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Explanatory document

# CONTROL STRUCTURE FOR THE PUBLIC ELECTRICITY SUPPLY GRID

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## 1. Purpose and scope

### 1.1 Purpose

The purpose of this explanatory document is to summarise and describe the control structure that applies to the public electricity supply grid.

The control structure is designed to ensure the following in all operating situations:

- Control room responsibility and responsibility for coordination with other control rooms are well-defined
- No control room is responsible for contact with more cooperating control rooms than it is practically possible to manage – including in urgent situations
- The control rooms receive and pass on necessary operational information.

### 1.2 Scope

All electricity supply companies in Denmark are subject to the control structure and must comply with applicable technical regulations and provisions referring to this.

The purpose of the control structure is to contribute to ensuring well-functioning system operation through structured and precise communication.

This explanatory document provides an overview of the legislation and rules governing the control structure

### 1.3 Effective date

This explanatory document is valid from 17 August 2020 and replaces:

- Doc. 13/89692-310 dated 10 April 2015 (3rd edition) – Control structure for the public electricity supply grid.

## 2. Terminology and definitions

### Distribution grid

A public electricity supply grid intended to supply electricity to an indefinite group of consumers, or a grid owned by a collective electricity supply company and is intended to connect a consumer directly to the transmission grid.

### DSO

#### Distribution system operator (DSO)

Any natural person or legal entity responsible for operating, maintaining and, if necessary, expanding the distribution system in a particular area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to satisfy reasonable demand for the distribution of electricity.

### Electricity supply company

#### Public electricity supply company

Concession holder or electricity supply company operated by Energinet or its wholly owned subsidiaries that operate transmission grid in pursuance of section 2 (2) and (3) of the Danish Act on Energinet.

### Energinet

Concession holder authorised to operate the entire Danish transmission grid. In Denmark, this function is combined in Energinet or its wholly owned subsidiaries that operate transmission grid – in pursuance of Executive Order no. 516 of 20 May 2010, section 2 (2) and (3), of the Danish Act on Energinet.

### Control Centre Electricity

The transmission system operator's control room function, which handles overall control/monitoring of the entire electricity system and operates the entire transmission grid.

### Public electricity supply grid

Transmission and distribution grids that serve to transmit electricity for an indefinite group of electricity suppliers and consumers on terms laid down by public authorities.

### Control structure

Describes the roles and responsibilities of Energinet, DSOs, producers, and balance-responsible parties regarding coordination, communication, and collaboration in general in connection with security of supply in the public electricity supply grid.

### Point of common coupling (PCC)

The point of common coupling (PCC) is the point in the public electricity supply grid where consumers are or can be connected.

The point of common coupling and the point of connection may coincide electrically. The point of common coupling (PCC) is always closer to the public electricity supply grid.

Energinet determines the point of common coupling.

### Grid company control room

The grid company control room (NK) primarily controls and monitors 30-60 kV and/or 10-20 and 0.4 kV grids.

#### Grid region

A DSO or a collaboration between DSOs that, as a minimum, handles the operation of distribution grids in the interface with Energinet on behalf of several DSOs. A grid region covers a geographically (or electrically) defined supply area.

#### Transmission grid

A public electricity supply grid intended to transmit electricity from generation facilities to a primary centre in the distribution grid or to connect it to other interconnected electricity supply grids.

### 3. Energinet's obligations under legislation

Energinet is responsible for ensuring that an interconnected electricity supply grid and sufficient generation capacity are available to the system at all times. Furthermore, Energinet is responsible for overall planning and management in the electricity sector. Obligations are imposed on Energinet under the Danish Electricity Supply Act, cf. Executive Order no. 119 of 6 February 2020 as amended.

Energinet must likewise handle the overall, coordinated planning and operational tasks pertaining to the emergency preparedness mentioned in the "Executive Order concerning emergency preparedness for the electricity sector" (Executive Order no. 819 of 14 September 2019).

### 4. Control structure for the public electricity supply grid

The transmission grid is managed in day-to-day operation by Control Centre Electricity and includes all grid facilities above 100 kV. Facilities under 100 kV are owned by DSOs, each of which operates the distribution grid in a defined area. These grid facilities are primarily managed from the individual DSO's grid company control room or in a collaboration between two or more DSOs in a grid region and with a joint grid company control room.

The distribution grids are operated differently from one area to another. In some areas, the DSO owns and operates the entire distribution grid from Energinet's point of common coupling to the grid customer (consumer or generator). In other areas, a DSO owns and operates the grid from Energinet's point of common coupling to another DSO, which in turn owns and operates the grid from there to the grid customer.

In areas where DSOs are part of a grid region or are supplied by another DSO, steps must be taken to ensure that the individual overall grid company control rooms have a sufficient overview of the grid area covered by the grid company control room. Furthermore, it is important that these overall grid company control rooms have the necessary competences and authority from the individual underlying DSOs to meet the requirements set out in the control structure. Steps must also be taken to ensure that the grid company control rooms have sufficient access to relevant data, including the online data that is important for the grid overview.

In daily operations, well-defined operation limits must be agreed between Control Centre Electricity and the grid company control rooms at the points of common coupling. These limits are documented through interconnection agreements describing the division of responsibilities in the operational interfaces between Energinet and the DSOs. These agreements may be individual for the individual facilities depending on the structure and the operating conditions.

In situations where a concession-holding DSO outsources monitoring and switching management at Energinet's point of common coupling to another DSO or an operating company, there must be no doubt as to which DSO/which operating company and grid company control room has control room responsibility for the individual facilities within the operation limits. Furthermore, the DSO must notify the operation manager and switching managers of the individual facilities in accordance with Executive Order no. 1608 on safety for operation of electrical facilities.

Control Centre Electricity must at all times be able to ensure that communication takes place with the right individuals with the necessary authority and competences for the individual control room. This is achieved by using communication that only authorised operating staff are able to access in the individual companies.

Control Centre Electricity must be able to communicate individually with each grid region/DSO in all operating situations, especially during operational disturbances, as the system operator must be able to issue information/orders for grid regions and DSOs individually (for example regarding manual load-shedding).

Appendix 1 contains an overview of the DSOs and the grid company control rooms responsible for points of common coupling with Energinet.

The grid company control rooms responsible for supplying underlying DSOs must ensure the subsequent coordination of operations with the underlying grid company control rooms.

## **5. Control structure for electricity generation in the electricity system**

Generators can be connected at all voltage levels; in other words they can be connected to either the transmission grid or the distribution grid.

The market structure for active power generation for all generators connected at transmission level and distribution level is laid down in market regulations which describe how the daily active power generation is to be planned and reported to Energinet from the balance-responsible parties for generation. This concept is intended to provide certainty that planned generation does not exceed the predicted, permissible loads in the transmission grid.

The market structure ensures that 24-hour planning of generation is under control, but not real-time regulation and operating conditions of generators.

For operational purposes, the market concept is supplemented with an operational control structure that takes account of the fact that generators contribute to maintaining reliable system operation. The relevant procedure and precautions are described in Technical regulation 5.3.4.2 The Produktionstelegraf system.

## **6. Emergency preparedness**

In crisis situations, responsibility for coordinating the individual sectors rests with the police and the government.

In the event of major national crises, the Danish National Police may convene NOST (the National Operations Staff) if deployment needs to be coordinated across local emergency preparedness teams. The Danish Energy Authority is responsible for ensuring that the energy sector participates in NOST, and it can instruct Energinet to participate also.

In crisis situations, the chief police officer of a police district may convene the local emergency preparedness team of that police district (Appendix 3). Energinet is responsible for ensuring that the electricity sector participates in local emergency preparedness teams.

The composition of the local emergency preparedness team in an emergency preparedness situation will depend on the specific situation. Energinet is responsible for staffing the local emergency preparedness teams when the electricity sector is called to participate, but Energinet can make arrangements to be represented by employees from local DSOs.

Executive Order no. 819 gives Energinet responsibility for overall coordination in the electricity sector – for planning as well as operations in emergency preparedness situations.

In practice, this means that Energinet must advise the companies in the sector on emergency preparedness activities. Energinet is also responsible for ensuring that the companies are coordinated before an emergency preparedness event occurs and during an emergency preparedness situation.

During the crisis situation, Energinet is responsible for coordinating the sector's handling of the crisis situation and the restoration of supply – including appointing representatives to the local emergency preparedness teams and participating in NOST if applicable. Furthermore, Energinet is responsible for informing the Danish Energy Agency and other central authorities about the situation in the sector.



## 7. Division of responsibilities and tasks between the control rooms in the control structure

Figure 1 shows the typical interfaces between the various market participants in the electricity system. The interfaces are illustrated by the numbered arrows in the drawing. The contents of the interface are typically described and specified in various types of documents, such as technical regulations and market regulations, operating/interconnection agreements, emergency preparedness plans, memorandums etc.

The memorandum primarily focuses on the electricity grid, shown with green/light fields. The blue/dark fields are included to give an idea of the overall electricity sector nationwide.

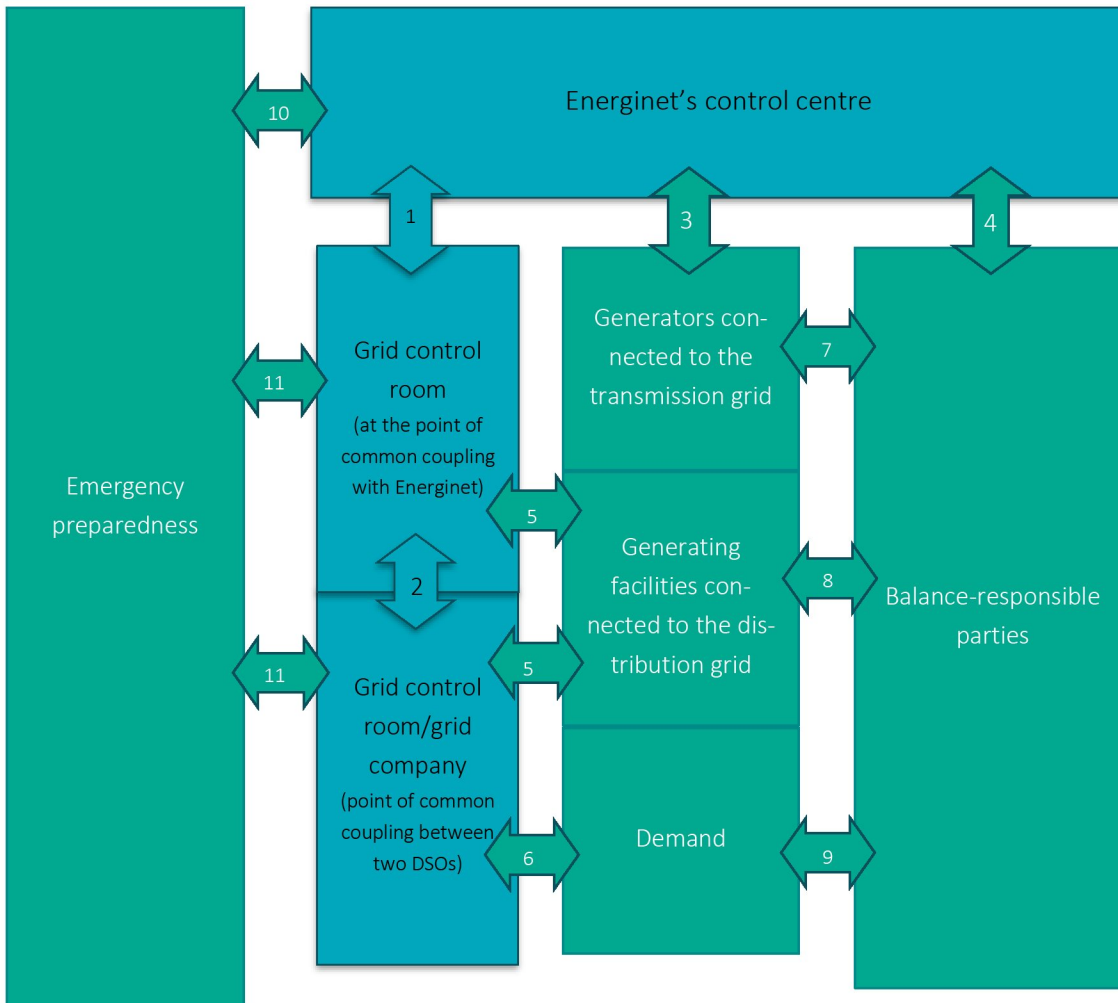


Figure 1 Typical communication interfaces between market participants in the electricity system.

In general, and especially in the control rooms, the operating staff must contribute to ensuring the safe operation of the entire electricity system through cooperation and coordination. Examples of the main actions and information to be exchanged between the staff of the control rooms are described below.

### 7.1 Energinet – grid company control room (interface no. 1)

The interface between transmission and distribution is coordinated in terms of operations and emergency preparedness by Control Centre Electricity and the grid company control room, which represents the DSO at Energinet's point of common coupling.

If two or more DSOs share a grid company control room, the grid company control room is responsible for coordinating operations and emergency preparedness with the underlying DSOs.

**The interface is specified in:**

- Technical regulation 5.3.4.1 – The Nettelegrafen system
- Technical regulation 2.1.2 – Load-shedding etc.
- Technical regulation 5.4.1 – Outage planning
- Emergency preparedness plan for the electricity sector
- Interconnection agreements for electricity supply facilities
- Operation manager agreements
- Electricity sector emergency preparedness plan.

**Coordination in the interface:**

The interface must be specified and coordinated so that operational and emergency preparedness situations can be handled precisely and efficiently in terms of actions as well as the flow of information. Some of the important information and activities to be exchanged between the control room staff are:

- Relevant switching operations in the transmission grid, planned and unforeseen
- Identification of the cause(s) of faults and inspection of facilities
- Current operating level determined by Energinet
- Current emergency preparedness level determined by the authorities and/or Energinet
- Coordination of electricity system restoration efforts in the event of/after faults
- Information in accordance with applicable system operation regulations and instructions
- Use of a control structure to report and collect information from the individual grid company control rooms
- Exchange of operational information, for example via the Nettelegrafen system.
- Coordination of switching operations in grids of mutual importance, planned and unforeseen
- Exchange of information about abnormal system conditions and events such as unintended loss of supply to electricity consumers
- Exchange of grid topology and essential metered data (online data).

**7.2 Grid company control room – underlying grid company control room (interface no. 2)**

In some areas, several DSOs work together to operate the main distribution grid (for example 60 kV). This may be through a jointly owned DSO, which owns and operates the grid, or a joint operating company, which operates the grid on behalf of the individual DSO.

In other areas, the higher-level distribution grid is owned and operated by a DSO, and other DSOs are connected exclusively to this network without any ownership of the higher-level distribution grid.

In both cases above, some DSOs operate and are responsible for a distribution grid connected at Energinet's points of common coupling and up to a distribution grid operated by another DSO. In these cases, the DSOs connected to Energinet's point of common coupling are responsible for further coordination with the grid company control rooms for the underlying grid in relation to the control structure.

**The interface is specified in:**

- Emergency preparedness plan for the electricity sector
- Interconnection agreements for electricity supply facilities
- Operation manager agreements
- Agreements on the establishment of and functions of a joint operating company (joint control room)
- Other.

**Coordination in the interface:**

Coordination and cooperation between control rooms is essential for reliable operation and supply in the areas. Some of the most important information and activities to be exchanged between the control room staff are:

- Coordination of switching operations in grids of mutual importance, planned and during operational disturbances
- Identification of the cause(s) of faults and inspection of facilities
- Current operating level and emergency preparedness level determined by Energinet
- Coordination of efforts to restore the electricity system in the event of/after faults (taking into account personal safety, facility safety, system operation, and servicing of the market)
- Use of a control structure to report and collect information from the individual grid company control rooms
- Exchange of information about abnormal conditions and events such as unintended loss of supply to electricity consumers
- The grid company control room must have a sufficient overview of the grid area, including necessary information about lower voltage levels
- Exchange of grid topology and essential metered data (online data).

**8. Technology and shared tools**

Control room cooperation is highly dependent on efficient and robust technical systems and aids. It is vital, especially during operational disturbances, that the control rooms can communicate via systems with high operational reliability.

It is important to note that secure systems must also be covered by on-duty arrangements which are not carried out from the company's grid company control room. Typically this means on-duty from home arrangements, mobile on-duty operators etc., where the on-duty activities take place from different addresses. It is therefore not sufficient in those situations to rely solely on public internet and mobile telephony.

The requirements for the technical communication systems are laid down in Technical regulation 5.3.4.1. The Nettelegrafren system.

**9. Control room staffing requirements**

The control structure and the control room staff must be sufficient to handle operational disturbances quickly and efficiently and to meet the emergency preparedness provisions.

Many grid region and grid company control rooms are only physically staffed during normal working hours. Outside normal working hours, monitoring is typically carried out by the on-duty operators via on-duty from home arrangements using a connection to the remote control system. Communication often takes place via public mobile phones and/or a landline.

The electricity supply sector – including the electricity supply companies – is extremely important in maintaining the infrastructure of society. This is true in day-to-day operational situations and also in more acute emergency preparedness situations. It is therefore a condition that these on-duty arrangements must not result in reduced performance compared to the performance of physically staffed control rooms.

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## 10. Appendices

Appendix 1: Overview of DSOs and control rooms at points of common coupling with Energinet.

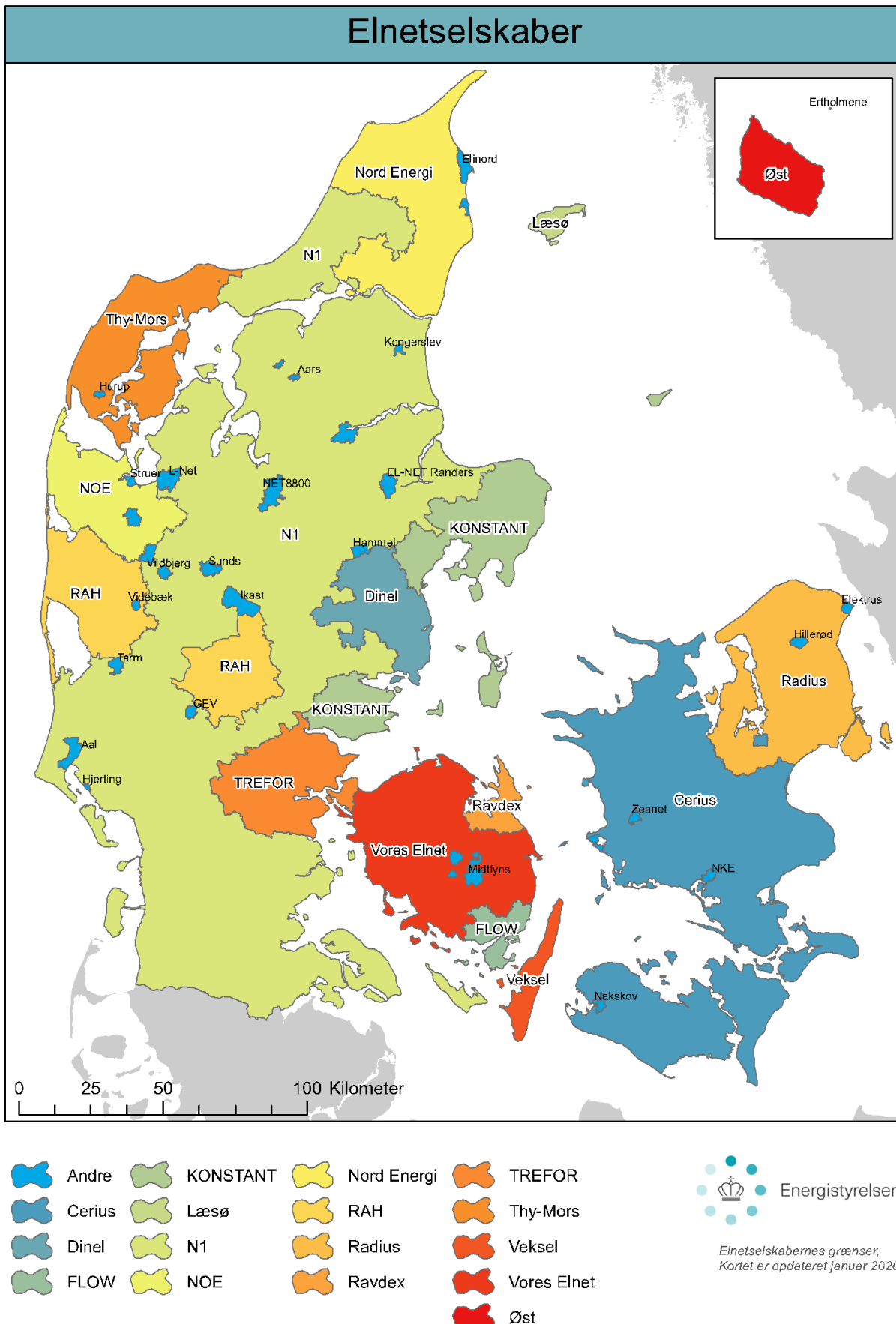
Appendix 2: Map of DSOs.

Appendix 3: Map of local police districts/local emergency preparedness teams.

## 10.1 Appendix 1: Overview of DSOs and control rooms at the point of common coupling with Energinet

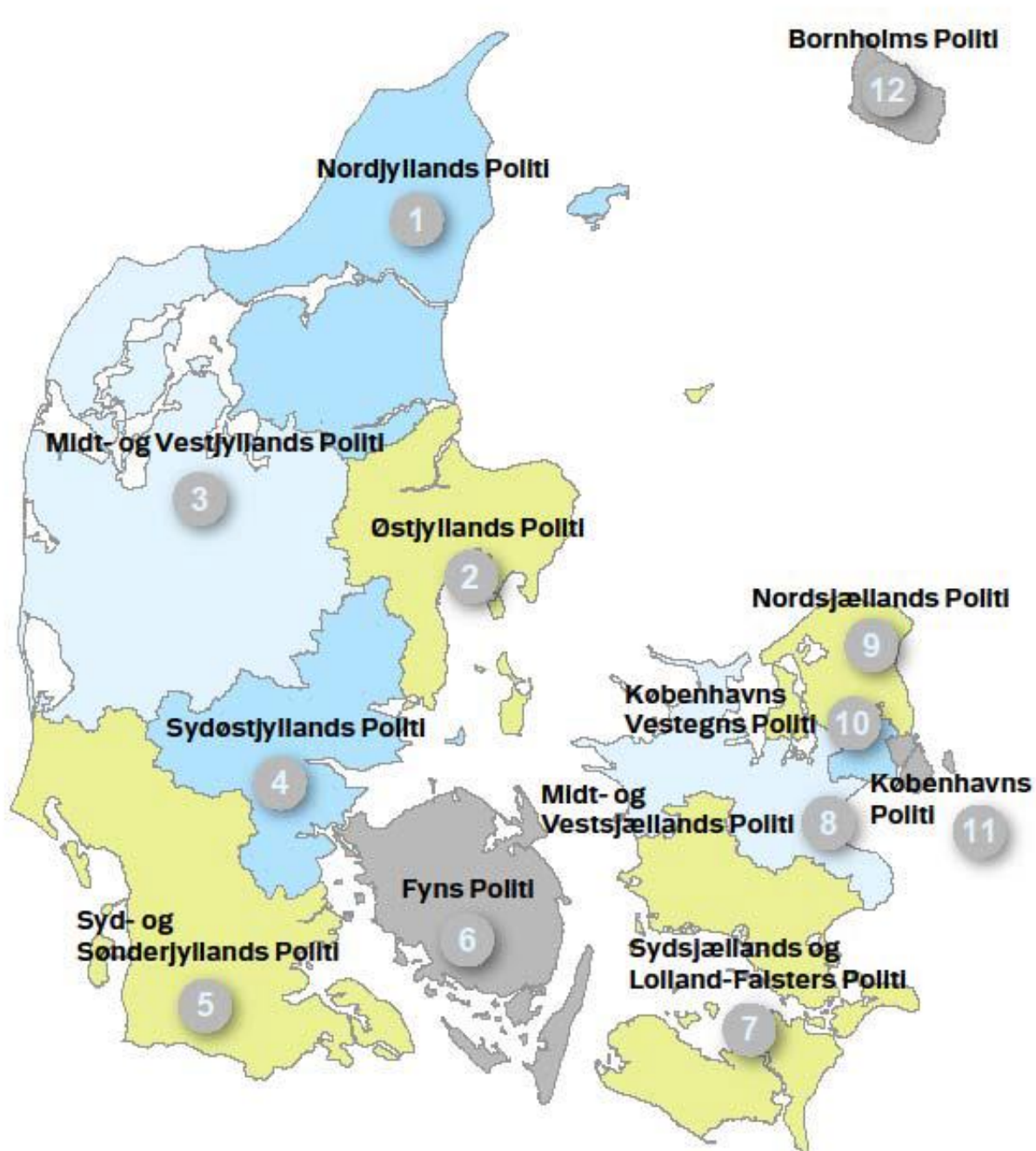
Geographical area	Control room with point of common coupling with Energinet	Underlying DSOs
<b>Jutland</b>	Dinel	-
	Elinord	-
	Elnet Midt	-
	KONSTANT Net (Nord)	-
	KONSTANT Net (Syd)	-
	N1 (Midt) Støvring	EL-NET Kongerslev Hammel Elforsyning Net Sunds Elforsyning Vildbjerg Elværk A.m.b.a Aars-Hornum Net
	N1 (Syd) Esbjerg	Hjerting Transformatorforening Tarm Elværk Net Aal El-net A.m.b.a
	Nord Energi Net	Læsø Elnet
	RAH Net	-
	Thy-Mors Energi El-Net	Hurup Elværk Net
	TREFOR El-net	-
	Vestjyske Net 60 kV	GEV Elnet Ikast El Net L-Net NOE Net - Forsyning Elnet RAH Net (f. Ringkøbing) - Videbæk Elnet Thy-Mors Energi El-Net
<b>Funen</b>	Vores Elnet	FLOW Elnet Midtfyns Elforsyning Ravdex TREFOR El-Net, (f. Middelfart) VEKSEL
<b>Zealand</b>	Cerius	Elnet Zealand Nakskov Elnet NKE-Elnet
	Radius (City)	-
	Radius (Nord)	Elektrus N1 Hillerød
<b>Bornholm</b>	El-Net Øst	Christiansø Elværk

10.2 Appendix 2: Map of DSOs



Source: Danish Energy Agency (updated January 2020).

## 10.3 Appendix 3: Map of local police districts/local emergency preparedness teams



Source: Danish National Police