

Joint operation between the Norwegian and Western Danish subsystems on the DC links Skagerrak poles 1, 2, 3 and 4

Appendix 4 to SOA Annex OS (NO and DK1)

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1 Background

The subsystems of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected. The subsystem of Western Denmark is connected to Norway, Sweden and Eastern Denmark 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	Receiving end
Kristiansand-Tjele SK3	350 kV DC	Receiving end
Kristiansand-Tjele SK4	500 kV DC	Receiving end

Together, SK1, SK2, SK3 and SK4 make up the Skagerrak link.

3 Operation of facilities under 2

3.1 General

The common ground for the electrical safety work of the system operator companies within ENTSO-E Regional Group Nordic 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 operation

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

3.3 Switching responsible operator

3.3.1 Switching

In the event of outages on the HVDC cables, there shall be an exchange of written confirmation, before a work authorization can be dispatched, between Statnett's Regional Control Centre in Oslo and Energinet's control room at Tjele stating that the HVDC disconnectors 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's Control Centre at Erritsø, while authorization for all switching 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 Control Centre in Oslo gives the switching authorization, and issues work authorizations on the Norwegian side.

Switching at the AC facilities are normally carried out from Energinet's Control Centre at Erritsø and from Statnett's Regional Control Centre in Oslo.

3.4 Operation monitoring and control

Operation monitoring and control is carried out from:

- Energinet's Control Centres at Erritsø or Tjele.
Statnett's Regional Control Centre in Oslo.
- The four DC poles can be operated individually from Statnett's Control Centre in Oslo and from Energinet's Control Centre in Tjele.
- The four DC poles can be operated bi-pole level from Erritsø.
- Energinet's Control in Erritsø is only receiving group alarms.

3.5 Outages

Prior to planned outages on the HVDC links, written confirmation shall be exchanged between Statnett's Regional Centre in Oslo and Energinet's control room at Tjele.

Statnett or Energinet may disconnect the link without such written confirmation, to prevent endangering personnel safety, damaging equipment or to ensure system operation in emergency state, according to Article 14 of the Network Code Emergence & Restoration.

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 Total Transmission Capacity

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

SK1, SK2:	Technical min. 12,5 MW/pole	Nominal 500 MW
SK3:	Technical min. 13 MW	Nominal 500 MW
SK4:	Technical min. 0 MW	Nominal 715 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'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 (Net Transmission Capacity - NTC)

The normal trading capacity (NTC) in "bi-pole operation", in day-ahead-market, is:

1680 MW at 20°C in market sending end
(Market capacity is based on the loss factor, currently at 2,9%)

In the intra-day-market the trading capacity is:

1632 MW at 20°C in receiving end

The trading capacity may also be restricted based on specific operational conditions in the AC grid on either side of the link or in the DC link itself. The following calendar day's trading capacity is decided each day. Scheduled losses is calculated in the market (losses covered by market), the

difference between the measured losses and the scheduled losses will be handled in the sending end

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 is carried out from:

- Energinet's Control Centres at Erritsø or Tjele.
Statnett's Regional Control Centre in Oslo.
- The four DC poles can be operated individually from Statnett's Control Centre in Oslo and from Energinet's Control Centre in Tjele.
- The four DC poles can be operated bi-pole level from Erritsø.
- Energinet's Control in Erritsø is only receiving group alarms.

4.4.1 The power flow and distribution between the DC links

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.

The distribution of power flow between the DC links is described in the agreement for SK1-4.

4.4.2 Control of the link

Control of the Skagerrak link in accordance with agreed exchange plans will be carried out by Statnett and Energinet alternating each month.

The plans are issued as power plans in whole MW for each 5 minutes. The link is controlled 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 in planning phase.

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.

Outage 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 Delta power

Delta power consists of control measures which are initiated manually.

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

Delta power without previous notice may be activated with up to 100 MW and 100 MWh/calendar day. Prior to activation over and above this, notification and approval shall occur between Energinet'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 control will be interrupted. Activation over and above the agreed limits and control back to plan may not occur until the counterparty has approved this. (See further in Appendix 9 – System protection schemes).

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

5 Miscellaneous

5.1 System services

For the manual activation of operation reserves, the available transmission capacity (the "leftover" from Day ahead and Intraday) can be used.

Both Statnett and Energinet have the right to utilize idle transmission capacity for the transmission of system services. Configuration values, power limits etc. are agreed upon bilaterally.

Energinet and Statnett can also conclude agreements concerning other types of system services.

5.2 Settlement

Energinet and Statnett manage the settlement in cooperation and agrees upon settlements data on daily basis. Each party sends the demand to the other party.