in advance for each operating hour for exchange between the *synchronous system* and Western Denmark. The plans are given per 15 minutes and they are drawn up on the basis of forecasts for imbalance in Western Denmark, current bids in the joint *regulation list* and other information exchange between Statnett and Energinet.dk West.

Statnett and Energinet.dk West are jointly responsible for the plan concerning the coming hour being acceptable with respect to regulation in both systems at the latest 15 minutes before the hour shift.

After this, the plan can be altered during the hour of operation in accordance with the rules below.

Supportive power is exchanged between the *synchronous system* and Western Denmark in one direction only during each hour. The volume can increase or decrease during the hour of operation, but not more often than every 15 minutes.

After a decrease in the *supportive power* volume, the volume cannot increase again during the same hour. However, this does not apply to hour shifts if the agreed exchange during the coming hour is higher than the current volume.

Exchange of *supportive power* takes place in accordance with a power plan at 5 minutes' discontinuation. In the activation of *supportive power* during the hour of operation, a change in the power plan shall normally be carried out in a maximum of 15 minutes.

Exchanging information

The purpose of this Appendix is to describe the information which shall routinely be exchanged between the concerned *Parties* to an extent which is significant for the collaboration between the *Parties* in respect of system operation and balance management.

The technical description (network model, network data etc.) of the power system is governed by other agreements.

Information to be provided to the *players* on the electricity market is governed by the *system operators'* agreement vis-à-vis Nord Pool Spot.

1 Outage planning

Plans for outages having impact on the *transmission capacity* between the *subsystems* or which are in some other way significant for *system security* or the electricity market shall be exchanged and co-ordinated between the *Parties* concerned. Plans shall be advised for up to one year forward in time. Alterations to plans shall be advised as soon as possible.

The impact of such outages on the *transmission capacities* between the *subsystems* shall also be exchanged. Preliminary values shall be exchanged as early on as possible. Final values shall be exchanged immediately following approval of the capacities.

Outages having impact on the *transmission capacity* between the *subsystems* shall be entered in the joint Nordic outage planning system NOPS (Nordic Outage Planning System).

2 Prior to the hour of operation

Information which is to be routinely exchanged between the *Parties* prior to the hour of operation:

- Plans for the *transmission capacities* and *trading capacities* on the links between the *subsystems* on an hourly basis
- Current limitations within the *subsystems*
- Forecast of available *frequency controlled normal operation reserve*, *frequency controlled disturbance reserve* and *fast active disturbance reserve*
- Forecast of *dimensioning faults*

- Changes to the network configuration of significance to the *subsystems' system security* and the impact of these changes
- Changes to settings of regulation equipment and automatic systems
- Hourly *exchange plans* and *trading plans* between the *subsystems*
- Hourly *exchange plans* for non-Nordic links
- Hourly plans or forecasts regarding the overall production and consumption. Quarter-hourly plans for production shall be exchanged to the extent these are available.
- Plans for *counter trading* between the *subsystems*
- *Regulation bids.*

The joint Nordic information system NOIS (Nordic Operational Information System) shall be used for the exchange of information which is necessary in *balance regulation* (regulation bids, production plans and HVDC plans, consumption forecasts etc.).

3 During the hour of operation

Information which must routinely be available to the *Parties* during the hour of operation:

- Ongoing outages
- Authorization-dependent *transmission capacity* and parameters of significance in this regard (e.g. *system protection*)
- *Counter trading*/*special regulation* and other corresponding measures concerning the other *Parties*
- An account of events and disturbances of a major character, together with implemented measures
- Volume and duration of requested *load shedding* in the event of *power shortages.*

Measured values and status indications to be exchanged between the *Parties* during the hour of operation:

- Transmission of reactive and active power on the individual links, plus the sum of the active power between the *subsystems*
- Transmission of reactive and active power on the individual links, plus the sum of the active power to systems outside the Nordic power system provided that the counterparty approves of this
- Active power in critical *transmission constraints* within the *subsystems*
- Activated regulations and current prices for regulating imbalances upwards and downwards
- Area control errors
- Surpluses/deficits as defined in Appendix 9
- Overall production and consumption
- Production at power plants that are critical to the *interconnected Nordic power system's* operational situation

- *Frequency response* and available *frequency controlled normal operation reserve*, *frequency controlled disturbance reserve* and *fast active disturbance reserve*. If measured values are not available, forecasts shall be exchanged.
- Measurements that are needed for monitoring the stability of the power system.

4 Following the hour of operation

Information which must routinely be exchanged between the *Parties* following the hour of operation:

- Activated upward and/or downward regulation volume and *regulation prices*
- Reconciliation of previous calendar day's exchanges, *frequency response*, deals, prices etc, in accordance with the settlement routines
- Measured values on the links between the *subsystems* in accordance with other relevant agreements
- An account of events and disturbances, together with implemented and planned measures, to be rendered as soon as possible.

System protection

1 General

Automatic *system protection* is used to limit the impact of faults by means of measures over and above disconnecting the defective component. *System protection* can be used to increase the *system security*, the *transmission capacity,* or a combination of these. For *system protection* which is used to increase the *transmission capacity,* requirements have been set. These are specified in Appendix 2 of the System Operation Agreement.

Automatic *system protection* uses two different principles of operation. One of these is *system protection* that is activated via measurements of the system state, e.g. the voltage at a critical point or the system frequency. The other is *system protection* that is activated by predetermined events, e.g. one or more relay signals from the facilities' protective equipment.

Automatic *system protection* limits the consequences of operational disturbances in one or more of the following ways:

- regulation of DC facilities, *emergency power*
- production shedding or downward regulation of production
- load shedding and, in some cases, reactive shunts
- start-up of production
- network switchings.

Automatic *system protection* is adapted to the combined *operational reserves* of the *interconnected Nordic power system*. Frequency controlled functions are shown in Figure 1. A detailed description of the Figure can be found in the Nordel report ”Rekommandasjon for frekvens, tidsavvik, regulerstyrke og reserve” from August 1996. Minor frequency deviations are dealt with by the *frequency controlled disturbance reserve* on generators. Major frequency deviations start up regulation at the DC facilities. At lower frequencies, automatic *load shedding* starts up.

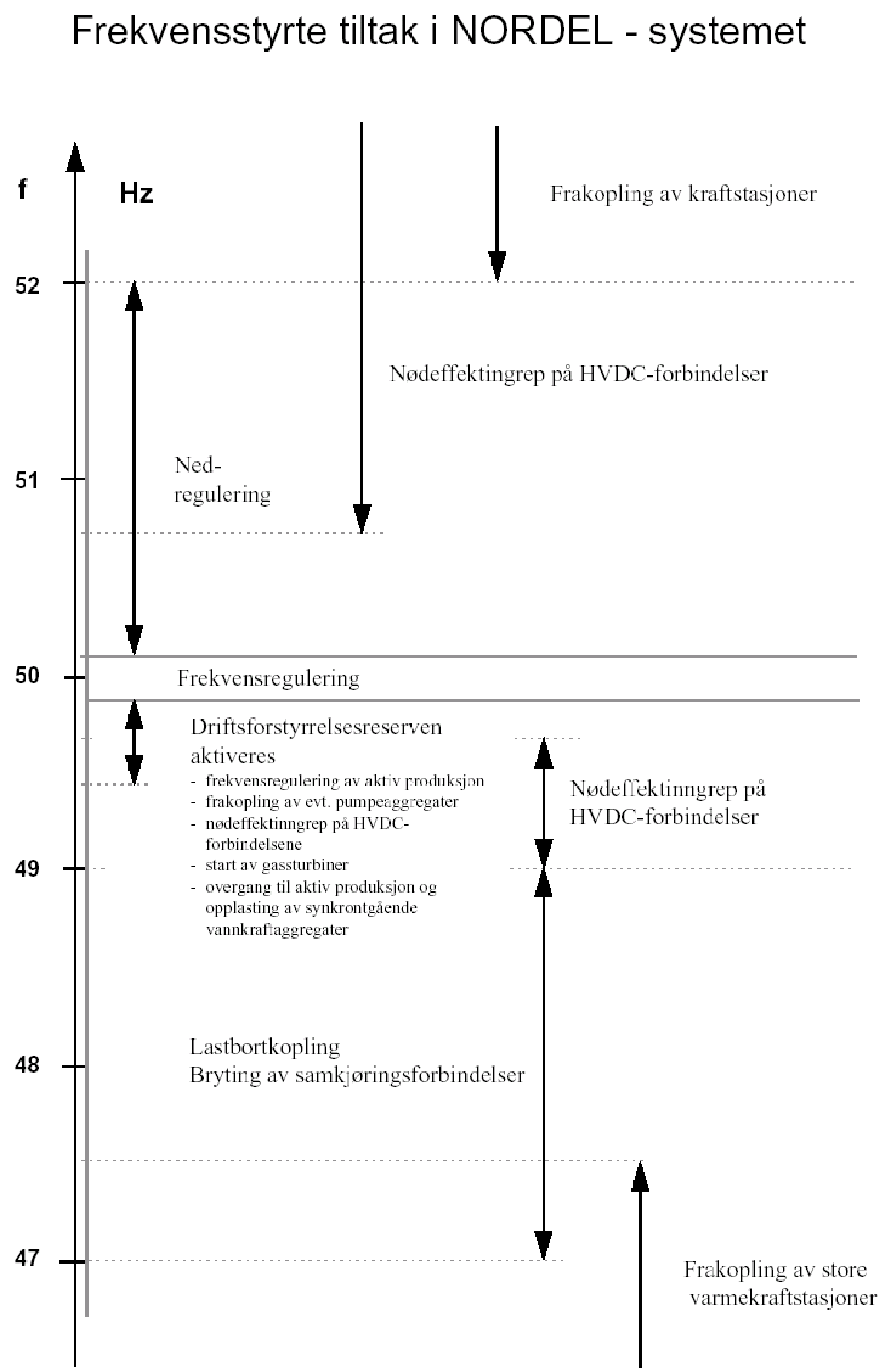
Frekvensstyrte tiltak i NORDEL - systemet
f
Hz
52
51
50
49
48
47
Frakopling av kraftstasjoner
Nødeffektingrep på HVDC-forbindelser
Ned-
regulering
Frekvensregulering
Driftsforstyrrelsesreserven
aktiveres
- frekvensregulering av aktiv produksjon
- frakopling av evt. pumpeaggregater
- nødeffektinngrep på HVDC-
forbindelsene
- start av gassturbiner
- overgang til aktiv produksjon og
opplasting av synkrontgående
vannkraftaggregater
Nødeffektinngrep på
HVDC-forbindelser
Lastbortkopling
Bryting av samkjøringsforbindelser
Frakopling av store
varmekraftstasjoner

Figure 1

2 System protection activated by frequency deviations

Frequency controlled *system protection* activated by a deviating frequency:

- regulation of DC facilities, *emergency power*
- *production shedding* or downward regulation of production, PFK
- start-up of production
- *load shedding*, AFK
- network switchings.

A low frequency during *operational disturbances* is traditionally dealt with using *frequency controlled disturbance reserve*.
Frequency controlled disturbance reserve is dimensioned to maintain the frequency within permissible limits in the event of *operational disturbances*. If this is not successful and the frequency continues to drop, *load shedding*, for instance, might curb the frequency drop. The increased use of frequency controlled regulation of DC installations, *emergency power*, is in order to prevent major frequency drops.

A high frequency is traditionally dealt with using the downward regulation of production or, in extreme situations, using *load shedding*. In this case too, there will be an increased use of the frequency controlled regulation of DC installations.

2.1 Frequency controlled regulation of DC installations, Emergency power

The maximum impact of regulation of DC installations during frequency drops can be seen in Figure 2. As illustrated by the Figure, all DC installations between *the synchronous system* and other AC systems contribute frequency controlled *emergency power*. It should be pointed out, however, that if a DC installation is performing a full import to a area with a low frequency, it will not be able to contribute *emergency power*.

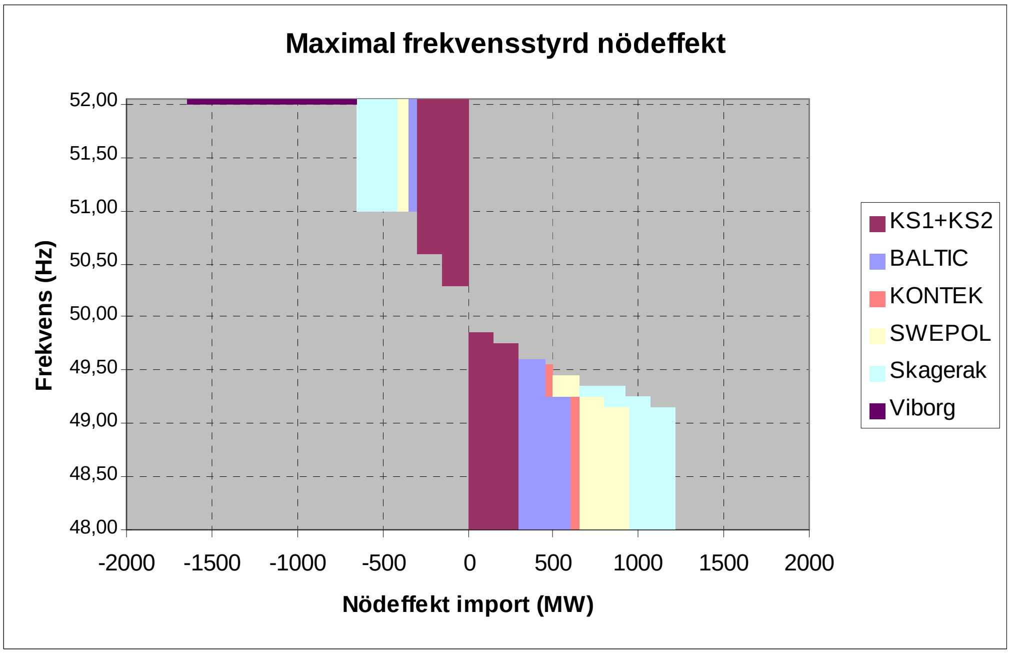

Figure 2

The Vyborg DC link is disconnected at a frequency in Finland of > 52 Hz for 0.5 sec.

2.2 Frequency controlled start-up of production

Automatic frequency controlled start-up of production is carried out in order to increase the number of production units in the power system during *operational disturbances*.

Hz	Denmark East	Denmark West	Norway	Sweden	Finland
49.8		25 MW GT			
49.7-49.5				520 MW GT in three stages of 0.1 Hz	180 MW GT, 15 sec
49.5					

Schedule 1

2.3 Frequency controlled load shedding

If a frequency drop cannot be curbed by the regulation of DC installations and the frequency continues to drop, automatic *load shedding* will occur. This will take place in accordance with Schedule 2:

Denmark	East	10 % of consump. f<48.5 Hz momentary, f<48.7 Hz 20 sec. 10 % of consump. f<48.3 Hz momentary, f<48.5 Hz 20 sec. 10 % of consump. f<48.1 Hz momentary, f<48.3 Hz 20 sec. 10 % of consump. f<47.9 Hz momentary, f<48.1 Hz 20 sec. 10 % of consump. f<47.7 Hz momentary, f<47.9 Hz 20 sec.
	West	15 % of consump. f<48.7 25 % of consump. f<47.7
Norway		7,000 MW* in stages from 49.0 Hz to 47.0 Hz
Sweden	South of constraint 2	electrical boilers and heat pumps P ≥ 35 MW. f< 49.4 for 0.15 sec 35>P ≥ 25 MW. f< 49.3 for 0.15 sec 25>P ≥ 15 MW. f< 49.2 for 0.15 sec

	15>P ≥ 5 MW. f< 49.1 for 0.15 sec 30 % of consump in 5 stages stage 1. f< 48.8 for 0.15 sec stage 2. f< 48.6 for 0.15 sec stage 3. f< 48.4 for 0.15 sec stage 4. f< 48.2 for 0.15 sec. f<48.6 for 15 sec stage 5. f< 48.0 for 0.15 sec. f>48.4 for 20 sec
Finland	10 % of consump. f<48.5 Hz 0.15 sec. f<48.7 Hz 20 sec 10 % of consump. f<48.3 Hz 0.15 sec. f<48.5 Hz 20 sec

Schedule 2

* For Norway, this refers to peak loads.

2.4 Frequency controlled disconnection of lines

Denmark East	Disconnection of the Swedish link at f<47.0 Hz for 0.5 sec or f<47.5 for 9 sec
West	-
Norway	-
Sweden	-
Finland	Disconnection of Vyborg DC link at a frequency in Finland of >52 Hz for 0.5 sec Disconnection of northern AC links to Sweden at a frequency of > 50.7 for 2 sec if imports from Sweden are > 900 MW and the voltage on the 400 kV network is < 380 kV.

3 System protection activated by voltage deviations

In Sweden, there are two important types of *system protection* which are controlled by voltage. Both types of *system protection* regulate down exports to the continent on HVDC links in the event of a risk of voltage collapse or overloads on important lines.

3.1 System protection in Sweden constraint 2

The *System protection* that is to relieve constraint 2 during *operational disturbances* measures the voltage at 4 stations north of constraint 2; Storfinnforsen, Kilforsen, Stornorrfors, and Hjälta. When the voltage has been lower than 390 kV for 2 seconds, a signal will be sent to the *system protection*. If the voltage has been low in at least two of the stations, the *system protection* will send a signal to Fenno-Skan (*emergency power* 400 MW) and Konti-Skan 2 (*emergency power* 100 MW).

3.2 System protection in Sweden constraint 4

The *System protection* will regulate down the transmissions on three DC links to the continent when the voltage in southern Sweden falls below 390 kV. In doing so, constraint 4 will be relieved immediately in the event of an *operational disturbance*. When *system protection* is in operation, a higher level of transmission will be allowed in constraint 4 (2/3 of the *emergency power* intervention). The increased capacity in constraint 4 may only be used when consumption south of constraint 4 is less than 4,500 MW.

System protection obtains measured values from 6 substations: Breared, Hallsberg, Hjälta, Kilanda, Tenhult and Sege. When *system protection* is in operation, a higher level of transmission will be allowed in constraint 4. The increase will accrue on the respective overseas interconnector, Baltic Cable, the SwePol link and Öresund connection.

The criterion for the activation signal of *system protection* is that the voltage in one of these six points goes under 390 kV for 4 seconds. Upon activation, there will be a power change of 200 MW northbound for Baltic Cable (BC emergency power control entry 3), 250 MW northbound for Kontek, and 300 MW northbound for the SwePol Link (SwePol emergency power control entry 4). For the SwePol Link to become activated, it is also necessary that the voltage at Stärnö is lower than 415 kV.

3.3 System protection in southern Norway

In Norway, there is *system protection*, which is voltage-controlled. The Skagerrak cables have *emergency power* regulation which is controlled by local voltage measurements at Kristiansand. A low voltage of 275 and 270 kV will provide 200+200 MW of relief.

3.4 System protection in Finland

In Finland, there is *system protection* which is controlled by voltage and the transmission between Sweden and Finland at the critical *transmission constraint* in Finland (north - south). The s*ystem protection* uses *emergency power* regulation with automated systems on the HVDC Fenno-Skan link. The *system protection* provides a power change of 200 or 400 MW to Finland.

The four types of *system protection* are shown in Figure 3.

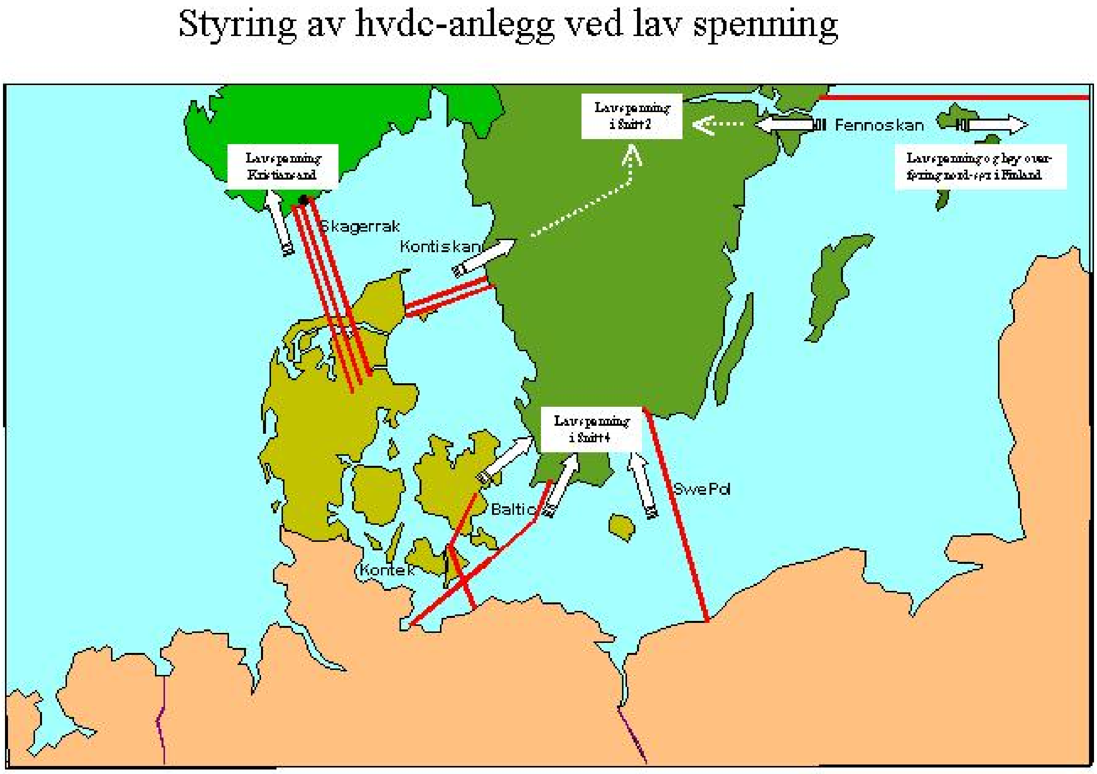

Figure 3

4 System protection activated by one or more relay signals from the facilities' protective equipment

System protection activated by relay signals is often more complicated and the protection often controls facilities a long way from the relays. Figure 4 shows an overview of *system protection* for *load shedding* and/or control of the HVDC links. Figure 5 shows an overview of *system protection* for *load shedding* and/or network division.

The Figures are followed by a description of the *system protection.*

Systemvern for produksjonsfrakobling eller styring av hvdc

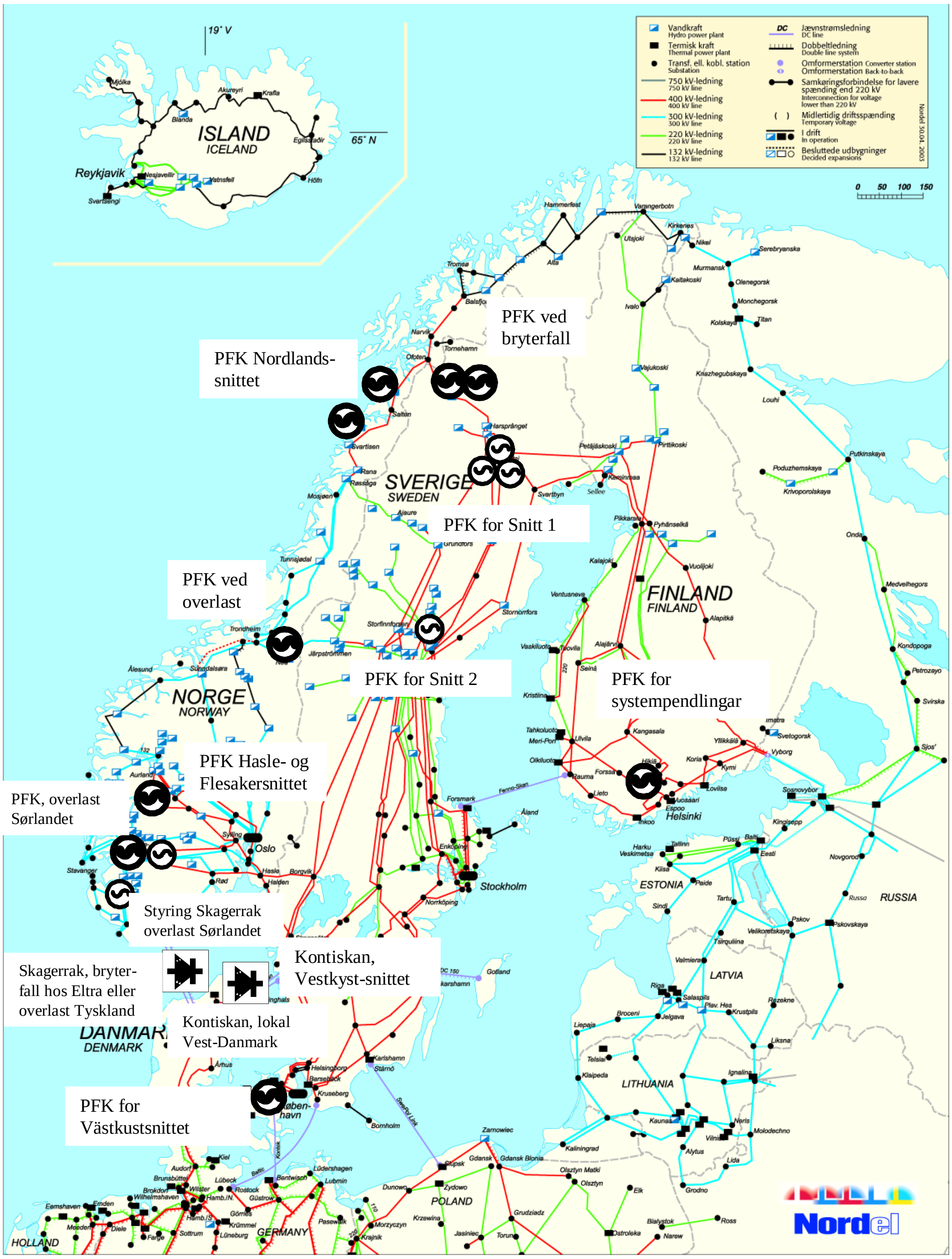

Figure 4

Systemvern for lastfrakobling eller nettdeling

Figure 5

4.1 Eastern Denmark: System protection for stability in Eastern Denmark

Disconnection of gas turbines and downward regulation of the steam turbine at unit 2 of the Avedøre plant upon activation of certain breakers on the 400 kV network in Zealand. This *system protection* is only activated during operational situations when critical 400 kV network components are disconnected or during high export volumes towards Sweden.

4.2 Sweden: System protection with production shedding for limiting overloads on lines in Sweden

Shedding of hydropower production in northern Sweden via remotely-transmitted signals from activated protection functions. Extent of approx. 1,600 MW of installed power. Upon disconnection of lines in constraint 1, there is a risk that other lines will become overloaded. The *system protection* will disconnect production so that the lines will be relieved. The signals originate from Grundfors, Betåsen, and Hjälta and are sent to stations northwards. The setting of the automated equipment is adapted to the state of operation.
The *system protection* also includes a link with Norway so that the loss of a link between Porjus and Ofoten will lead to *load shedding* in northern Norway.

4.3 Sweden: System protection in the West Coast constraint (Kilanda-Horred + Stenkullen-Strömma)

During imports from Germany, Zealand and Jutland and a high level of production at Ringhals, simultaneous to exports towards Norway, there is a risk of overloads on the remaining line in the event of a long-term fault on one of the lines.
The *system protection* will work as follows:
- In the event of losing Kilanda-Horred <u>and</u> transmission of more than 500 MW northbound on the line, this will result in a power change of 350 MW on Konti-Skan 2 towards Western Denmark.
- In the event of losing Stenkullen-Strömma <u>and</u> transmissions of more than 500 MW northbound on the line, this will result in a power change of 350 MW on Konti-Skan 2 towards Western Denmark.
- In the event of losing Kilanda-Stenkullen <u>and</u> transmissions of more than 500 MW northbound on the line, this will result in a power change of 350 MW on Konti-Skan 2 towards Western Denmark.

These *system protections* do not provide increased capacity, rather they increase the *system security*.

During exports to Jutland, there is a risk that the regional network around Gothenburg will be overloaded in the event of a long–term fault on the Strömma-Lindome line. The *system protection* will function as follows:
In the event of losing Strömma-Lindome, Konti-Skan 2 will be regulated down to 0 if there are exports on the link.
In addition to *system protection*, there is “last line” protection which disconnects Konti-Skan 1 in the event of losing line Strömma-Lindome.

Extended *system protection*:
This protection disconnects ”production” in Zealand through *production shedding*. This will reduce the imports from Zealand which will relieve the West Coast constraint and provide increased system security. The activation of ”production” in Zealand by the s*ystem protection* will be taken, following agreement between the *Parties* concerned, into and out of operation on the basis of the operational situation.

4.4 Sweden: System protection Forsmark

In the event of a stoppage on either of the lines Forsmark-Odensala (FL4) or Tuna-Hagby, the transformer at Tuna risks becoming overloaded if a fault arises on the remaining line.
The *system protection* will go into operation in the event of a stoppage on one of the mentioned lines. The *system protection* will regulate down the production at Forsmark to unload the transformer.
The *system protection* will work as follows:
- In the event of losing Forsmark-Odensala (FL4) or Tuna-Hagby, G12 will be regulated down if Forsmark G11, G12 and G21 or G22 are in operation, <u>and</u>:
- in the event of losing Forsmark-Odensala (FL4) or Tuna-Hagby, G22 will be regulated down if Forsmark G21, G22 and G11 or G12 are in operation.

4.5 Sweden: System protection Långbjörn

Production at Ångermanälven is fed out via transformations at Långbjörn and Betåsen. In the event of losing a transformation, there is a risk that the other will become overloaded. The *system protection* at Långbjörn will disconnect the Långbjörn-Korsselbränna-Stalon line or line Linnvasselv-Blåsjön-Junsterforsen-Gäddede-Bågede-Långbjörn with its connected production when the link between Kilforsen and Långbjörn is broken.

4.6 Sweden: System protection Sege

System protection is normally not in use, but it will be taken into use with either a planned or unplanned outage of either line Alvesta-Sege or line Sege-Barsebäck.
In the event of a relay protection function which disconnects the remaining line in Sege, system protection activates the disconnection of Baltic Cable. System protection is activated irrespective of the direction of transmissions on Baltic Cable.

4.7 Norway: System protection in the Hasle and Flesaker constraint

During high export levels from southern Norway to Sweden, there is a risk that the loss of a line can bring about overload, voltage or stability problems. In the event of critical losses, the *system protection* must relieve the constraints by means of automatic *production shedding* at Kvilldal, Sima, Aurland, Tonstad, Tokke and/or Vinje. The maximum permissible *production shedding* is 1,200 MW and activation will occur as a result of the following events:

Loss of Hasle-Borgvik, Tegneby-Hasle, Rød-Hasle, Hasle-Halden, Halden-Skogssäter, Kvilldal-Sylling and Sylling-Tegneby. During these events, the *system protection* has redundancy when measuring high power levels on Hasle-Borgvik, Hasle-Halden, 300 kV Tegneby-Hasle, 300 kV Flesaker-Tegneby and 300 kV Flesaker-Sylling. The *system protection's* setting will depend on the operational situation.

4.8 Norway: System protection in the Nordland constraint

In the event of a large power surplus in northern and central Norway, there is a risk of *network collapse* in the event of losing critical lines. The *system protection* must rapidly relieve the constraint by means of automatic *production shedding* or through network division so that the *surplus area* is separated from the rest of the *synchronous system*. The largest permissible *production shedding* is 1,200 MW.
The *system protection* will be activated by the following events:
- The loss of Ofoten-Ritsem, Ritsem-Vietas, Vietas-Porjus, Ofoten-Kobbelv or Svartisen-N.Røssåga.
- High levels of current on 300 kV Tunnsjødal-Verdal, 300 kV Tunnsjødal-Namsos or 300 kV Nea-Järpströmmen.

The *system protection's* setting will depend on the operational situation and can result in *production shedding* at Vietas, Ritsem, Kobbelv and/or Svartisen. Loss of the lines Ofoten-Ritsem-Vietas-Porjus might also lead to network division south of Kobbelv. The *system protection* is also described under point 4.2.

4.9 Norway: Local system protection at Kvilldal

Automatic *load shedding* at Kvilldal when the loss of a line entails high levels of transmission westbound (towards Saurdal).

4.10 Norway: Network division in southern Norway

Automated systems that establish separate operation for the southern Norway area during simultaneous stoppages on both the links between southern Norway and Sweden.

4.11 Norway: System protection for load shedding

System protection which disconnects up to 220 MW of industrial load in the event of the loss of one or both 300 kV lines in the Sauda constraint which supplies Bergen and important industrial centres in Vestlandet.
System protection which disconnects 150 MW or 400 MW of industrial load in the event of the loss of one or two 300 kV lines adjacent to Møre or in the event of loss of lines which entails a low voltage or overload on the Nea-Järpströmmen line. The network supplies general consumption and important industrial centres in Nord-Vestlandet.
System protection which disconnects up to 110 MW of industrial load in the event of losing the 420 kV lines north of Ofoten. The *system protection* will prevent overloads in the parallel 132 kV network which might otherwise lead to a collapse in the most northerly part of Norway.

4.12 Norway: System protection at Sørlandsnittet (PFK and HVDC control)

During abundant exports from Southern Norway to Denmark and with simultaneous low local production, there is a risk of loss of a line, which can lead to overload or voltage problems. During a critical loss of a line, the *system protection* will relieve the constraint through automatic downward regulation of the Skagerrak HVDC line. The *system protection* measures overload on the 300 kV lines at 4 stations. The *system protection* regulates 400 MW of exports down on Pole 3 during 1 sec.

During abundant imports to Southern Norway from Denmark and with simultaneous high local production, there is a risk of loss of a line, which can lead to overload or voltage problems. During a critical loss of a line, the *system protection* will relieve the constraint through automatic downward regulation of the Skagerrak HVDC line or PFK at Tonstad. The *system protection* measures overload on the 300 kV lines at 3 stations. The *system protection* regulates 300 MW of imports down on Pole 3 during 1 sec and/or regulates production down at the Tonstad power plant (4 x 160 MW available).

4.13 Western Denmark: Konti-Skan pole 2

The *system protection* on Konti-Skan 2 will be activated at a load of over 80 % of the 400 kV transformer at the Nordjylland plant (NVV3+NNV5) (see point 1 in Figure 6). Transmissions on pole 2 will be reduced until the load is once again under 80 % of the transformer (30 MW per sec.).

The *system protection* is used to increase the import capacity from Sweden (load flow).

4.14 Western Denmark: Skagerrak pole 3

In the event of a disconnection of the 400 kV line Tjele – Askaer and the 400 kV line Askaer - Revsing - Kassö, imports are reduced from Skagerrak pole 3 to 50 MW.

The *system protection* is not used to increase the import capacity from Norway, only to protect the HVDC station.

4.15 Western Denmark: the German link

In the event of loads on the links to Germany in excess of 120 % for more than 15 seconds, the remote control system will automatically commence downward regulation of the HVDC links. Regulation will be terminated when transmissions are normal again or when maximum regulation has been reached. The function allows a maximum of 200 MW on Skagerrak poles 1, 2 and 3 as well as 150 MW on each of the Konti-Skan poles.

4.16 Finland: Frequency regulation (during island operation) with automated systems on the HVDC Fenno-Skan link

The *system protection* can be used when the northern AC network between Rauma and Dannebo is broken. This can control the frequency of the potential island network in Finland.

4.17 Finland: Power modulation for Fenno-Skan (Power modulation control)

The *system protection* can be used to attenuate large power oscillations between the countries. Uses the frequency difference between Sweden and Finland as a signal and modulates the power ± 100 MW.

4.18 Finland: Network division in northern Finland to protect the 110 kV network from overloads

The *system protection* sections the line Vajukoski-Meltaus 110kV when the power on the line is over 100 MW for 0.2 seconds.

4.19 Finland: System protection for avoiding system oscillations

The *system protection* is used to increase the capacity in the north towards Sweden. In certain fault scenarios, with large transmission levels, there is a risk of system oscillations. *System protection* relieves transmissions by means of *production shedding* in southern Finland. *Production shedding* is activated by means of remotely-transmitted signals from activated protection functions. Extent approx. 900 MW. The *system protection* is activated automatically depending on the operational situation. The Power System Centre in Helsinki can put *system protection* into/out of operation using the remote control system, depending on the transmission situation.

System services

System services is a generic term for services that the *system operators* need for the technical operation of the power system. The availability of *system services* is agreed upon between the *system operator* and the other companies within the respective *subsystem*.

1 Survey of system services

1.1 System services defined in Appendix 2 of the System Operation Agreement

1.1.1 Frequency controlled normal operation reserve

Activated automatically within a ± 0.1 Hz deviation and shall be regulated out within 2-3 minutes. The joint requirement for the *synchronous system* is 600 MW. This means a joint requirement for *frequency response* in the *synchronous system* of 6,000 MW/Hz. This service can be exchanged to a certain degree. Each *subsystem* shall have at least 2/3 of the *frequency controlled normal operation reserve* within its own system in the event of splitting up and island operation. A major exchange of the service between the *subsystems* can require a greater need for *regulating margin* (the difference between the *transmission* and *trading capacities*). Elspot exchanges and joint Nordic *balance regulation* take priority over the exchange of *automatic active reserve*. Thus, the exchange of this service is agreed after the Elspot has closed.

TSO	Generation of system service	Exchange between subsystems
Energinet.dk East	Droop control at thermal power plants.	Yes
Energinet.dk West	No requirement regarding frequency controlled normal operation reserve from UCTE.	
Fingrid	Measured droop control at hydropower and thermal power plants. DC link towards Russia.	Yes Yes
Statnett	% turbine opening/Hz in hydropower.	Yes
Svenska Kraftnät	% turbine opening/Hz in hydropower.	Yes

1.1.2 Frequency controlled disturbance reserve

Activated automatically at 49.9 Hz and fully activated at 49.5 Hz. At least 50 % shall be regulated out within 5 sec and 100 % within 30 sec. Joint requirement for the *interconnected Nordic power system* is approx 1,000 MW, depending on the relevant *dimensioning fault.*

The service is closely linked to *frequency controlled normal operation reserve*, and the principle of exchange is the same.

TSO	**Generation of system service**	**Exchange between subsystems**
Energinet.dk East	Disconnection of district heating. Turbine opening at thermal power plants. Droop control from thermal power plants. HVDC interventions.	Yes
Energinet.dk West	Condensate stoppage at thermal power plants. Droop control (modified gliding pressure) at thermal power plants.	No (only exchanged between Energinet.dk West and UCTE)
Fingrid	Droop control at hydropower and thermal power plants. Sheddable load.	Yes Yes
Statnett	% turbine opening/Hz in hydropower. HVDC interventions, in stages depending on freq	Yes
Svenska Kraftnät	% turbine opening/Hz in hydropower. HVDC interventions, in stages depending on freq. Automatic start-up of gas turbines, in stages depending on freq. Some with 5 sec start-up delay.	Yes

1.1.3 Voltage controlled disturbance reserve

This service becomes relevant when low voltage activates *emergency power* on HVDC links out from the *synchronous system.* The service is applicable to exchanges.

TSO	**Generation of system service**	**Exchange between subsystems**
Energinet.dk East	Not used.	
Energinet.dk West	Not used.	
Fingrid	Not used.	
Statnett	Emergency power Skagerrak.	Yes
Svenska Kraftnät	Automatic export restriction on DC links south of constraint 4 in Sweden. SwePol Link, Baltic Cable and Kontek (Zealand).	Yes

1.1.4 Fast active disturbance reserve

This service restores *frequency controlled disturbance reserve* and shall be activated within 15 minutes.
This service can be exchanged between the *subsystems* of the joint Nordic *regulation market* or as *supportive power.* However, in the event of *power shortages,* Appendix 9 comes into force.

TSO	**Generation of system service**	**Exchange between subsystems**
Energinet. dk East	Contract with producer. Gas turbines, upward regulation of rolling reserve, fast-start thermal power plants.	Yes
Energinet. dk West	Contract with producer, bids can be made via regulation market.	Yes
Fingrid	Gas turbines. Sheddable load. Russian DC link.	Yes Yes Yes
Statnett	Contracted regulating power: Options market for regulating power (production and consumption). Voluntary bids on regulation market.	Yes Yes
Svenska Kraftnät	Requirement for producers to report to SvK, gas turbines and hydropower.	Yes

1.1.5 Slow active disturbance reserve

Requirements for each *system operator* to comply with will depend on national legislation. Activation is slower than 15 minutes. The service is not yet relevant to exchanges between the *subsystems*. However, in the event of *power shortages,* Appendix 9 comes into force.

TSO	**Generation of system service**	**Exchange between subsystems**
Energinet. dk East	Thermal power plants with a start-up time of up to 4 hours and rearrangement of production types at thermal power plants.	
Energinet. dk West	There are no plants with a start-up time of < 4 hours.	
Fingrid	Power available after 15 minutes, market is responsible.	No
Statnett	Not used	
Svenska Kraftnät	Most frequently replaced by a surplus of fast active disturbance reserve.	No

1.1.6 Reactive reserve

Reactive reserve is of a local nature. Consequently, it cannot be exchanged between the *subsystems.*

TSO	Generation of system service	Exchange between subsystems
Energinet. dk East	Over/under magnetization of production plants. Synchronous condenser operation in one generator. Connection/disconnection of capacitor batteries and reactors.	No
Energinet. dk West	Over/under magnetization of central production plants. Change of Mvar production at power plants. Synchronous condensers at Tjele and Vester Hassing. Connection/disconnection of capacitors. Connection/disconnection of reactors.	No
Fingrid	Over/under magnetization of production plants. Synchronous condenser operation at certain hydropower plants. Connection/disconnection of power lines. Connection/disconnection of capacitor batteries and reactor.	No No No No
Statnett	Over/under magnetization of production plants. Connection/disconnection of power lines. Connection/disconnection of capacitor batteries. Static phase compensation (SVC plants).	No
Svenska Kraftnät	Over/under magnetization of production plants. Connection/disconnection of power lines. Connection/disconnection of capacitor batteries, reactors. Static phase compensation (SVC plants).	No

[1]) Payment for production of reactive power in generators outside certain limits for tanφ.

1.2 System services not defined in Appendix 2 of the System Operation Agreement

1.2.1 Load following

Load following entails that *players* with major production changes report production plans with a resolution of 15 minutes. *Load following* with a quarter-hourly resolution improves the quality of the frequency of the *synchronous system*. This service can be exchanged between the *subsystems*.

TSO	Generation of system service	Exchange between subsystems
Energinet. dk East	Not used.	
Energinet. dk West	Production balance centres with variable production deliver running schedules with a resolution of 5 min.	Partly, 5 min and 15 min. plans are sent to other TSOs
Fingrid	Hour shift regulation. Balance centres inform Fingrid about hours containing more than 100 MW of changes in their balance.	Yes[1]
Statnett	Players with major production changes make their production plans using a quarter-hourly resolution. Statnett can move planned production changes for all players by up to 15 minutes.	Yes[1] Yes[1]
Svenska Kraftnät	Players report production plans with a quarter-hourly resolution to SvK. SvK has the right to move production by at least a quarter of an hour.	Yes[1]

[1]) Quarter hourly regulation improves the quality of the frequency throughout the synchronous system.

1.2.2 System protection

The service is exchanged to some degree today. It is imaginable that the Nordic power system will become more integrated in the future. Then, events in one *subsystem* will be able to activate *system protection* in another *subsystem*.

TSO	Generation of system service	Exchange between subsystems
Energinet. dk East	Automatic downward regulation and/or disconnection of power plants and/or KONTEK, automatic upward regulation of KONTEK. Specified in App. 5.	No
Energinet. dk West	Emergency power on Kontiskan and Skagerrak. Downward regulation of Kontiskan in the event of an overload on transformers. Downward regulation of Skagerrak 3 upon the loss of some 400 kV lines (downward regulation in respect of voltage quality).	Yes
Fingrid	Automatic production shedding. Network division. Specified in App 5.	No
Statnett	Automatic disconnection of power plants and smelting works. Emergency power on Skagerrak.	Yes Yes
Svenska Kraftnät	Automatic downward regulation of SwePol link, Baltic Cable and Kontek.	Yes

1.2.3 Black starts

This service is of a local nature. Consequently, it cannot be exchanged between the *subsystems*.

TSO	**Generation of system service**	**Exchange between subsystems**
Energinet. dk East	Diesel generator and/or gas turbines.	No
Energinet. dk West	2 gas turbines.	No
Fingrid	Some hydropower plants and gas turbines.	No
Statnett	Some selected hydropower plants.	No
Svenska Kraftnät	Some selected hydropower plants.	No

1.2.4 Automatic load shedding

This service is relevant during major *operational disturbances*. The *subsystems* will then hardly be interconnected and the service will not be relevant to exchanges.

TSO	**Generation of system service**	**Exchange between subsystems**
Energinet. dk East	Frequency controlled load shedding and disconnection of links between Sweden and Zealand. Specified in App. 5.	No
Energinet. dk West	Load shedding. Link with Germany is not disconnected. Load shedding between 48.7 Hz and 47.7 Hz.	No
Fingrid	Automatic load shedding between 48.7 Hz – 48.3 Hz.	No
Statnett	Automatic load shedding between 49.0 Hz – 47.0 Hz.	No
Svenska Kraftnät	Automatic load shedding between 48.8Hz – 48.0 Hz.	No

1.2.5 Manual load shedding

This service is used during major *operational disturbances* and *power shortages* and cannot be exchanged between the *subsystems*. This is regulated by Appendix 9.

TSO	**Generation of system service**	**Exchange between subsystems**
Energinet. dk East	The load can be shed to eliminate non-approved transmissions on the network, for managing power shortages, during island operation and when automatic shedding has not been sufficient.	No
Energinet. dk West	The load can be shed to eliminate non-approved transmissions on the network, for managing power shortages, during island operation and when automatic shedding has not been sufficient.	No
Fingrid	Sheddable load used as fast active disturbance reserve, can also be used during power shortages when only 600 MW of fast active disturbance reserve remains in the synchronous system.	No
Statnett	Used during power shortages when only 600 MW of fast active disturbance reserve remains in the synchronous system.	No[1]

Svenska Kraftnät	Used during power shortages when only 600 MW of fast active disturbance reserve remains in the synchronous system.	No

[1]) No particular compensation is paid to the players. However, when the service is activated, Statnett will obtain the CENS (Compensation for Energy Not Supplied) liability, entailing a reduction of the revenue limit.

1.2.6 Fast active forecast reserve

This service restores the *frequency controlled normal operation reserve*. Using this, deviations in consumption and/or production forecasts are adjusted. Requirements for each *system operator* to comply with will depend on national legislation. Activation time is 10-15 min.
The service is exchanged between the *subsystems* in the joint Nordic *regulation market* as voluntary or contracted *regulation power*, but in the event of *power shortages,* Appendix 9 will come into force.

TSO	Generation of system service	Exchange between subsystems
Energinet.dk East	Contract with producers regarding bids (as bids in the regulation market).	Yes
Energinet.dk West	Contract with producers regarding minimum bids (as bids in the regulation market). Voluntary bids in the regulation market.	Yes Yes
Fingrid	Voluntary bids in the regulation market.	Yes
Statnett	Contracted regulation power: Options market for regulation power (production and consumption). Voluntary bids in the regulation market.	Yes Yes
Svenska Kraftnät	Voluntary bids in the balance regulation (secondary regulation).	Yes

1.2.7 Fast active counter trading reserve

Requirements for each *system operator* to comply with will depend on national legislation. The service can be exchanged between the *subsystems* during the *operational phase*.

TSO	Generation of system service	Exchange between subsystems
Energinet.dk East	Particular purchases from producers.	
Energinet.dk West	Particular purchases from producers and bids in the regulation market can be used.	Yes
Fingrid	Voluntary bids in the regulation market can be used.	Yes
Statnett	Contracted regulation power: Options market for regulation power (production and consumption). Voluntary bids in the regulation power market.	Yes Yes
Svenska Kraftnät	Voluntary bids in the balance regulation (secondary regulation).	Yes

1.2.8 Peak load resource

Requirements for each *system operator* to comply with will depend on national legislation.

By *peak load resource* is meant active reserve which is not normally used. For anticipated peak load periods, the preparedness time is reduced so that the capacity, as and when needed, can be used. The service can be exchanged between the *subsystems* in the joint Nordic *regulation market*. However, in the event of *power shortages,* Appendix 9 will come into force.

TSO	**Generation of system service**	**Exchange between subsystems**
Energinet.dk East	Not used.	
Energinet.dk West	Not used.	
Fingrid	Not used.	
Statnett	Not used.	
Svenska Kraftnät	Being procured.	

2 Description of routines for trading in system services

2.1 General

Trading in *system services* shall not be an obstacle to either *Elspot trading* or *balance regulation*.

2.2 Trading in frequency controlled normal operation reserve and frequency controlled disturbance reserve

Trading in *frequency response* can be simultaneously trading in *frequency controlled normal operation reserve* and *frequency controlled disturbance reserve* depending on how the individual services are acquired in the separate *subsystems*.

During conversion between the *frequency response*, *frequency controlled normal operation reserve* and *frequency controlled disturbance reserve,* the following conversion table is to be used, unless otherwise agreed:

Frequency response	Frequency controlled normal operation reserve	Frequency controlled disturbance reserve
10 MW	1 MW	1.5 MW

System operators can inform each other on a daily basis after the Elspot has closed regarding surpluses of *frequency response* that can be offered to the other *system operators*.

System operators that have a need to purchase can contact the relevant *system operator* to obtain information on prices and volumes.

When the total purchasing requirement is larger than the supply, distribution shall take place on the basis of the basic requirement for the *frequency controlled normal operation reserve and frequency controlled disturbance reserve*.

Trading is carried out bilaterally between *system operators*.

If trading involves transit transmission through a *subsystem*, the *system operator* in whose network the transit transmission will take place shall be informed before making the agreement.

In the event of selling to several *system operators,* all will pay the same price, the marginal price.

2.3 Exchanges using other types of reserves

Services linked to the joint Nordic *regulation market* are described in Appendix 3.

Joint operation between the Norwegian and Swedish subsystems on the AC links

1 Background

The *subsystems* of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected. The *subsystem* of Western Denmark is connected to Norway and Sweden using DC links. This Appendix describes the operation of the AC links between the *subsystems* of Sweden and Norway.

2 Transmission facilities linking the subsystems of Sweden-Norway

2.1 Transmission facilities which are owned/held by system operators at both ends

Facility	**Voltage kV**	**Settlement point**	**Remarks**
Ofoten-Ritsem	400	Ritsem	
N.Rössåga-Gejmån-Ajaure	220	Gejmån, Ajaure	
Nea-Järpströmmen	300	Nea	
Hasle-Borgvik	400	Hasle	Included in Hasle constraint
Halden-Skogssäter	400	Halden	Included in Hasle constraint

2.2 Other transmission facilities

Sildvik-Tornehamn	130	Tornehamn	Vattenfall owner on Swedish side

2.3 Other transmission facilities than those under 2.2

Eidskog-Charlottenberg	130	Charlottenberg	Fortum owner on Swedish side

This *transmission facility* is not included in the grid on the Swedish side. The *trading capacity* of the link is submitted to Nord Pool by Statnett on the Norwegian side and by Fortum on the Swedish side.

3 Electrical safety for facilities under 2.1

3.1 General

The common ground for the electrical safety work of the *system operator* companies within Nordel is constituted by the European standard for managing electrical high-voltage facilities EN 50 110 which governs the organisation and working methods. In addition to the standard, there are national regulations and special instructions which entail certain mutual differences between the *system operators* as regards dealing with operational issues from an electrical safety point of view.

3.2 Responsibility for electrical operation/Operational management

Responsible for the electrical operation of the facility on the Swedish side is Svenska Kraftnät, while on the Norwegian side it is Statnett. The *power operation responsibility boundaries* for electrical operation for facilities under 2.1 lie at the national border between Sweden and Norway.

3.3 Switching responsible operator

For each of the cross-border links, there is a specific switching agreement between the parties.

Line	Norway	Sweden
Ofoten-Ritsem	Regional Centre at Alta	Operations Centre at Sollefteå (DCSO)
N.Rössåga-Gejmån-Ajaure	Regional Centre at Sunndalsöra	Operations Centre at Sollefteå (DCSO)
Nea-Järpströmmen	Regional Centre at Sunndalsöra	Operations Centre at Sollefteå (DCSO)
Hasle-Borgvik	Regional Centre in Oslo	Operations Centre at Råcksta (DCRÅ)
Halden-Skogssäter	Regional Centre in Oslo	Operations Centre at Råcksta (DCRÅ)

3.4 Operations monitoring and control in respect of electrical safety

Same *Parties* as under 3.3.

3.5 Switching schedule

Switchings on the links are carried out in accordance with a switching schedule drawn up by Svenska Kraftnät. Before the work begins, the Operations Centres shall confirm that the link is grounded and secured against switching on by exchanging switching confirmations.

3.6 Disturbance management

3.6.1 Cross-border link trips – management

During *operational disturbances*, measures in accordance with issued instructions shall as soon as possible restore the link to *normal state*.

3.6.2 Switching schedule

In the event of faults needing switchings which will affect the *cross-border link,* Statnett and Svenska Kraftnät are to be informed before any switchings are made. In the case of switchings on the Swedish grid, switching schedules are to be drawn up by Svenska Kraftnät.

3.6.3 Fault finding

Initial fault finding will be carried out differently from case to case. Generally speaking, the respective facility owner will be responsible for fault finding in consultation with the switching responsible operator.

3.6.4 Fault clearance, remaining faults

Once the fault has been localized, the respective facility owner will attend to clearing the fault.

4 System operation for facilities under 2.1 and 2.2

4.1 Transmission capacity (TTC)

The *transmission capacity* of the links is as follows, in MW.

Line	-20 °C	-10°C	0°C	10°C	20°C	30°C	Total to Sweden	Total to Norway
Sildvik – Tornehamn (to Sweden)	120	120	120	120	120	100	Approx 900-1,300	Approx 700-1,100
Sildvik – Tornehamn (from Sweden)	70	70	70	70	70	70		
Ofoten – Ritsem	1,350	1,350	1,350	1,350	1,170	880		
N.Rössåga - Gejmån – Ajaure	536	496	451	398	334	250		
Nea – Järpströmmen	730	690	650	610	550	500		
Hasle –Borgvik	2,100	2,000	1,900	1,780	1,650	1,510	See below	See below
Halden – Skogssäter	3,070	2,900	2,700	2,490	2,260	2,000		

The *transmission capacity* is limited by defined *transmission constraints*, stability conditions or similar. The *transmission capacity* thus varies in accordance with how it is distributed between the links.

- To Norway in the Hasle constraint: The *transmission capacity* is dependent on the temperature as follows (at temperatures below 0°C, the transmission capacity is restricted by voltage in Sweden):

Temperature [°C]	-20	-10	0	10	20	30
Capacity [MW]	2,150	2,150	2,150	2,150	2,050	1,900

- To Sweden in the Hasle constraint: The *transmission capacity* is 1,600 MW without *production shedding*. For every 100 MW of production, *production shedding* increases the *transmission capacity* by 50 MW. The maximum *production shedding* is 1,200 MW, corresponding to 2,200 MW of capacity.

The *transmission capacity* will be reduced due to a high Oslo load, in accordance with the following table:

Oslo load	3,200	3,300	3,400	3,500	3,600	3,700	3,800	3,900	4,000	4,100
Capacity [MW]	2,200	2,175	2,090	2,000	1,900	1,785	1,700	1,600	1,450	1,250

Oslo load	4,200	4,300	4,400	4,500	4,600	4,700	4,800	4,900	5,000
Capacity [MW]	1,050	850	650	500	350	200	100	50	0

4.2 Routines for determining the transmission capacity

The *transmission capacity* between Norway and Sweden shall be jointly determined on a daily basis by the *Parties*.

4.3 Trading capacity (NTC)

When determining the *trading capacity* of the links, the *transmission capacity* shall be reduced by the *regulating margin*.

The *regulating margin* of the Hasle constraint is normally 150 MW. The total *regulating margin* of the other links is normally 50 MW.

If a country can guarantee *counter trading* and the existence of a sufficient *fast active disturbance reserve*, then the *trading capacity* may be increased.

For the *trading capacity,* a weekly forecast is established for the coming week. The forecast is sent to Nord Pool by at the latest the Tuesday of the week before.

4.4 Operation monitoring and control in respect of system operation

Operation monitoring of capacities and *transmission constraints*, which can affect exchanges, are conducted in accordance with the below:

Line	Norway	Sweden
Sildvik-Tornehamn	National Centre in Oslo	Vattenfall Norrnät's Operations Centre at Luleå
Ofoten-Ritsem	National Centre in Oslo	SvK's Grid Supervisor at Network Control at Råcksta
N.Rösspåga-Gejmån-Ajaure	National Centre in Oslo	SvK's Grid Supervisor at Network Control at Råcksta
Nea-Järpströmmen	National Centre in Oslo	SvK's Grid Supervisor at Network Control at Råcksta
Hasle-Borgvik	National Centre in Oslo	SvK's Operations Centre at Råcksta
Halden-Skogssäter	National Centre in Oslo	SvK's Grid Supervisor at Network Control at Råcksta

4.5 Voltage regulation

The basic principle for voltage regulation is governed by item 7 point 7.5 in the agreement.

4.5.1 Voltage regulation on the Norwegian side

Voltage is monitored by the National Centre in Oslo and Regional Centres in Alta, Sunndalsöra and Oslo. If the Regional Centres do not have sufficient resources to maintain the voltage within the given limits, the National Centre will be contacted.

The following voltage levels are applied:

Substation	Min voltage kV	Normal operation range kV	Max voltage kV
Ofoten	400	400-415	425
Nedre Rössåga	235	240-250	250
Nea	285	285-300	306
Hasle	380	410-415	430
Halden	380	410-415	430

4.5.2 Voltage regulation on the Swedish side

The Operations Centre in Sollefteå (DCSO) is responsible for voltage regulation in the northern parts of the grid, and the Operations Centre in Råcksta (DCRÅ) is responsible for voltage regulation in the southern parts of the grid. If the Operations Centres do not have sufficient resources to maintain the voltage within the given limits, SvK's Operations Centre shall be contacted.

The following voltage levels are applied:

Substation	Min voltage kV	Normal operation range kV	Max voltage kV
Ritsem	395	400-415	420
Ajaure	230	245-255	260
Järpströmmen	280	285-295	305
Borgvik	395	400-415	420
Skogssäter	395	400-415	420

4.5.3 Co-ordination of voltage regulation

In normal operation, the goal is the higher voltage within the normal operation range. In conjunction with operational disturbances and switching, the respective operations centres in Sweden and Norway can agree on action to maintain the voltage within the given intervals.

4.6 Outage planning

Svenska Kraftnät shall plan the following in consultation with Statnett:

- Outages or other measures on the Swedish network impacting upon the *transmission capacity* of the links between Sweden and Norway.
- Outages on one of the 400 kV lines between Porjus and Ritsem.
- Outages on the 400 kV line between Midskog and Järpströmmen or the 400/300 kV transformer at Järpströmmen.
- Outages on one of the 220 kV lines between Grundfors and Gejmån or the 400/220 kV transformer at Grundfors.
- Outages causing a major reduction of the *transmission capacity* in constraints 1 or 2, or the West Coast constraint in Sweden.
- Control facility works at Skogssäter, Borgvik, Porjus, Ritsem and Vietas.

Statnett shall plan the following in consultation with Svenska Kraftnät:

- Outages or other measures on the Norwegian network impacting upon the *transmission capacity* of the links between Sweden and Norway.
- Outages entailing that, on the Norwegian network, there is no link between Ofoten and Rössåga.
- Outages entailing that, on the Norwegian network, there is no link between Rössåga and Nea.
- Outages entailing that, on the Norwegian network, there is no link between Nea and Hasle.

4.7 Disturbance situation

The term disturbance situation means that the *transmission capacities* have been exceeded due to, for instance, long-term line faults or the loss of production. If the *transmission capacities* are not exceeded during the faults, the situation will be deemed to be normal.

In the event of *operational disturbances,* measures in accordance with the issued instructions shall, as soon as possible, restore the link to *normal state*.

Joint operation between the Finnish and Swedish subsystems on the AC links and Fenno-Skan

1 Background

The *subsystems* of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected. The *subsystem* of Western Denmark is connected to Norway and Sweden using DC links. This Appendix describes the operation of the AC links and the Fenno-Skan DC link.

2 Transmission facilities linking the subsystems Sweden – Finland

2.1 Transmission facilities which are owned/held by system operators

Facility	Voltage level	Settlement point:
Petäjäskoski - Letsi	400 kV AC	Letsi 400 kV
Keminmaa - Svartbyn	400 kV AC	Svartbyn 400 kV
Fenno-Skan	400 kV DC	Dannebo 400 kV
Ossauskoski – Kalix*)	220 kV AC	Kalix 220 kV

*) SvK and Fingrid own the line, Vattenfall Norrnät and Fingrid are responsible for its electrical operation.
The transmissions depend on consumption in the Kalix region. The transmissions are taken into account when determining the trading capacity between Finland and Sweden.

3 Electrical safety for facilities under 2.1

3.1 General

The common ground for the electrical safety work of the *system operator* companies within Nordel is constituted by the European standard for managing electrical high-voltage facilities EN 50 110 which governs the organisation and working methods. In addition to the standard, there are national regulations and special instructions which entail certain mutual differences between the *system operators* as regards dealing with operational issues from an electrical safety point of view.

3.2 Responsibility for electrical operation/Operational management

The responsibility for electrical operation for the *transmission facilities* is held in Finland by Fingrid. In Sweden, SvK holds the responsibility for electrical operation.

The *power operation responsibility boundary* concerning the 400 kV links lies at the border between Finland and Sweden. The *power operation responsibility boundary* regarding Fenno-Skan lies at the ownership boundaries of the cable.

3.3 Switching responsible operator

Table 1

Facility	**Swedish side**	**Finnish side**
Petäjäskoski – Letsi	Operations Centre at Sollefteå (DCSO)	Tavastehus Network Centre
Keminmaa - Svartbyn	Operations Centre at Sollefteå (DCSO)	Tavastehus Network Centre
Fenno-Skan	Operations Centre at Råcksta (DCRÅ)	Tavastehus Network Centre

3.4 Operations monitoring and control in respect of electrical safety

Same parties as under 3.3.

3.5 Switching schedule

Switchings on the links are carried out in accordance with a switching schedule drawn up by Svenska Kraftnät. Before the work begins, the Operations Centres shall confirm that the link is grounded and secured against switching on by exchanging switching confirmations.

Switching concerning Fenno-Skan takes place as follows:

- Switching in Rauma alone takes place in accordance with a switching plan drawn up by Fingrid.
- Switching on the Finnish part of the cable takes place in accordance with a switching plan drawn up by Fingrid. Before the work begins, the Operations Centres shall confirm that the link is grounded and secured against switching on by exchanging switching confirmations.
- Switching in Dannebo alone takes place in accordance with a switching schedule drawn up by SvK.
- Switching on the Swedish part of the cable takes place in accordance with a switching schedule drawn up by SvK. Before the work begins, the Operations Centres shall confirm that the link is grounded and secured against switching on by exchanging switching confirmations.

3.6 Disturbance management

When a *cross-border link* is taken out of operation, the control rooms will contact each other immediately.

As and when required, the switching responsible operators issue the necessary switching schedules in order to carry out fault finding and clearance.

The switching responsible operators conduct fault finding in consultation.

Clearance of remaining faults is organised by the switching responsible operators in consultation.

For Fenno-Skan, the Preparedness plan for fault clearance is used.

4 System operation for facilities under 2.1

4.1 Transmission capacity (TTC)

4.1.1 400 kV AC links

The *transmission capacity* to Finland is dependent upon the temperature in northern Sweden and Finland, as follows:

Temperature °C	< 20	> 20
Capacity	1,650 MW	1,600 MW

The *transmission capacity* to Sweden is limited because of dynamic reasons as follows:

Constraint 1	Max. transmission to Sweden
3,000 MW	1,200 MW
3,100 MW	1,100 MW
3,300 MW	1,000 MW

The *transmission capacity* of only one 400 kV link in the north is a maximum of:

	Planned outage in the other link	Disturbance in the other link
To Finland	700 MW	500 MW
From Finland	400 MW	400 MW

4.1.2 Fenno-Skan

The *transmission capacity* of Fenno-Skan is transiently max. 600 MW. The *transmission capacity* of Fenno-Skan is temperature-dependent, the normal value being 550 MW. As the *trading capacity,* a temperature-dependent value is used continuously, normally 550 MW.

4.2 Routines for determining the transmission capacity

The *transmission capacity* between the *subsystems* is set on a daily basis in consultation between the System Operation Centre in Helsinki and SvK's Grid Supervisor at Network Control at Råcksta.

Both parties shall inform the other *party* in good time before the day of operation of the *transmission capacity* on Fenno-Skan and on the northern links. The minimum values will be the *transmission capacity.*

4.3 Trading capacity (NTC)

When determining the *trading capacity* of the AC links, the *transmission capacity* is reduced by a *regulation margin* of 100 MW. Consumption in the Kalix region is taken into account when determining the *trading capacity* between Finland and Sweden. The *trading capacity* of Fenno-Skan is equal to its *transmission capacity*, normally 550 MW.

4.4 Operations monitoring and control in respect of system operation

Operations monitoring and control in Finland are carried out from:

- The System Operation Centre in Helsinki as regards AC links and Fenno-Skan.

Operations monitoring and control in Sweden are carried out from:

- SvK's Grid Supervisor at Network Control at Råcksta concerning 400 kV AC links and Fenno-Skan.

Regulation of Fenno-Skan is carried out on an alternating basis per half calendar year: the first half by Svenska Kraftnät's Operations Centre at Råcksta and the second half by the System Operation Centre in Helsinki.

4.5 Voltage regulation

The basic principle for voltage regulation is governed by item 7 point 7.5 in the agreement.

4.5.1 Voltage regulation on the Swedish side

The Operations Centre in Sollefteå (DCSO) is responsible for voltage regulation in the northern parts of the grid.

The following voltage levels are applied:

Substation	Min voltage kV	Normal operation range kV	Max voltage kV
Letsi	395	400-410	415
Svartbyn	395	400-415	420

The minimum voltage is a voltage which the power system can withstand with a certain margin against a voltage collapse. The maximum voltage is the design voltage of the equipment. The target value for voltage lies within the normal operation range.

4.5.2 Voltage regulation on the Finnish side

For voltage regulation, there are reactors on the tertiary windings of transformers and capacitors in the 110 kV system.

At Keminmaa, the capacitor is connected for reactive power on the 110 kV side of transformers. The reactors are connected by means of automation for 400 kV voltages. The automation has three windows of +/- 4 kV and it can be adjusted upwards and downwards from the System Operation Centre.

At Petäjäskoski, the reactors are connected manually.

The following voltage levels are applied:

Substation	Min voltage kV	Normal operation range kV	Max voltage kV
Petäjäskoski	380	400-417	420
Keminmaa	380	399-417	420

4.5.3 Co-ordination of voltage regulation

Problems can arise on the Svartbyn - Keminmaa line if the Swedish side does not pay attention to the Finnish voltage regulation principle. There can be consequential impacts between reactor connections at Svartbyn and corresponding connections at Keminmaa on account of the size of the reactor at Svartbyn, 150 Mvar. The voltage at Svartbyn shall be held within 406 - 414 kV. If problems occur, the relevant parties shall contact each other.

4.6 Outage planning

The *Parties* shall plan, in consultation with each other, outages on the links and on their own networks when such outages will impact upon the *transmission capacities* of the links.

Planned outages on Fenno-Skan are to be co-ordinated with the other HVDC links of the Nordic area.

4.7 Disturbance management

The term disturbance situation means that the *transmission capacity* has been exceeded due to, for instance, long-term line faults or the loss of production. If the *transmission capacity* has not been exceeded during the faults, the situation will be deemed normal.

When a *cross-border link* is disconnected, the control rooms will immediately contact each other and jointly reduce the transmission level to permissible values.

During hours when a disturbance situation is in force, loss minimization is not employed. This means that no compensation for loss minimization benefit will be paid out. The *Parties* will only pay for non-notified *balance power*.

During disturbance situations, both *Parties* have the right to regulate Fenno-Skan to support their networks. Fenno-Skan can be used as much as possible facility-wise and to an extent not entailing any difficulties in the other *Party's* network.

During a disturbance situation, the *Parties* shall immediately contact each other and agree that it is a disturbance situation. In conjunction with this, it must also be agreed how much Fenno-Skan is to be regulated and who will regulate. If the situation is very serious and the situation in the other *Party's* network can be assumed to be normal, then Fenno-Skan can be regulated by the *Party* affected by the disturbance without any previous contact. Such unilateral regulation may not, however, exceed 300 MW counted from the current setting.

If Fenno-Skan's *emergency power* regulation has been activated, this will also be deemed to be a disturbance situation. If the *emergency power* intervention entails *counter trading* requirements for a *Party* not being affected by a disturbance, then Fenno-Skan shall be regulated within 15 minutes to such a value that the *counter trading* requirement ceases.

5 Distribution of capacity utilization between Finland and Sweden

The distribution of capacity utilization on the cross-border links is governed by a separate agreement between Fingrid and Svenska Kraftnät. The main principles are as follows:

The transmission capacity of the cross-border links is defined for the AC links in the north and for Fenno-Skan. The transmission capacity shall be determined continuously by the parties in accordance with the relevant technical conditions of the System Operation Agreement. The trading capacity is determined by calculating the transmission capacity minus determined regulating margin.

5.1 Basic distribution

Basic distribution is used as a starting point for the distribution of electricity transmissions between northern and southern links. Basic distribution is determined by the proportion between the determined *trading capacity*, at any one given time, of the AC links and Fenno-Skan 1. Basic distribution shall be used if neither loss minimization nor the use of the other *Party's* idle capacity is relevant.

Basic distribution is applied as follows:

- For each hour, the planned cross-border power trade is totalled.
- The power trade is distributed between the northern AC links and Fenno-Skan in accordance with the above basic distribution.
- Elbas and *supportive power* trading across the border are not handled in basic distribution.

If either *Party* needs to limit the AC links or Fenno-Skan due to internal limitations, e.g. constraints 1, 2 or P1, the above trading capacity will nevertheless be used for the AC link and Fenno-Skan when calculating basic distribution.

5.2 Loss minimization (Fenno-Skan optimization)

In the event of loss minimization, Fenno-Skan will be regulated in such a way that the transmission losses on the Finnish and Swedish grids are minimized. The benefits thus gained are to be divided equally between Fingrid and SvK through financial reimbursement twice a year.

5.3 Loss minimization model

The model for loss minimization is based upon SvK and Fingrid calculating their network losses as a function of the transmissions on Fenno-Skan. The curves are calculated using the current operating situation and the constant net trade. The curves are sent to the other company and added in order to obtain the minimum point giving a reference value for Fenno-Skan.

The price of energy used in loss minimization shall be *area price* Sweden in Nord Pool Spot's Elspot market. The *Parties* shall specify the prices in SEK. As of the beginning of 2006, the prices shall be specified in EUR.

5.4 Distribution of benefit

The overall benefit to the system during a period of one hour is defined as the positive difference between the calculated overall loss overheads during basic distribution and during the real reference value. Normally, the minimum point is used as the reference value.

The overall benefit shall be distributed in accordance with the 50/50 principle; both *Parties* shall have equal benefit of loss minimization. The distribution of benefit will be as follows: firstly the overall benefit is calculated as set out above. Following this, Fingrid's benefit is calculated as the difference between its loss overheads during basic distribution and during the real reference value. SvK's benefit is calculated the same way. Subsequently, either of the *Parties* compensates the other *Party* to the extent that SvK's benefit increased/decreased by the compensation is the same as Fingrid's benefit increased/decreased by the compensation.

5.5 Utilizing the other party's idle capacity

Both countries have pledged to internally *counter trade* in the event of transmission limitations on their own networks during *normal state*, this applies during the *operational phase*. *Parties* experiencing problems on their networks due to loss minimization have the right to change, free of charge, the power distribution within the range [basic distribution, optimum]. If there are, nevertheless, bottlenecks in one of the networks, the System Operation Centre in Helsinki and SvK's Grid Supervisor at Network Control at Råcksta shall agree upon the redistribution as follows.

5.5.1 Bottlenecks in Fingrid's network

If there are *bottlenecks* in Fingrid's network and there is idle capacity in SvK's network, the System Operation Centre in Helsinki and SvK's Grid Supervisor at Network Control at Råcksta shall agree upon the utilization of SvK's network in order to relieve Fingrid's transmissions. The agreement must feature the following points:

– new reference values for the northern links and Fenno-Skan

– the transit amount=the volume outside the range [basic distribution, optimum].

Afterwards, Fingrid shall compensate SvK for utilizing SvK's capacity. This compensation will be calculated as the product of the transit price and the transit sum. The transit price is, until further notice, set at SEK 30/MWh unless otherwise agreed between the parties. The transit price shall, however, be adjusted by the parties for each commencing period of two (2) calendar years.

5.5.2 Bottlenecks in SvK's network

If there are *bottlenecks* in SvK's network and there is idle capacity in Fingrid's network, the System Operation Centre in Helsinki and SvK's Grid Supervisor at Network Control at Råcksta shall agree upon the utilization of Fingrid's network in order to relieve SvK's transmissions. The agreement must feature the following points:

– new reference values for the northern links and Fenno-Skan

– the transit amount=the volume outside the range [basic distribution, optimum].

Afterwards, SvK shall compensate Fingrid for utilizing Fingrid's capacity. This compensation will be calculated as the product of the transit price and the transit amount. The transit price is, until further notice, set at SEK 30/MWh unless otherwise agreed between the parties. The transit price shall, however, be adjusted by the parties for each commencing period of two (2) calendar years.

5.5.3 Bottlenecks in both parties' networks

If both parties are experiencing *bottleneck* situations simultaneously, the net trade shall be distributed between the links as in basic distribution. But if the *counter trading* overheads in the parties' networks differ greatly and the control rooms agree upon cost distribution, another type of power distribution can be used.

5.6 Settlement of floss minimization

The compensation of loss minimisation takes place twice a year, at the beginning of January and at the beginning of July, if the parties do not agree upon another procedure. Fingrid makes out the invoice if the parties do not agree otherwise.

The compensation of the use of the other party's idle capacity also takes place twice a year at the same time with loss minimisation compensation.

Joint operation between the Norwegian, Finnish and Swedish subsystems in Arctic Scandinavia

1 Background

The *subsystems* of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected. The *subsystem* of Western Denmark is linked to Norway and Sweden using DC links. This Appendix governs the special circumstances resulting from no separate trade being conducted via the Ivalo-Varangerbotn link. The capacity will instead be included in the trading scope for Nord Pool's Elspot market between Norway-Sweden and Sweden-Finland.

2 Transmission facilities linking the subsystems of Norway-Finland

Transmission facilities owned/held at both ends by *system operators*:

Facility	**Voltage kV**	**Settlement point**
Ivalo-Varangerbotn	220 kV AC	Varangerbotn

3 Electrical safety for facilities under 2

3.1 General

The common ground for the electrical safety work of the *system operator* companies within Nordel is constituted by the European standard for managing electrical high-voltage facilities EN 50 110 which governs the organisation and working methods. In addition to the standard, there are national regulations and special instructions which entail certain mutual differences between the *system operators* as regards dealing with operational issues from an electrical safety point of view.

3.2 Responsibility for electrical operation/Operation management

Responsible for the electrical operation on the Norwegian side is Statnett, while on the Finnish side it is Fingrid. The *power operation responsibility boundary* lies at the border between Finland and Norway.

3.3 Switching responsible operator

Line	Norway	Finland
Ivalo-Varangerbotn	Regional Centre at Alta	Tavastehus Network Centre

3.4 Operations monitoring and control in respect of electrical safety

In accordance with 3.3.

3.5 Switching schedule

Switchings on the links are carried out in accordance with a switching schedule drawn up by the *Party* with the outage requirement. The *Party* drawing up the switching schedule is also the switching responsible operator.

3.6 Disturbance management

3.6.1 Cross-border link trips – management

During *operational disturbances*, measures in accordance with issued instructions shall, as soon as possible, restore the link to *normal state*.

3.6.2 Switching schedule

Same as under 3.5.

3.6.3 Fault finding

Initial fault finding is conducted differently from case to case. Generally speaking, the respective facility owner will be responsible for fault finding.

3.6.4 Fault clearance, remaining faults

Once the fault has been localized, the respective facility owner will attend to clearing the fault.

4 System operation for facilities under 2

4.1 Transmission capacity (TTC)

4.1.1 From Norway to Finland

The *transmission capacity* varies between 50 and 130 MW depending on where the sectioning point in Norway is located and the transmission situation in Finland.

4.1.2 From Finland to Norway

The *transmission capacity* is 100 MW from Finland to Norway.

4.2 Routines for determining the transmission capacity

The exchange of *supportive power* is agreed upon on each separate occasion between Statnett and Svenska Kraftnät and between Fingrid and Svenska Kraftnät.

Statnett manages the transmissions on the *cross-border link* by redistributing production and sectioning in Norway so that the *transmission capacity* is not exceeded. Fingrid confirms the daily *transmission capacity*.

4.3 Trading capacity (NTC)

The *trading capacity* is included in the trading scope of Nord Pool's Elspot market between Norway - Sweden and between Sweden - Finland.

4.4 Operations monitoring and control in respect of system operation

In Finland, *operations monitoring* is carried out from the System Operation Centre in Helsinki. *Control* is carried out from the Tavastehus Network Centre following permission from the System Operation Centre.

In Norway, *operations monitoring and control* are carried out from the Regional Centre at Alta following permission from the National Centre in Oslo.

4.5 Voltage regulation

The basic principle for voltage regulation is governed by item 7 point 7.5 in the agreement.

4.5.1 Voltage regulation on the Norwegian side

At Varangerbotn, the target voltage level is 220 kV in normal operation, but the voltage can range between 205 and 235 kV.

4.5.2 Voltage regulation on the Finnish side

The normal operation range of voltage is 230 – 243 kV, but the voltage can range between 215 and 245 kV. At Utsjoki, there is a stationary reactor of 20 MVA.

4.5.3 Co-ordination of voltage regulation

The link is long and sensitive to voltage variations. The voltage is monitored in co-operation between the relevant control centres.

4.6 Outage planning

Outage planning and maintenance are co-ordinated in conjunction with Fingrid's System Operation Centre in Helsinki/Uleåborg Regional Centre and Statnett's National Centre in Oslo/Operation Centre at Alta.

4.7 Disturbance management

The term disturbance situation means that the *transmission capacities* have been exceeded due to, for instance, long-term line faults or the loss of production. If the *transmission capacities* have not been exceeded during the faults, the situation will be deemed normal.

In the event of disturbances, measures in accordance with issued instructions shall, as quickly as possible, restore the link to *normal state*.

5 Miscellaneous

5.1 Settlement

Settlement of power exchanges between Norway and Finland shall be carried out in accordance wit the following principles:

– Power exchanges via the Ivalo - Varangerbotn line shall, for Statnett's part, be included in the total exchanges between Statnett and Svenska Kraftnät.
– Power exchanges via the Ivalo - Varangerbotn line shall, for Fingrid's part, be included in the total exchanges between Fingrid and Svenska Kraftnät.

Settlement is carried out in accordance with separate bilateral agreements between Statnett and Svenska Kraftnät, and between Fingrid and Svenska Kraftnät.

5.2 Information exchange

Statnett is responsible for Fingrid and Svenska Kraftnät obtaining calendar day forecasts for transmissions on the Ivalo – Varangerbotn line.

Joint operation between the Norwegian and Western Danish subsystems on the DC links Skagerrak poles 1, 2 and 3

1 Background

The *subsystems* of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected. The *subsystem* of Western Denmark is connected to Norway and Sweden using DC links. This Appendix describes the operation of the DC links between Norway and Western Denmark.

2 Transmission facilities linking the subsystems of Norway-Western Denmark

Facility	Voltage kV	Settlement point
Kristiansand-Tjele		
SK1, SK2	250 kV DC	Kristiansand 300 kV DC
SK3	350 kV DC	Kristiansand 300 kV DC

Together, SK1, SK2 and SK3 make up the Skagerrak link.

3 Electrical safety for facilities under 2

3.1 General

The common ground for the electrical safety work of the *system operator* companies within Nordel is constituted by the European standard for managing electrical high-voltage facilities EN 50 110 which governs the organisation and working methods. In addition to the standard, there are national regulations and special instructions which entail certain mutual differences between the *system operators* as regards dealing with operational issues from an electrical safety point of view.

3.2 Responsibility for electrical operation/Operational management

The responsibility for electrical operation of the *transmission facilities* is held in Western Denmark by Energinet.dk and in Norway by Statnett. The responsibility for electrical operation is regulated by the operation agreements between Energinet.dk and Statnett.

The *power operation responsibility boundaries* for the links lie on the Danish side of the submarine cable at Bulbjerg in Jutland.

3.3 Switching responsible operator

3.3.1 Switchings

In the event of outages on the HVDC links, there shall be an exchange of written confirmation, before a work authorization can be despatched, between Statnett's Regional Centre in Oslo and Energinet.dk's control room at Tjele stating that the

HVDC isolators are open and the line is terminal grounded and blocked against connection.

3.3.2 Switching responsible operator

On the Danish side, the authorization to switch in respect of the switching and switching off of the converter stations is given by Energinet.dk's Control Centre at Erritsø, while authorization for all switchings and work authorizations on the HVDC side of the facilities is given by the local operational management at Tjele.

On the Norwegian side, Statnett's Regional Centre in Oslo gives the switching authorization, and issues work authorizations on the Norwegian side.

Switchings at the AC facilities are normally carried out from Energinet.dk's Control Centre at Erritsø and from Statnett's Regional Centre in Oslo. Switchings at the HVDC facilities, once these have been disconnected from the AC network, are carried out from Kristiansand and Tjele.

3.4 Operation monitoring and control in respect of electrical safety

Operation monitoring and control in Western Denmark is carried out from:
- Energinet.dk's Control Centres at Erritsø or Tjele.

Operation monitoring and control in Norway is carried out from:
- Statnett's Regional Centre in Oslo.
- The three poles can be operated individually.

3.5 Switching schedule

Prior to planned outages on the HVDC links, written confirmation shall be exchanged between Statnett's Regional Centre in Oslo and Energinet.dk's control room at Tjele. *Outage planning* for the links will be carried out in accordance with 4.5.

3.6 Disturbance management

Faults entailing the disconnection of links are managed via consultation in accordance with internal instructions. For fault localization and clearance, there is a special preparedness plan for submarine cables.

4 System operation for facilities under 2

4.1 Transmission capacity (TTC)

The *transmission capacity* of the links is dependent on the temperature of the air, cable runway and earth.

SK1, SK2:	Techn. min 10 MW/pole	Nominal (500 + 40) MW
SK3:	Techn. min 13 MW	Nominal 500 MW

4.2 Routines for determining the transmission capacity

The *transmission capacity* between Western Denmark and Norway shall be jointly determined on a routine basis by the *Parties*. In the case of intact connecting networks, the *transmission capacity* will be determined by the thermal capacity of the facilities' components. The thermal overload capability allowed by monitoring equipment shall be capable of being used as and when required in accordance with special instructions. For any limitations to the connecting AC networks, Energinet.dk's Control Centre at Erritsø is responsible for supportive data on the Western Danish side and Statnett for the equivalent on the Norwegian side.

4.3 Trading capacity (NTC)

The normal *trading capacity* in ”bipolar operation” is:

950 MW from Western Denmark to Norway
1,000 MW from Norway to Western Denmark

when Kristiansand is the exchange point (losses purchased in Western Denmark) and:

1000 MW from Western Denmark -> Norway
950 MW from Norway -> Western Denmark

when Tjele is the exchange point (losses purchased in Norway). This is calculated with 50 MW of losses.

Statnett and Energinet.dk agree weekly on the basis of the principal direction of transmissions where the losses can be bought most inexpensively.

The following calendar day's *trading capacity* is decided each day. Similarly, a weekly forecast is established for the coming week's *trading capacity*. The forecast is submitted to Nord Pool Spot by at the latest the Tuesday of the week before. The *trading capacity* can be limited by line work, production in the connection area, overhauls etc.

Both *Parties* inform the other *Party* in good time prior to the relevant calendar day about the *transmission capacity* seen from each respective side. The values that are the lowest will form the basis for determining the *trading capacity*.

4.4 Operation monitoring and control in respect of system operation

Operation monitoring and control in Western Denmark is carried out from:

- Energinet.dk's Control Centre at Erritsø.

Operation monitoring and control in Norway is carried out from:

- Statnett's National Centre in Oslo.

The three poles can be operated individually.

4.4.1 The power flow and distribution between the poles

The distribution of the power flow between the poles shall be determined on a routine basis by the *Parties* taking into account the minimum electrode currents, loss minimization or other technical circumstances in the poles or on the transmission networks on each respective side.

To minimize losses and electrode currents, the following shall be aimed at during resulting exchanges:

> ≥ 75 MW for > 2 hours, the power is distributed at 42 % on SK1, 2 and 58 % on SK3. Also applies during ”monopole operation”.
>
> < 75 MW, SK3 is used alone.

During special operational circumstances, other types of operation can be agreed upon.

4.4.2 Regulating the link

Regulation of the Skagerrak link in accordance with agreed *exchange plans* will be carried out, until further notice, from the Danish side. Energinet.dk’s Control Centre at Erritsø is responsible for its own *balance regulation* towards Norway. Regulation is carried out, in principle, in accordance with a power plan using *ramping* transitions between different power levels.

The plans are issued as power plans in whole MW for each 5 min value. The link is regulated in accordance with this power linearly from power value to power value.

The power plan is determined in accordance with the energy and power plan agreements forming the basis for utilizing the Skagerrak link.

Planned power regulation during the *operational phase* is set at max. 30 MW/min.

4.5 Outage planning

Outages on the links and on own networks which affect the *transmission capacity* shall be planned in consultation between the *Parties*.

Planning and maintenance are co-ordinated between the respective operational managements.

Overhaul planning is co-ordinated with the other HVDC links in the Nordic area.

4.6 Disturbance management

4.6.1 General

The Skagerrak link is of great importance to Norway and Denmark, thus outages due to disturbances generally entail major economic losses. In the event of *operational disturbances,* measures in accordance with issued instructions shall, as soon as possible, restore the link to *normal state*.

Automated operational disturbance systems are installed at Kristiansand and Tjele which begin to function during disturbances on the Norwegian or Jutland networks.

4.6.2 Emergency power

Emergency power consists of regulating measures which are initiated manually (*manual emergency power*) or automatically by means of a control signal being transmitted to the converter stations using telecoms.

Both sides have the right to initiate *manual emergency power* in the event of unforeseen losses of production, network disturbances or other *operational disturbances*.

Manual emergency power without previous notice may be activated within 100 MW and 100 MWh/calendar day. Prior to activation over and above this, notification and approval shall occur between Energinet.dk's Control Centre at Erritsø and Statnett's National Centre in Oslo.

4.6.3 System protection

At the DC facilities, *system protection* is constituted by *emergency power* settings at the converter stations. Activation criteria can be locally measured frequency and voltage or via telecoms based on the supplied signal. In the event of activation, any ongoing normal regulation will be interrupted. Activation over and above the agreed limits and regulation back to plan may not occur until the counterparty has approved this. (See further in Appendix 5 – System protection).

Energinet.dk and Statnett can additionally enter into agreements regarding other types of system services.

5 Miscellaneous

5.1 System services

For the automatic or manual activation of *operation reserves,* the available *transmission capacity* can be used.

The *regulation margin* is maintained following the agreement between the *Parties* taking into account the exchange of system services. The *Parties* have the right to utilize idle *transmission capacity* for the transmission of *system services.* Configuration values, power limits etc are agreed upon bilaterally.

5.2 Settlement

Energinet.dk manages balance settlement.

Joint operation between the Western Danish and Swedish subsystems on the Konti-Skan 1 and 2 DC links

1 Background

The *subsystems* of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected. The *subsystem* of Western Denmark is connected to Norway and Sweden using DC links. This Appendix describes the DC links between Sweden and Western Denmark.

2 Transmission facilities linking the subsystems of Sweden - Western Denmark

Facility	Voltage kV
KS1 Lindome - Vester Hassing	 285 kV DC
KS2 Lindome - Vester Hassing	 285 kV DC

Together, KS1 and KS2 make up the Konti-Skan link.
Settlement presently takes place on the AC side at Vester Hassing.

3 Electrical safety for facilities under 2

3.1 General

The common ground for the electrical safety work of the *system operator* companies within Nordel is constituted by the European standard for managing electrical high-voltage facilities - EN 50 110 - which governs the organisation and working methods. In addition to the standard, there are national regulations and special instructions which entail certain mutual differences between the *system operators* as regards dealing with operational issues from an electrical safety point of view.

3.2 Responsibility for electrical operation/Operational management

The responsibility for electrical operation of the transmission facilities is held in Western Denmark by Energinet.dk and in Sweden by Svenska Kraftnät. The responsibility for electrical operation is regulated by facility agreements between Energinet.dk and Svenska Kraftnät.

The *power operation responsibility boundary* between Svenska Kraftnät and Energinet.dk lies at Läsö Öst, at the transition between the submarine and shore-end cables.

3.3 Switching responsible operator

Table 2

Facility	**Swedish side**	**Danish side**
Konti-Skan 1	Operations Centre at Råcksta (DCRÅ)	Energinet.dk's control room at Vester Hassing
Konti-Skan 2	Operations Centre at Råcksta (DCRÅ)	Energinet.dk's control room at Vester Hassing

During work between Lindome and XL1-F at Läsö Öst or Lindome and XL2-F at Läsö Öst, the Operations Centre at Råcksta (DCRÅ) shall be the *power operation manager* for the entire link up to Vester Hassing.

During work on the Danish parts of the link, Energinet.dk's control room at Vester Hassing is the *power operation manager* for the entire link up to Lindome.

3.4 Operation monitoring and control in respect of electrical safety

Operation monitoring and control is carried out from Energinet.dk's Control Centre at Erritsø or Vester Hassing and the Operations Centre at Råcksta (DCRÅ).

- Normally, bipolar operation is applied to Konti-Skan 1 and 2 but each of them can also be operated in monopolar mode.

3.5 Switching schedule

Switching concerning Konti-Skan takes place as follows:

- Switching which concerns Vester Hassing alone takes place in accordance with a switching schedule drawn up by Energinet.dk.
- Switching on the Danish part of the cable takes place in accordance with a switching plan drawn up by Energinet.dk. Before the work begins, the Operations Centres shall confirm that the link is grounded and secured against switching on by exchanging switching confirmations.
- Switching in Lindome alone takes place in accordance with a switching plan drawn up by SvK.
- Switching on the Swedish part of the cable takes place in accordance with a switching schedule drawn up by SvK. Before the work begins, the Operations Centres shall confirm that the link is grounded and secured against switching on by exchanging switching confirmations.

3.6 Disturbance management

3.6.1 Cross-border link trips – management

During *operational disturbances*, measures in accordance with issued instructions shall, as soon as possible, restore the link to *normal state*.

3.6.2 Switching schedule

In the event of faults requiring switchings impacting upon the *cross-border link,* Energinet.dk's Control Centre at Erritsø and Svenska Kraftnät are informed prior to any switchings being made. In the event of switchings on the Swedish grid, a switching schedule will be drawn up by Svenska Kraftnät.

3.6.3 Fault finding

Initial fault finding will be carried out differently from case to case. Generally speaking, the respective facility owner will be responsible for fault finding. For fault finding, a special preparedness plan for submarine cables has been drawn up.

3.6.4 Fault clearance, remaining faults

Once the fault has been localized, the respective facility owner will attend to clearing the fault. For fault clearance, a special preparedness plan for submarine cables has been drawn up.

4 System operation for facilities under 2

4.1 Transmission capacity (TTC)

The *transmission capacity* of the link is dependent on the temperature of the air and the earth.

> In bipolar operation, the nominal capacity is 740 MW, and in monopolar operation (KS1 or KS2), the capacity is 370 MW.
>
> Technical minimum capacity of KS1: 12 MW; KS2: 9 MW.

4.2 Routines for determining the transmission capacity

The *transmission capacity* between Jutland and Sweden shall be set on a routine basis by the *Parties*. In the case of intact connecting networks, the *transmission capacity* is determined by the thermal capacity of the facilities' components. The thermal overload capability allowed by monitoring equipment shall be capable of being used as and when required in accordance with special instructions. Technical data for the facilities' *transmission capacities* is reported in the current facility agreement between Energinet.dk and Svenska Kraftnät.

For any limitations in the connecting AC networks, Energinet.dk's Control Centre at Erritsø is responsible for supportive data on the Western Danish side and Svenska Kraftnät for the same on the Swedish side.

4.3 Trading capacity (NTC)

The normal *trading capacity* is:

740 MW from Western Denmark → Sweden
680 MW from Sweden → Western Denmark

The above applies when Vester Hassing is the exchange point (30 MW of losses).

The following calendar day's *trading capacity* is set every day. Similarly, a weekly forecast is established for the coming week's *trading capacity*. The forecast is submitted to Nord Pool by at the latest the Tuesday of the week before. The *trading capacity* can be limited by line work, production in the connection area, overhauls etc.
Both *Parties* inform the other *Party* in good time prior to the relevant calendar day regarding the *transmission capacity* seen from the respective sides. The values that are the lowest will be the *trading capacity*.

4.4 Operation monitoring and control in respect of system operation

Operation monitoring and control is carried out from Energinet.dk's Control Centre at Erritsø and Svenska Kraftnät's Grid Supervisor at Network Control at Råcksta.

4.4.1 The power flow and distribution between the poles

Konti-Skan 1 and 2 are normally operated in bipolar mode.
During disturbances and maintenance on one pole, monopolar operation is applied.

4.4.2 Regulating the link

Regulation of the Konti-Skan links in accordance with agreed *exchange plans* will be carried out, until further notice, from the Danish side. Energinet.dk's Control Centre at Erritsø is responsible for its own *balance regulation* towards Sweden.

Regulation takes place, in principle, in accordance with a power plan using *ramping* transitions between different power levels. The plans are issued as power plans in whole MW for each 5 min of plan value. The links are regulated in accordance with this power linearly from power value to power value.

The power plan is determined in accordance with the energy and power plan agreements which form the basis for utilizing the Konti-Skan link.

4.5 Outage planning

The *Parties* shall, in consultation, plan outages on the link itself and on their own networks when these outages impact upon the *transmission capacity* of the link.

Operational planning and maintenance are co-ordinated between Svenska Kraftnät's Operational Department and Energinet.dk's Control Centre at Erritsø.

Overhaul planning is co-ordinated with the other HVDC links in the Nordic area.

4.6 System protection - emergency power

4.6.1 General

The Konti-Skan link is of major importance to Sweden and Denmark and outages due to disturbances thus generally entail major economic losses. In the event of *operational disturbances,* measures in accordance with issued instructions shall, as soon as possible, restore the link to *normal state*.

Automated operational disturbance systems are installed at Lindomen and Vester Hassing which can begin to function during *operational disturbances* on the Swedish or Jutland networks.

4.6.2 Emergency power

Emergency power is regulating measures which are initiated manually (*manual emergency power*) or automatically by means of a control signal being transmitted to the converter stations by means of telecommunications.

On the Western Danish side, Energinet.dk's Control Centre at Erritsø has the right to initiate *manual emergency power* in the event of disturbances to the power balance or *transmission network*.

On the Swedish side, Svenska Kraftnät has the right to initiate *manual emergency power* in the event of disturbances to the power balance or *transmission network*.

Manual emergency power of less than 100 MW and 100 MWh/calendar day may be activated without previous notification. Prior to activation over and above this, notification and approval shall take place between the staff of Energinet.dk's Control Centre at Erritsø and Svenska Kraftnät's Grid Supervisor at Network Control at Råcksta.

4.6.3 System protection

At the DC facilities, *system protection* is installed in the form of an *emergency power* function. Activation criteria for *emergency power* can be locally-measured frequency and voltage or via telecommunications on the basis of a supplied signal. In the event of activation, any ongoing normal regulation will be interrupted. Activation over and above the agreed limits and regulation back to plan may not occur until the counterparty has approved this. (See further in Appendix 5 – System protection).

5 Miscellaneous

5.1 System services

5.1.1 Transmission scope for operation reserves

Available *transmission capacity* can be used for the automatic or manual activation of *operational reserves*.

The *regulation margin* is maintained following the agreement between the *Parties* taking into account the exchange of *system services*. The *Parties* have the right to utilize idle *transmission capacity* for the transmission of *system services.* Configuration values, power limits etc. are agreed upon bilaterally.

Joint operation between the Eastern Danish and Swedish subsystems on the AC links across Öresund and to Bornholm

1 Background

The *subsystems* of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected. The *subsystem* of Western Denmark is connected to Norway and Sweden using DC links. This Appendix describes the operation of the AC links across Öresund and to Bornholm.

2 Transmission facilities linking the subsystems of Eastern Denmark and Sweden

2.1 Transmission facilities owned/held by system operators at both ends

Facility	Voltage level	Settlement point
Hovegaard - Söderåsen (FL25)	400 kV	Söderåsen
Gørløse - Söderåsen (FL23)	400 kV	Gørløse

The ownership structure of the facilities is set out in ”Anlægsaftalen for 400 kV forbindelserna” between Svenska Kraftnät and Elkraft Transmission (merged with Energinet.dk as of 1 January 2005), dated 12 December 2001.

Svenska Kraftnät owns three single phase 400 kV cables included in FL23, cables K4001, K4002 and K4003, between Kristinelund and Ellekilde Hage, including the corresponding share belonging to the oil equipment at Kristinelund and Ellekilde Hage. The ownership boundary between wholly-owned Danish and Swedish facilities is constituted by the splicing points between the land lines and submarine cables on the Danish side. The cable joints belong to the Swedish-owned facilities.

A single phase 400 kV cable K4004 between Kristinelund and Ellekilde Hage, including the corresponding share belonging to oil equipment at Kristinelund and Ellekilde Hage, is owned to 50 % by Svenska Kraftnät and to 50 % by Energinet.dk. The boundary between K4004 and surrounding facilities is composed of the splicing points between the land lines and submarine cables on both the Danish and Swedish sides. The cable joints are part of K4004.

Energinet.dk owns three single phase 400 kV cables which are included in FL25, cables K4005, K4006 and K4007, between the Swedish shore and Ellekilde Hage, with associated oil equipment at Kristinelund and Skibstrupgaard. The ownership boundary between the Danish and Swedish-owned facilities is constituted by the splicing points between the submarine cables and land lines on the Swedish side. The cable joints belong to the Danish-owned facilities.

2.2 Other transmission facilities

Facility	**Voltage level**	**Settlement point**
Teglstrupgaard 1 - Mörarp	130 kV	Mörarp
Teglstrupgaard 2 - Mörarp	130 kV	Teglstrupgaard
Hasle, Bornholm - Borrby	60 kV	Borrby

The ownership structure of the 130 kV links is set out in ”Anlægsaftalen for 132 kV forbindelserna” between Sydkraft and Elkraft Transmission (merged with Energinet.dk as of 1 January 2005), dated 13 May 2002.

The ownership structure of the 60 kV facility is set out in ”Anlægsaftale for 60 kV forbindelsen” between Sydkraft and Østkraft.

3 Electrical safety for facilities under 2.1

3.1 General

The common ground for the electrical safety work of the *system operator* companies within Nordel is constituted by the European standard for managing electrical high-voltage facilities - EN 50 110 - which governs the organisation and working methods.
In addition to the standard, there are national regulations and special instructions which entail certain mutual differences between the *system operators* as regards dealing with operational issues from an electrical safety point of view.

3.2 Responsibility for electrical operation/Operational management

Responsibility for electrical operation of the 400 kV Öresund links on the Swedish side is held by Svenska Kraftnät, and operational management on the Danish side is carried out by Energinet.dk.

The *power operation responsibility boundaries* for electrical operation/operational management are the same as the ownership boundaries, see under 2.1.

The *power operation manager* of K4004 is Svenska Kraftnät.

3.3 Switching responsible operator/Switching leader

Table 3

Facility	Swedish side	Danish side
Söderåsen – Kristinelund – Gørløse (FL23)	Operations Centre at Råcksta (DCRÅ)	Energinet.dk's Control Centre at Erritsø
Söderåsen – Kristinelund Hovegaard (FL25)	Operations Centre at Råcksta (DCRÅ)	Energinet.dk's Control Centre at Erritsø

The *power operation manager* for the 400 kV Öresund links on the Swedish side is Svenska Kraftnät's Operations Centre at Råcksta (DCRÅ), and the switching leader on the Danish side is Energinet.dk's Control Centre at Erritsø.

Switchings on the links take place after agreement between Svenska Kraftnät's Operations Centre at Råcksta (DCRÅ) and Energinet.dk's Control Centre at Erritsø.

The *party* which initiates a planned outage is the switching responsible operator/switching leader for the switchings and other operational measures carried out (leading switching leader) if not otherwise agreed upon.

In the event of faults which require switchings that have an impact on the 400 kV Öresund links, that *party* whose facility suffers from the fault is the switching responsible operator/switching leader for the switchings and other operational measures carried out (leading switching leader). If the fault cannot be located, the switchings shall take place on the basis of mutual consultation.

If a *party* needs switchings by the other *party* because of electrical safety reasons, the other *party* shall carry out such switchings without delay.

3.4 Operation monitoring and control in respect of electrical safety

Operation monitoring and control of the 400 kV Öresund links is managed on the Danish side by Energinet.dk's Control Centre at Erritsø and on the Swedish side by Svenska Kraftnät's Operations Centre at Råcksta (DCRÅ).

Both *parties'* switching responsible operators/switching leaders have access to status indications and electronic measured values via remote control from each others' facilities and from those stations where the 400 kV Öresund links are connected to the respective *parties'* grids.

3.5 Operational orders/Switching schedule

Switchings on the links are carried out in accordance with operational orders drawn up by SvK. Energinet.dk's Control Centre at Erritsø shall acknowledge the receipt of order. Before the work begins, the Operations Centres shall confirm that the link is grounded and secured against switching on by exchanging switching confirmations. After the work is finished, switching confirmations shall be exchanged.

3.6 Disturbance management

3.6.1 Cross-border link trips – management

In the event of *operational disturbances,* measures in accordance with issued instructions shall, as soon as possible, restore the link to *normal state.*

3.6.2 Switching schedule/Operational orders

In the event of faults requiring switchings which have an impact on the 400 kV Öresund links, Energinet.dk's Control Centre at Erritsø and Svenska Kraftnät's Operations Centre at Råcksta (DCRÅ) are informed prior to any switchings are made.
For switchings in the Swedish grid, a switching schedule/operational order is drawn up by Svenska Kraftnät's Operations Centre at Råcksta (DCRÅ).

For switchings in the Danish grid, a switching programme is drawn up by Energinet.dk's Control Centre at Erritsø.

3.6.3 Fault finding

Initial fault finding is carried out differently from case to case. Generally, it is the respective facility owner who is responsible for fault finding. A special preparedness plan has been drawn up for fault finding and repair for submarine cables.

3.6.4 Fault clearance, remaining faults

Once the fault has been localized, the respective facility owner will look after fault clearance. For fault clearance, a special preparedness plan for submarine cables has been drawn up.

4 System operation for facilities under 2.1 and 2.2

4.1 Transmission capacity (TTC)

4.1.1 Transmission capacity in MW per cable bundle

Line	5 °C	15-20 °C	30 °C
Hovegaard – Söderåsen	830	830	830
Gørløse – Söderåsen	830	830	830

Teglstrupgaard 1 – Mörarp	182	182	154
Teglstrupgaard 2 – Mörarp	173	173	157
Hasle, Bornholm - Borrby,	51	51	51

4.1.2 Transmission capacity in MW per link

– To Eastern Denmark

Link	Capacity
Öresund (Zealand)	1,350
Bornholm	51

– To Sweden (thermal limitation)

Link	Capacity
Öresund (Zealand)	1,750
Bornholm	51

The *transmission capacities* of the links are technically dependent and can be affected by the current operational situation in Zealand.

4.2 Routines for determining the transmission capacity

The *transmission capacity* between Eastern Denmark and Sweden shall be set on a daily basis by the *Parties*.

4.3 Trading capacity (NTC)

Determination of the capacity is based on the combined *transmission capacity* of the 400, 130, and 60 kV *transmission facilities*. When determining the *trading capacity* of the links, the applicable *regulation margin* of 50 MW is taken into account. A weekly forecast for the *trading capacity* shall be established for the coming week.

If a country can guarantee *counter trading* and the existence of sufficient *fast active disturbance reserve,* the *trading capacity* may be increased.

4.4 Operation monitoring and control in respect of system operation

Operation monitoring of borders and transmission constraints, which can affect exchanges, is managed on the Danish side by Energinet.dk’s Control Centre at

Erritsø and on the Swedish side by Svenska Kraftnät's Network Control Centre at Råcksta (SvK-vhi).

4.5 Voltage regulation

The basic principle for voltage regulation is governed by item 7 point 7.5 in the agreement.

4.5.1 Voltage regulation on the Swedish side

The Operations Centre in Råcksta (DCRÅ) is responsible for voltage regulation in the southern parts of the grid.
The following voltage levels are applied:

Substation	Min voltage kV	Normal operation range kV	Max voltage kV
Söderåsen	395	400-410	420

4.5.2 Voltage regulation on the Danish side

The Control Centre at Erritsø is responsible for voltage control in Zealand.
The following voltage levels are applied:

Substation	Min voltage kV	Normal operation range kV	Max voltage kV
Hovegaard	380	390-410	420
Gørløse	380	390-410	420
Teglstrupgaard 1	130	130-137	137
Teglstrupgaard 2	130	130-137	137

4.5.3 Co-ordination of voltage regulation

Mvar contribution from the cables is distributed between Svenska Kraftnät and Energinet.dk in the same proportion as their ownership.
At a voltage of 400 kV, the facilities FL23 and FL 25 each will generate 150 – 170 Mvar. The reactors at Hovegaard and Söderåsen compensate this generation by 110 Mvar per line.
The 400 kV voltage at Hovegaard and Söderåsen shall be regulated so that the given Mvar distribution is achieved as well as possible. Minor deviations in the region of 25 Mvar are accepted in normal operation. Short-term deviations from this Mvar range can occur for example in conjunction with the connection of capacitor batteries or reactors. There can be deviations in the Mvar distribution in conjunction with disturbances.

4.6 Outage planning

The *Parties* shall, in consultation, plan outages on the links and on their own networks if the *transmission capacity* of the links is affected.

Operational planning and maintenance are co-ordinated in consultation between Energinet.dk's Operational Planning at Erritsø and Svenska Kraftnät's Outage

Planning at Råcksta.

Operational planning and maintenance which affects the entire Nordic system shall, whenever possible, be co-ordinated in consultation with all *system operators*.

4.7 Disturbance management

The term disturbance situation means that the *transmission capacity* has been exceeded due to, for instance, long-term line faults or losses of production. If the *transmission capacities* are not exceeded during the faults, the situation will be deemed normal.

In the event of *operational disturbances*, measures in accordance with issued instructions shall, as soon as possible, restore the link to *normal state*.

5 Miscellaneous

5.1 Parallel operation 130 kV

Power transmitted via the 130 kV network does not entail any liability to render payment or any other reimbursement of expenses from Svenska Kraftnät or Energinet.dk.

5.2 Transmissions to Bornholm

As regards balance, Bornholm is managed as a part of the Eastern Danish *subsystem*. Energinet.dk shall be responsible for the production resources on Bornholm being capable of being utilized for general system operation requirements in the same way as the production resources in the rest of Eastern Denmark.

5.3 Co-ordination of fast active disturbance reserve south of constraint 4

Svenska Kraftnät and Energinet.dk shall ensure that there is sufficient *fast active disturbance reserve* to cope with *dimensioning faults* based upon each *subsystem's* responsibility for its own reserves. Svenska Kraftnät and Energinet.dk's Control Centre at Erritsø shall exchange information regarding how much *fast active disturbance reserve* there is which can restore the operational situation to *normal state* following a fault.

During *normal state,* Svenska Kraftnät and Energinet.dk's Control Centre at Erritsø co-ordinate the *fast active disturbance reserve* in Southern Sweden and Eastern Denmark in accordance with the following distribution rules:

(Dimensioning fault) x (own fault) / (own fault + counterparty fault)

Dimensioning fault = largest fault in area south of constraint 4

Own fault = largest fault in own area south of constraint 4

Counterparty fault = largest fault in counterparty's area south of constraint 4

In Sweden, south of constraint 4, the largest fault is typically the result of:
- Network part of constraint 4
- Baltic Cable
- SwePol Link.

In Eastern Denmark, the largest fault is typically the result of:
- Unit at the Avedøre or Asnæs plants
- KONTEK.

5.4 Counter trading

Energinet.dk's Control Centre at Erritsø can agree with Svenska Kraftnät on *counter trade* in Sweden to increase the *trading capacity* between Sweden and Eastern Denmark. Energinet.dk shall in this context compensate all of Svenska Kraftnät's costs in respect of this *counter trading*.

Joint triangular operation between the Norwegian, Swedish and Western Danish subsystems

1 Transmission facilities triangularly linking the subsystems Sweden - Western Denmark - Norway

Facility	Voltage kV	Other
Hasle - Borgvik	400 kV AC	Included in Hasle constraint
Halden - Skogssäter	400 kV AC	Included in Hasle constraint
Lindome - V Hassing	250 kV DC	Konti-Skan 1
Lindome - V Hassing	285 kV DC	Konti-Skan 2
Kristiansand - Tjele 1 and 2	250 kV DC	Skagerrak 1 and 2
Kristiansand - Tjele 3	350 kV DC	Skagerrak 3

2 Principles for the distribution of exchange plans on the links

Nord Pool utilizes the *trading capacity* which the *system operators* have set in order to try to avoid price differences between the *Elspot areas*.

Energinet.dk's Control Centre at Erritsø sets a *trading capacity* to and from the *Elspot area* in Western Denmark which can entail a limitation of the *trading capacity* between the *Elspot areas* Western Denmark - Norway and Western Denmark - Sweden. Distribution between the cables takes place on a pro rata basis, depending on the DC links' *trading capacities*. In the event of a price difference between the areas, the *trading capacity* will be redistributed so that it is increased from a low-*price area* to a high-*price area* within the framework of the overall *trading capacity*.

Svenska Kraftnät, Energinet.dk and Statnett agree that *trading plans* between Western Denmark and the rest of the Nordic *subsystem* will not be changed more than 600 MW from one hour to the next (this applies to the overall net regulation between Western Denmark and Sweden/Norway as well as per single link).

The planned *ramping* rate on Konti-Skan and the Skagerrak link is a maximum of 30 MW/min.

Based on hourly plans from Nord Pool Spot, Energinet.dk's Control Centre at Erritsø draws up preliminary power plans on the DC links towards Sweden and Norway with *ramping* transitions between the different power levels, taking into account the *ramping* rate and minimising network losses in the triangular link. Energinet.dk's Control Centre at Erritsø is responsible for the plans meeting the stipulated requirements.

The *UCTE* system has a requirement that the entire regulation must be completed within +/- 5 minutes at hour shifts.

Transits through Western Denmark entail that power plans and regulations for the DC links reflect the *UCTE* requirement.

These power plans can later be re-planned as a result of exchanges of *supportive power*, either bilaterally between two of the relevant *system operators* or between all three *system operators*.

The exchange of equal volumes of *supportive power* between all three *system operators* in a triangle (triangular trading) is used to relieve heavily loaded links on the network, to obtain scope for regulating the frequency and to minimise the need for *counter trading*. All three *system operators* can take the initiative as regards *supportive power* trading via the relevant DC links or the Hasle constraint. Statnett has a co-ordinating function. Triangular trading requires the approval of all three *Parties*.

Energinet.dk's Control Centre at Erritsø is responsible for drawing up new power plans for the DC links in accordance with the stipulated requirements and for informing the other *system operators*.

All *Parties* shall be informed about the potential *transmission capacity* of all three links as regards the allocation of *balance power* and *supportive power*.

Managing transmission limitations between subsystems

1 Background

All *trading capacity (NTC)* shall be put at the disposal of the electricity market.

System operators may need, for reasons of *system security* or the state of affairs in their own or adjacent networks, to limit the *transmission capacity* of the links between the *subsystems*.

For the *transmission capacity* of the *cross-border links* between *Elspot areas*, the same prioritization rules are to be applied by all *system operators* in the *subsystems*. See table below.

Priority		Sweden	Finland	Norway	Eastern Denmark	Western Denmark
1	Elspot	X	X	X	X	X
2	Elbas	X	X		X	X
3	Balance power/ Supportive power	X	X	X	X	X

Supportive power agreed in advance between the *system operators,* with reference to start-ups of thermal power or similar, has a higher priority than *balance power*.

2 Transmission limitations during the planning phase, prior to completed trading on Elspot

2.1 Elspot is used to balance transmission limitations between the *subsystems* during the *planning phase*. The involved *Parties* reach agreement on a daily basis regarding the *trading capacity* for exchanges between the *subsystems*.

2.2 In the event of limited-duration reduced *transmission capacity* between the *subsystems*, the *system operators* will be able to agree to use *counter trading*.

2.3 In the event of transmission limitations within an *Elspot area,* it will be the respective *system operator's* responsibility to manage the limitation by using *counter trading* or by limiting the *trading capacity*.

3 Transmission limitations during the operational phase, following completed trading on Elspot

3.1 During the *operational phase*, reduced *transmission capacity* between the *subsystems*, as a consequence of an *operational disturbance*, is managed by means of *counter trading.* There is no limitation of the *players'* planned power trading on Elspot. *Counter trading* takes place during the remainder of the current period when trade on Elspot has been fixed.

For *Elbas trading*, the *trading capacity* is reduced but prearranged trading will be *counter traded* for the remainder of the current Elspot period.

3.2 In the event of an *operational disturbance* in a *Party's subsystem*, the responsible *Party* will bear the full technical, financial and operative liability for eliminating the effects of the incident in its own *subsystem* and minimising the effects in other *subsystems.*

3.3 In the event of an *operational disturbance* on the *cross-border links* themselves, the *system operators* on both sides of the link will bear the technical, financial and operative liability for eliminating the effects of the incident on their own *subsystems.*

If the agreed trading exceeds the reduced *trading capacity* between *subsystems, supportive power* is exchanged between the parties concerned. The volume of *supportive power* in *counter trading* as a result of an *operational disturbance* on the *cross-border link* itself is normally the difference between the agreed trading capacity and current *trading capacity.*

3.4 Acute situations, such as during a general *power shortage* or during *power shortages* resulting from *operational disturbances* in networks or during *bottleneck situations*, when compulsory *load shedding* has to occur, are managed in accordance with Appendix 9.

4 Step by step of the trading capacity

Major changes to the *trading capacity* between two *Elspot areas* can result in major changes in power flows from one hour to the next. These major changes can be difficult to manage in balance regulation. Thus, restrictions are placed on changes to *trading capacities*, MW, from one hour to the next. This change may be a maximum of 600 MW, unless otherwise agreed.

5 Ramping of trading plans on HVDC connections

Major changes to the *trading plans* on the HVDC connections from the Nordic synchronous area can result in major changes in power flows at the change of hours. These major changes can be difficult to manage in balance regulation. Thus, restrictions are placed on the magnitude of changes to the *trading plans,* MW, from one hour to the next. This change may be a maximum of 600 MW from one hour to the next on each of the following connections: NorNed, Skagerrak, KontiSkan, Kontek and Baltic Cable.

For Skagerrak and KontiSkan, the total changes to the *trading plans* on the two connections may be a maximum of 600 MW from one hour to the next.

6 Elspot trade in the event of "extensive grid disturbance"

6.1 General

In the event of a grid disturbance which changes the opportunities of the market to trading and to make plans and give bids to the spot market, the TSO in question shall declare an "extensive grid disturbance", which entails that:

- all imbalance is calculated in accordance with specific rules where the market players' risks are restricted
- all bids to the spot market shall be given as if the grid was intact (with no limitations caused by the disturbances) with the exception of the ongoing disturbance.

Once the disturbance has been cleared and a normal state has been restored, the relevant TSO shall declare that the system is intact and that normal conditions and pricing rules apply.

The purpose of the above procedure is that:

- The system will be in a planned and managed balance after the disturbance has been cleared and once the grid is intact again (however, deviations will happen during the restoration phase).
- A "normal" spot price can be calculated and communicated to the market.
- The settlement of financial contracts can continue in the normal manner.
- The risk of a major imbalance being created during a spot day is smaller if individual players can guess how great an impact the disturbance has on the system and to what extent the disturbance influences the system.
- The restoration phase should be more stable as all parties have a balance goal to attain when the deviation is exclusively the result of the disturbance, measures ordered by the TSO(s) and/or imbalance as a result of normal variation.

6.2 Planning phase

In the planning phase, before pricing in Elspot, the relevant TSO shall inform the market of the lines and transformers which are most likely going to be out of operation during the next day. This information shall be sent via Nord Pool Spot as UMM (Urgent Market Message).

Calculation of capacities takes place in the normal manner. The calculations must take into account the lines and production facilities which are most likely going to have an ongoing fault in the next day.

Plans and forecasts shall be given as if the grid was intact with the exception of the ongoing disturbance. Disturbances in production facilities shall be reported immediately with a forecast of the duration of the disturbance.

6.3 Operational phase

In the operational phase, after pricing in Elspot, the relevant TSO shall inform the market players directly to the extent that is required of swift and reliable restoration of the grid. Information which has an impact on the market must generally be sent via Nord Pool Spot as UMM (Urgent Market Message).

Physical regulation in the regulation power market can be managed as normally. Active regulations are priced as normally in accordance with a bid list but the regulation costs are borne by the TSO.

The relevant TSO can decide when to apply special rules to the pricing of the players' balance power. This decision is made primarily when a TSO can no longer manage its system in accordance with the normal rules.

Subsystems which are not inflicted by the disturbance are managed as normally.

Pricing of balance power and supportive power between the Elspot areas takes place in accordance with normal principles. If it turns out that pricing has become unreasonable, for example due to frequency regulation, this is corrected afterwards.

Rules for managing power shortages during high consumption, bottlenecks or disturbances

Introduction

These rules describe how the *system operators* of the *interconnected Nordic power system* shall jointly manage possible *power shortages.* This shall be carried out taking the *system security* requirements into account. The main goal is to prevent collapse in a part or the entire synchronised system. A secondary goal is that no more loads are disconnected than what is necessary to save the entire system.

Extracts from Appendix 1 Definitions:

A **subsystem** is the power system for which a *system operator* is responsible. A *system operator* can be responsible for several *subsystems.*

Subsystem balance is calculated as the sum of measured physical transmissions on the *cross-border links* between the *subsystems.* Thus, there is a deficit if this sum shows that power is flowing into a *subsystem* and a surplus if power is flowing out of a *subsystem.* (Exchanges on *cross-border links* like Finland-Russia, Norway-Russia, the SwePol Link, Baltic Cable, Kontek and Western Denmark-Germany are not to be included in the calculation.)

A risk of power shortage defines the state when forecasts show that a *subsystem* is no longer capable of maintaining the demand for a *manual active reserve,* which can be activated within 15 minutes, for the planning period.

Power shortage occurs during the hour of operation when a *subsystem* is no longer capable of maintaining the demand for a *manual active reserve* which can be activated within 15 minutes.

Critical power shortage occurs during the hour of operation when consumption has to be reduced/disconnected without commercial agreements about this.

Prerequisites

- Each *subsystem* is responsible for its own balance and for the requirements for automatic and manual reserves being fulfilled.

- All regulation resources shall exist as *regulation bids* on the joint Nordic *regulation list*. This concerns both market-based bids and *manual active reserve* (15 min).

- *System operators* inform each other on a continuous basis.

- A *subsystem* with a physical surplus does not need to carry out *load shedding* to the benefit of *subsystems* with a deficit.

- The need for *manual active reserve* (15 min) in each *subsystem* shall normally be equal to or greater than the *dimensioning faults* in each *subsystem.*

- When *power shortages* or *critical power shortages* exist, the *manual active reserve* (15 min) is reduced to less than the normal level. The *manual active reserve* (15 min), however, must not fall short of 600 MW, in total, in the *synchronous system.*

- The physical *transmission capacities* of the network shall be maintained and a frequency which does not drop below 50.0 Hz shall be aimed at.

- Each *system operator* formulates instructions which comply with this set of rules. The content of the instructions is co-ordinated between the *system operators*.

1 General power shortages without bottlenecks in the network

1.2 Maintenance of manual active reserve (15 min)

When a *subsystem* in normal *balance regulation* is approaching the limit of keeping the *manual active reserve* (15 min) in its own *subsystem* for its *dimensioning faults*, the control centres of the other *system operators* shall be informed. This shall also be done even if there is a surplus in the *subsystem.* This information shall be delivered by e-mail and by telephone as early as possible.

The *system operators* concerned assess whether the *manual active reserve* (15 min) in their own *subsystem* can also be used for upward regulation purposes in normal balance regulation. This means that the *subsystem* will not have sufficient own reserves to cover the need for *manual active reserve* (15 min).

If further *upward regulation* is needed, the parties shall ascertain whether there are available market-based upward regulation bids in the neighbouring systems to cover the *subsystem*'s deficit of *manual active reserve* (15 min). “Available” means that resources can be activated for this purpose and that there is sufficient *transmission capacity*.

If there are available market-based upward regulation bids, the parties can agree on maintaining part of the need for *manual active reserve* (15 min) in another *subsystem*. In this case, upward regulation can take place in price order in the joint Nordic *regulation list*.

In further upward regulation in price order, the *subsystem* can maintain parts of its *manual active reserve* (15 min) continuously. The *system operator* of the *subsystem* shall specify the volume and composition of this reserve on the basis of the current operational situation.

If there are not available market-based upward regulation bids in the neighbouring systems to cover the *subsystem*'s deficit of *manual active reserve* (15 min), a *power shortage* generally takes place in accordance with item 1.3.

1.2 Risk of power shortages

The *system operator* shall inform the other *Parties* as quickly as possible. The measures in question will be taken in order to avoid an unacceptable reduction of the *system security*.

Whenever required, the market *players* shall be informed via UMM as soon as possible. The information shall also be delivered directly from the *system operators* to the other P*arties*.

At least 600 MW of the most expensive *manual active reserve* (15 min) *in the regulation list* will be earmarked for each hour. Unavailable *regulation bids* will be marked on the joint *regulation list*. When there is a potential risk of *bottlenecks* arising, the reserve is to be distributed in consultation between the *Parties*.

The starting of *slow active disturbance reserve* and *peak load reserve* will be assessed. The other *system operators* will be informed on plans to start the reserve. The costs of starting the reserve in order to keep it in readiness are considered as *special regulation*.

1.3 Power shortages

When a *subsystem* is no longer capable of meeting the requirement for *manual active reserve* (15 min) and there are not sufficient available market-based *regulation bids* in the neighbouring systems, the other *system operators* are to be informed as quickly as possible

Prearranged trading between *players* is fixed and cannot be changed.

Svenska Kraftnät and/or Fingrid can demand that cross-border trading on Elbas between Sweden and Finland ceases, and Svenska Kraftnät and/or Energinet.dk can demand that cross-border trading on Elbas between Sweden and Denmark ceases.

When there is a requirement for upward regulation, bids on the *regulation list* are to be used in the order of price unless the *regulating power* will lead to *bottleneck*s in the *transmission network* or will be unavailable for other reasons. Market-based bids are used before *fast active disturbance reserve.* The earmarked *manual active reserve* will not, however, be activated until all of the remaining *regulation list* has been activated. When unexpected *bottleneck*s arise, the earmarked reserve can be redistributed.

1.4 Critical power shortages

When a *critical power shortage* is approaching, preparations for manual *load shedding* (15 min) will be ordered in the *deficit areas*. The *Parties* will agree on the *subsystem(s)* where the *load shedding* will take place and where in the *subsystem(s)* the *load shedding* will take place. The consequences for load shift must be assessed.

If no network problems arise, bids in the *regulation list* will be used until only 600 MW of *manual active reserve* (15 min) remains in the *synchronous system* at 50.00 Hz. The activation of *regulation bids* shall take place in price order, and if frequency regulation so requires, all market-based bids shall be activated before the *fast disturbance reserve*.

When only 600 MW of *manual active reserve* (15 min) remains in the *synchronous system*, it will be activated and retained as increased *frequency controlled normal operation reserve*. The activated reserve of at least 600 MW will be redistributed among rapidly regulating hydropower production in consultation between the *Parties.* The most expensive available upward regulation bid in hydropower production shall be deactivated. Bids with a low volume can be skipped in order to facilitate their handling. If there are no upward regulation bids, the downward regulations will be activated in price order. SvK and Statnett are responsible for and co-ordinate this.

When 600 MW of *manual active reserve* remains at 50.00 Hz but the underbalance increases (frequency decreases), load shedding without a commercial agreement must be implemented. The expected activation time for *load shedding* has to be weighed into the decision. *Load shedding* takes place in the *subsystem* with the greatest physical deficit in its balance. Shedding takes place in stages until the requirement for 600 MW of *manual active reserve* (15 min) in the *synchronous system* is met. When *load shedding* has taken place until two or more *subsystems* have an equally large deficit, *load shedding* is distributed thereafter between these *subsystems*. Attention must be paid to the practical handling; *load shedding* in stages of 200 – 300 MW at a time is considered a suitable level.

The 600 MW of *manual active reserve* (15 min) in rapidly regulating hydropower production is retained and used both as *frequency controlled normal operation reserve* and as *regulating power* to balance the *synchronous system* and maintain a frequency of 50.00 Hz while *load shedding* is activated.

When assessing a *subsystem's* balance, the *manual active reserve* (15 min) that is not activated must be taken into account. A *subsystem* with a physical deficit which can regulate itself into balance does not need to implement *load shedding.*

The *system operator* that carries out *load shedding* shall inform the market and the other *system operators* of *critical power shortage*.

2 Regional power shortages caused by bottlenecks or network disturbances

The relevant *subsystem* is responsible for measures as long as regulation resources are available.

If time allows, preparations for *manual load shedding* (15 min) will be ordered in the *deficit areas*.

If a *bottleneck* arises within a *subsystem* towards a area with a deficit and all available bids in the merit order *regulation list* that are without sufficient *manual active reserve* (15 min) within the area are activated, then *load shedding* will be ordered outside the merit order *regulation list. Load shedding* will be carried out in the *subsystem* with the greatest physical deficit in its balance and which remedies the *bottleneck.*

When assessing a *subsystem's* balance, the *manual active reserve* (15 min) which is not activated must be taken into account. A *subsystem* with a physical deficit which can regulate itself into balance does not need to implement *load shedding.*

If there are stable consumption conditions, the need for *manual active reserve* (15 min) within the *deficit area* will be less than if consumption had been rising. However, *manual active reserve* (15 min) must not fall short of 600 MW in the *synchronous system.*

3 Connection of consumption following load shedding

When the power balance within the *deficit area* improves, consumption will be reconnected in small steps. The potential for increased consumption as a consequence of shedding must be taken into account.

4 Pricing

The pricing of *supportive power* and *balance power* shall be set in accordance with normal principles. Normally, no *supportive power* shall be agreed upon, instead the power will be exchanged as *balance power*. In the event of price disputes, the setting of prices shall take place afterwards. The correction of irregularities in the pricing can be achieved by means of subsequently reaching agreement about *supportive power*.

The interconnected Nordic power system's joint operation with other systems

1 Western Denmark's joint operation with the UCTE system

1.1 Western Denmark's joint operation with Germany

Since the middle of the 1960's, Western Denmark has been parallel-connected with the German high-voltage network and has thus been a part of the synchronous continental *UCTE* system. Energinet.dk has been formally a member of *UCTE since March 2008*.

Energinet.dk's relationship with E.ON Netz is such that it does not have a formal system operation agreement with E.ON Netz, but there is a draft which is being processed.

In Germany, there is a "Grid Code" for the collaboration conditions relating to the technical system operation between the German *system operators*.

1.1.1 System operation collaboration with E.ON Netz

Energinet.dk is connected to E.ON Netz via the following links:
- 220 kV Kassø – Flensborg, *settlement point* Kassø
- 220 kV Ensted – Flensborg, *settlement point* Ensted
- 2 x 400 kV Kassø – Audorf, *settlement point* Kassø.

The *transmission capacity* is normally 1,500 MW southbound. Taking into account the risk of faults at major production facilities, the *transmission capacity* northbound is 950 MW.

Energinet.dk and E.ON Netz are discussing a system operation agreement. Irrespective of this agreement, Energinet.dk must comply with the following *UCTE* requirements:

- Contribute to the combined momentary reserve of the synchronous continental system. The proportion is determined by the *dimensioning faults*, and the requirement is in relation to the *system operator's* production in his own area. See Appendix 2 section 5.

- Each area inside *UCTE* must be able to manage its own balance.

  Technically, the balance is managed via a load frequency controller function on the Danish-German border.

- *Trading plans* are specified in quarter-hourly and hourly energy.

- The energy plan is converted into a power plan. To include the energy as per the *trading plan,* regulation is commenced between five minutes before and five minutes after a quarter shift.

- The *load shedding* is co-ordinated.

The ramping requirement for exchanges with E.ON Netz has a direct impact on transiting between the *synchronous system* and the continent. This means that the five-minute requirement is directly transferred to the transiting, when changes are made in the same direction during hour shifts.

1.1.2 Commercial conditions

The *transmission capacity* across the Danish-German border is utilized for commercial purposes in accordance with the following principles; a detailed description can be found on Energinet.dk’s and E.ON Netz’s websites.

- Annually and monthly, some of the *transmission capacity* in each direction is offered at auction. The winners of the auction obtain the right to submit bilateral *trading plans* via the Danish-German border on the morning prior to the day of operation. These plans are binding. Unutilized capacity is lost.

- Every day, the remaining part of the *transmission capacity* in each direction is offered at auction. The winners of the auction obtain the right to submit bilateral trade via the Danish-German border on the day before the day of operation. Utilization of the capacity is not compulsory.

There are formal requirements for the traders to comply with in order to be able to take part in the auction.

1.2 Western Denmark's joint operation with Flensborg

Since the beginning of the 1920's, Stadtwerke Flensborg (SWF) has conducted AC collaboration across the Danish-German border. This collaboration has, with time, become more and more intensive, and a 150 kV link between Flensborg and Ensted is now established.

Energinet.dk and SWF have entered into an agreement which regulates the system operation and market conditions.

1.2.1 System operation collaboration with SWF

Stadtwerke Flensborg is connected to Energinet.dk via the following links:

- 150 kV Ensted – Flensborg, settlement point Ensted
- 60 kV links between Kruså and Flensborg.

The *transmission capacity* is normally 150 MW in both directions.

SWF has the opportunity to carry out exchanges with Slesvig via the 60 kV network. Exchanges are regulated via a transverse voltage transformer.

1.2.2 Commercial conditions

SWF has a limited-duration prioritized transmission for utilizing the capacity of the network between Energinet.dk and SWF, i.e. on the 150 kV link between Flensborg and the Ensted station.

In SWF's area, there are no other market players than SWF as a producer. When other players emerge, and there are capacity limitations, an auction system will be introduced which will correspond to that which applies between Energinet.dk and E.ON Netz today.

2 The synchronous system's joint operation with the UCTE system

2.1 The synchronous system's joint operation with Germany via the Baltic Cable

The Baltic Cable is an HVDC link between Sweden and Germany. The link goes between Trelleborg on the Swedish side and Lübeck on the German side. Baltic Cable AB owns the cable link. Co-owners are E.ON Sverige and Statkraft Europa.

The capacity is 600 MW.

2.1.1 System operation collaboration with E.ON Netz

There is no system operation agreement. The *system services* that exist have been produced vis-à-vis E.ON Sverige. The link is equipped with an *emergency power* function. There is also a *system protection* function, which provides a greater *transmission capacity* in southern Sweden.

2.1.2 Commercial conditions

The link is presently used for the cable owners' day-ahead and intraday trade. The utilization fees are regulated by means of a tariff. Idle capacity permitting, there are opportunities for Svenska Kraftnät to do *supportive power* deals via E.ON Sverige.

2.2 The synchronous system's joint operation with Germany via Kontek

Kontek is an HVDC link between Eastern Denmark and Germany.
The link goes between Bjaeverskov on the Danish side and Bentwisch on the German side. Energinet.dk is the owner of the facilities in Denmark and the cable link across to the German coast. Vattenfall Europe Transmission is the owner of the facilities in Germany. The link is connected to the 400 kV network in Zealand and Germany. The *transmission capacity* is 600 MW.

2.2.1 System operation collaboration with Vattenfall Europe Transmission

The combined suite of agreements (entered into between the former VEAG and the former ELKRAFT) contains rules for system operation as well as allocation. As yet, there is no separate system operation agreement. There is an agreement regarding a *system protection* function, which could yield a higher transmission capability in southern Sweden.

2.2.2 Commercial conditions

The link's *transmission capacity* is utilized as follows:

Southbound:
550 MW is made available to Nord Pool Spot for *Elspot trading* and *Elbas trading*.
50 MW is utilized as *frequency controlled disturbance reserve*.

Northbound:
550 MW is made available to Nord Pool Spot for *Elspot trading* and *Elbas trading*.
50 MW is utilized as *frequency controlled disturbance reserve*.

Settlement point: Bentwisch.

2.3 The synchronous system's joint operation with Poland

SwePol Link is an HVDC link between Sweden and Poland. The link goes between Karlshamn on the Swedish side and Slupsk on the Polish side. SwePol Link AB owns the cable link. The owners are:

Svenska Kraftnät
Vattenfall AB
Polish Power Grid Company (PPGC)

The capacity is 600 MW.
The *system operator* on the Polish side is Polskie Sieci Elektroenergetyczne (PSE).

2.3.1 System operation collaboration with PSE

The system operation collaboration is regulated by a system operation agreement. This agreement regulates, for instance:

- Technical limitations
- Outage co-ordination
- *Emergency power functions*
- Exchanges of *trading plans*.

The link is regulated half-yearly from the respective *system operator*.

2.3.2 Commercial conditions

SwePol Link AB is a transmission company that sells *transmission capacity* on the link.
The utilization fees are regulated by means of a tariff. Today, the bulk of the link's capacity is being utilized via a long-term agreement. A minor part of the capacity remains unutilized. Idle capacity permitting, there are opportunities for the respective *system operator* to do *supportive power* deals.

2.4 The synchronous system's joint operation with the Netherlands

The NorNed HVDC link between Norway and the Netherlands was taken into commercial operation on 6 May 2008. The cable links together 380 kV Eemshaven in the Netherlands and 300 kV Feda in Norway. Statnett SF owns the HVDC facility in Feda and TenneT TSO B.V. owns the HVDC facility in Eemshaven. The submarine cable is owned in equal proportions by the parties, with Statnett owning the northern part. The cable is 580 km long and has a capacity of 700 MW at the receiving end. At the moment, there is no overloading capacity on the cable.

2.4.1 Joint system operation with TenneT

Statnett and TenneT signed a System Operation Agreement on 10 December 2007. This agreement specifies the principles and relationships for system operation. There is a separate agreement for the exchange of system services and a settlement agreement. The Operation and Maintenance Agreement specifies how the HVDC link and communications systems between the AC/DC converter stations in Norway and the Netherlands must be operated and maintained.

Maintaince of the link is planned in co-operation between TenneT and Statnett. On the Nordic side, this is co-ordinated with other maintenance work in Southern Norway and other essential outages in the synchronous Nordel area.

There is no system protection on the link. It is possible to request emergency assistance from the other party if a critical situation has emerged or can be expected.
In the event of operational disturbances where no other means are available and when there is no time to follow normal procedures, it is possible to quickly reduce the exports by 200 MW.

2.4.2 **Commercial conditions**

In 2008 the capacity (700 MW) is made available to the market parties hourly in the day market through explicit auctioning (NorNed Auction). Market parties which are either ”a Program Responsible Party” in the Netherlands or a balance provider in Norway can participate in auctioning. In Norway parties which have purchased capacity and wish to use this right can change the right in a bid in the same Elspot area as Feda.

It is possible to give bids on capacity in both directions but after the first calculation, the direction for auctioning is specified hourly (based on prices at 300 MW of sold capacity). In order to take care of the Nordel restriction of a maximum change of 600 MW in power flow from one hour to another, only 300 MW of capacity is made available for the hours at the change of hours when the desired capacity direction changes.

Unused capacity and potential overloading feature will be made available for a future IntraDay market and for the development of system services between Statnett and TenneT. This is expected to take place in 2009.

If the change in the specified programme is $<|300|$ MW from one hour to the next, ramping will begin 5 minutes before the change of hour and finish 5 minutes after the change of hour. If the change is $\geq|300|$ MW, this is ramped at 30 MW/min symmetrically around the change of hour. If the change is $>|600|$ MW, 600 MW will be ramped at 30 MW per minute symmetrically around the change of hour and the remainder of the change is placed in the step in the following hour.

Statnett and TenneT can temporarily restrict the available trading capacity in order to secure operational reliability if no other means are available.

3 The synchronous system's joint operation with Russia

Electricity imports from Russia began in 1960. There was a significant increase in imports at the beginning of the 1980's, when the HVDC stations at Viborg and the double 400 kV lines were commissioned. The third 400 kV line went into commercial operation at the beginning of 2003.

3.1 System operation collaboration with RAO UES of Russia

The Finnish grid is connected with Russia via three 400 kV lines from Viborg (Russia) to Yllikkälä and Kymi (both Finland). The technical *transmission capacity* is 1,400 MW. Transmissions take place via the HVDC stations at Viborg and from a 450 MW gas-fired power plant which is in isolated operation, i.e. synchronised with the *synchronous system*. In addition to this, there are two 110 kV links, Ivalo – Kaitakoski (60 MW) and Imatra – Svetogorsk (100 MW), owned by private regional network companies.

Fingrid and RAO UES of Russia signed a system operation agreement on 6 February 2003, which regulates operational and technical relations between the power systems. Nordel's recommendations and requirements have been taken into account. The agreement was updated in December 2007 and divided into four separate agreements, i.e. Intersystem Agreement, Operation Agreement, Capacity Allocation Agreement and System Service Agreement. The agreement parties are now Federal Grid Company of the Unified Energy System (FGC), System Operator - Central Dispatching Office for the Unified Energy System (SO) and Fingrid.

3.2 Commercial conditions

For technical and commercial reasons, trading via the link only occurs from Russia to Finland. The *trading capacity* is 1,300 MW.

The transmission service is based upon a firm fixed-period transmission. The minimum period for a transmission reservation is one year while the longest is three years. The smallest volume for individual *players* is 50 MW.

The daily hourly transmission programme is agreed upon on a daily basis and imports are managed as a firm delivery in the balance settlement. Fingrid carries the balance responsibility for the delivery.

Fingrid and RAO UES of Russia have agreed that the link and the HVDC stations at Viborg may also be used for technical requirements. 100 MW has been reserved for this purpose. The link is used for frequency regulation and can also be used for *fast active disturbance reserve*.

4 The synchronous system's joint operation with Estonia

Estlink is a HVDC Light link between Finland and Estonia. The link was taken into commercial operation on 4 January 2007, and it runs between Espoo in Finland and Harku in Estonia. AS Nordic Energy Link (NEL) is the owner of the cable link. The transmission capacity is 350 MW in both directions. The link has a 15 MW temperature-related overload capacity.

4.1 System operation collaboration with NEL

Fingrid and the Estonian TSO Põhivõrk are responsible for the technical operation of the link by virtue of an agreement with NEL. Fingrid operates the link during the first half of the year and Põhivõrk during the second half. The link is provided with *system services* such as oscillation damping on the Finnish side, *emergency power* function and *black start* function on the Estonian side as well as automatic *frequency control* function and reactive power support on both sides depending on active transmissions on the link.

4.2 Commercial conditions

The link is presently used for prioritised trading by the owners. Unutilized capacity shall be made available to the market. The trading capacity and trading results are managed using a specific information system, NELIS.