# National preventive action plan for Sweden’s natural gas supply

– in accordance with Regulation (EU) No 2017/1938 of the European Parliament and of the Council

Dnr: 2019-006087

## Foreword

As the competent authority, the Swedish Energy Agency (Energimyndigheten) is obliged, pursuant to Regulation (EU) No 2017/1938 of the European Parliament and of the Council, to draw up a preventive action plan at national level.

This preventive action plan covers the western Swedish natural gas system and is based on the risk assessment that was carried out in 2018 in accordance with the regulation.

This plan applies from 15th of April 2019.

Eskilstuna, March 2019


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| Robert Andrén | Patricia Enhörning |
| Head of Department | Project Manager |

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# 1 Introduction

The Security of Supply Regulation was adopted in November 2017 for the purpose of safeguarding the security of gas supply by ensuring the proper and continuous functioning of the internal market for natural gas. In accordance with the Regulation, security of gas supply is a shared responsibility of natural gas undertakings, Member States (notably through their competent authorities), and the Commission, within their respective areas of activities and competence. In addition, the Security of Supply Regulation states that gas supplies to protected customers must be ensured. In accordance with the option provided for in the Security of Supply Regulation, Sweden has chosen to include within the definition of 'protected customers' only household customers who are connected to a gas distribution network.[1] The term 'household customers' is also used in Directive 2009/73/EC[2]. However, in the Natural Gas Act (2005:403) the term 'household customer' has been replaced with the term 'consumer'.

In accordance with the Security of Supply Regulation, after consulting competent authorities at the appropriate regional level and the Commission, the competent authority must update the preventive action plan, which is to contain the measures to be taken to remove or mitigate the risks identified in the risk assessment[3] in relation to Sweden's natural gas supplies. The Swedish Energy Agency has consulted Denmark's competent authority. This document constitutes the updated preventive action plan as referred to above.

The entry into force of the first Security of Supply Regulation (994/2010) has resulted in the Security of Natural Gas Supply Act (2012:273) and the Security of Natural Gas Supply Ordinance (2012:275), both of which came into force on 1 July 2012 and are now being updated in accordance with the new regulation. The Act and Ordinance authorise the Swedish Energy Agency (the competent authority) to issue regulations on the obligation of natural gas undertakings and companies using large quantities of natural gas to draw up and adhere to a preventive action plan and emergency response plan for the undertaking's activities, referred to as 'company plans'. One of the aims of the company plans is to specify which measures the respective companies are to take at different crisis levels, as well as to make it easier for the competent authority to gather the information on which the national plans are based.

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[1] Government Bill 2011/12:68 Secure natural gas supply, Section 6.

[2] Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC.

[3] An account of the risk assessment is given in the document 'Risk assessment for the western Swedish natural gas system – in accordance with Regulation (EU) No 2017/1938 of the European Parliament and of the Council

The terms used in this national preventive action plan are based on the terms in the Security of Supply Regulation, which in turn refers to the definitions in Directive 2009/73/EC and Regulation (EC) No 715/2009[4]. Where terms relevant to this preventive action plan are not contained in the aforementioned legal acts, the terms of the Swedish Natural Gas Act have been used as far as possible.

The national preventive action plan is to be updated every four years, unless circumstances warrant more frequent updates, and is to reflect the updated risk assessment.

## 1.1 Note

This risk assessment concerns the western Swedish natural gas system.

Section 2 presents the results of the risk assessment carried out in accordance with the regulation.

Section 3 and 4 sets out the extent to which the western Swedish natural gas system fulfils the Security of Supply Regulation's infrastructure standard (Article 5), the supply standard (Article 6) and measures to maintain the gas supply to all customers.

Section 6 sets out the obligations on the system balancing operator, natural gas undertakings and large customers that are in place primarily to meet the supply standard.

[4] Regulation (EU) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005.

# 2 Summary of the risk assessments

## 2.1 Regional risk assessments

Sweden is a member of three regional risk groups: risk group Denmark, risk group Baltic Sea and risk group Norway.

### 2.1.1 Risk group Denmark

Risk group Denmark focused on the coming period when the Tyra facilities will be under reconstruction between November 2019-2022. During this period the Danish and Swedish market will be dependent on gas imports from Germany and an optimal use of the capacities in the system: full utilisation of the import capacity at the German-Danish border and Danish storage volumes.

The scenario which was chosen for analysis was therefore the Ellund entry point with a technical disruption in the form of an incident involving the Quarnstedt compressor station. At a minimum pressure of 60 barg the available capacity would still be around 52% of the maximum capacity of 5.186 MW. If the pressure is reduced to 55 bar, the available capacity would increase to 65% by utilising the compressor in Ellund. Therefore, there is a little risk that the capacity at Ellund will be zero.

The following scenarios were analysed: a total disruption of gas from Germany, and 65% imported gas from Germany. In both cases the Danish storage levels were assumed to be fully filled and were simulated on three different assumptions:

- A historical high demand winter
- A period of 2 weeks of exceptionally high demand
- One day (Peak Day) of exceptionally high demand.

The result of the simulations showed that if the storages were sufficiently filled, the Danish and Swedish markets will be able to manage the situation even with a 100% interruption in Ellund.

### 2.1.2 Risk group Baltic Sea

Two scenarios were chosen with different interruption durations and conditions. The first scenario was a 50% disruption of the Greifswald entry point with the following interruption durations and conditions:

- 2 months under average winter conditions
- extreme temperatures during a 14-day peak period occurring with a statistical probability of once in 20 years
- a peak day with a statistical probability of once in 20 years

The second scenario was a 100% disruption of the Greifswald entry point with the following interruption durations and conditions: extreme temperatures during a 14-day peak period occurring with a statistical probability of once in 20 years; and a peak day with a statistical probability of once in 20 years.

First, the competent authority in Germany analysed the effect of a 50% and a 100% disruption of the Greifswald entry point on all the cross-border points. This was made by looking at the different capacity products that the different cross-border points supplied based on statistical historical assumptions as well as the historical maximum network usage.

Next step of the analysis was for each member to take the capacity reduction found in the cross-border points relevant to their markets and apply these on their market to identify the impact. The risk group found that there is no particularly high-risk exposure and that each member state is in a position to handle the effects of the disruption scenarios with their own infrastructure and alternative sources.

None of the cases of the scenarios had any impact on the supply to the Swedish market.

### 2.1.3 Risk group Norway

The risk group used three different scenarios: disruption of the largest offshore infrastructure to the United Kingdom (Langeled pipeline); disruption of the largest offshore infrastructure to continental Europe (EUROPIPE II); and disruption of the largest onshore infrastructure from Norway (Emden station). For every scenario three cases were simulated to assess the effect of three high demand events: peak day, long high-demand period (historically high demand and two weeks in 20 years). The supply potential in each scenario were based on the average of a five-year period: gas imports from Norway do not exceed 669 TWh and the average import flows do not exceed 3.854 GWh/d however the daily limit of 4.100 GWh/d has been reached on some days.

None of the cases of the scenarios had any impact on the supply to the Swedish market.

## 2.2 National risk assessment

The risk assessment was carried out in September 2018. This risk assessment is based on the relevant infrastructure as of 1 January 2018, namely the transmission system in Sweden, including the Öresund pipeline, and the transmission system in Denmark.

The conclusions from the risk assessment are as follows:

1. The incidents that would have the greatest impact on gas supply in the western Swedish natural gas system are an interruption in gas supplies in

the Swedish transmission system, particularly in the Öresund pipeline, or an interruption in gas supplies to the Danish-Swedish natural gas market from the Danish North Sea, Germany via Ellund or the Stenlille gas storage facility.

2. In the event of a disruption of the single largest gas infrastructure on a day of exceptionally high gas demand (Article 5(1)), only a limited proportion of the market could be supplied with gas.
3. In the event of extreme temperatures during a 7-day period (Article 6(1)(a)), the gas market would be able to supply gas to all protected customers.
4. In the event of a period of at least 30 days of exceptionally high gas demand (Article 6(1)(b)), the gas market would be able to supply gas to all protected customers.
5. In the event of a disruption of the single largest gas infrastructure under average winter conditions (Article 6(1)(b)), gas could be supplied to protected customers for a period of at least 30 days.

Relevant risks that could lead to disruptions in accordance with point 1 above have been reported in the 2018 risk assessment for the western Swedish natural gas system. The material is deemed sensitive and is therefore not appended to this plan.

In addition to the risks referred to above, a disruption in gas supply to the western Swedish natural gas system could affect local electricity production.

# 3 Infrastructure standard

## 3.1 Infrastructure standard, Article 5(1)

In accordance with this article, the necessary measures are to be taken so that, in the event of a disruption of the single largest gas infrastructure (i.e. the Öresund pipeline), the capacity of the remaining infrastructure is able to supply the gas required during a day of exceptionally high demand occurring with a statistical probability of once in 20 years (-15°C).

The maximum gas demand in Sweden on a cold winter's day (20 year winter) is estimated to be 87 $GWh_h$/day (7.2 $MNm^3$/day).

In accordance with Article 5(1), the infrastructure standard must be met. Sweden has been granted an exception from the infrastructure requirement as per article 5.9, but the Swedish Energy Agency still preforms the calculation to give an idea of the supply situation in case of an N-1 event.

## 3.2 National Level

The West Swedish natural gas system is exclusively connected to the Danish natural gas system. The interconnection consists of one connection, the Öresund pipeline, which is thus the largest single infrastructure.

The calculated area is the geographic area supplied with gas through the West Swedish natural gas system.

The requirement in Article 5.1 of the Regulation is assumed to constitute a winter day with extreme temperatures when the heating requirement in premises and housing increases the consumption.

$$N - 1\,[\%] = \frac{EP_m + P_m + S_m + LNG_m - I_m}{D_{max} - D_{eff}} \times 100$$

For Sweden, the result is 2,5% due to no domestic gas production, one storage facility and only one route of supply. This is lower than previous years when the N-1 calculation yielded a result of 15%, but since the only storage facility was mothballed starting winter 2017/2018, the percentage is now considerably lower than before as the current calculations only take the strategic storage into account.

***Definitions and values of the parameters of the N – 1 formula***

| Parameter | Value [MNm$^3$/day] | Comment |
|---|---|---|
| $D_{max}$ | 7,2 | ‘$D_{max}$’ means the total daily gas demand (in mcm/d) of the calculated area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years. |
| $D_{eff}$ | 0 | ‘$D_{eff}$’ means the part (in mcm/d) of $D_{max}$ that in the case of a disruption of gas supply can be sufficiently and timely covered with market-based demand-side measures in accordance with point (c) of Article 6(1) and Article 5(2). |
| $EP_m$ | 8,6 | ‘$EP_m$’: technical capacity of entry points (in mcm/d), other than production, LNG and storage facilities covered by $P_m$, $LNG_m$ and $S_m$, means the sum of the technical capacity of all border entry points capable of supplying gas to the calculated area. |
| $P_m$ | 0,18 | ‘$P_m$’: maximal technical production capability (in mcm/d) means the sum of the maximal technical daily production capability of all gas production facilities which can be delivered to the entry points in the calculated area. |
| $S_m$ | 0 | ‘$S_m$’: maximal technical storage deliverability (in mcm/d) means the sum of the maximal technical daily withdrawal capacity of all storage facilities which can be delivered to the entry points of the calculated area, taking into account their respective physical characteristics. |
| $LNG_m$ | 0 | ‘$LNG_m$’: maximal technical LNG facility capacity (in mcm/d) means the sum of the maximal technical daily send-out capacities at all LNG facilities in the calculated area, taking into account critical elements like offloading, ancillary services, temporary storage and re-gasification of LNG as well as technical send-out capacity to the system. |
| $I_m$ | 8,6 | ‘$I_m$’ means the technical capacity of the single largest gas infrastructure (in mcm/d) with the highest capacity to supply the calculated area. When several gas infrastructures are connected to a common upstream or downstream gas infrastructure and cannot be separately operated, they shall be considered as one single gas infrastructure. |

The main conclusion of the result of the N-1 calculation is that the West Swedish gas grid far from lives up to the requirement, but instead due to no domestic natural gas production, no storage facility and only one route of supply. Sweden has been granted an exception from the infrastructure requirement. The exception was granted due to the following applying to Sweden:

(a) no gas transit to other Member States on its territory;

(b) an annual gross inland gas consumption of less than 2 Mtoe; and

(c) less than 5 % of total primary energy use from gas.

The exception will apply to Sweden as long as the above situation hasn't changed.

## 3.3 Bi-directional capacity

The link between Sweden and Denmark is characterized by the fact that all gas flows in one direction, into Sweden via the Danish border station in Dragør and through the Öresund trunk line. Sweden has no production of natural gas or any significant gas storage, nor is biogas production significant. This means that Sweden cannot contribute to the security of supply in the Danish or European gas system, and there is therefore no need for reverse flow over the connection to Denmark.

# 4 Compliance with the supply standard

## 4.1 Supply standard, Article 6(1)

In accordance with Article 6(1), the competent authority shall require the natural gas undertakings that it identifies to take measures to ensure the supply of gas to the *protected customers*[5] of the Member State in the following cases:

a) extreme temperatures during a 7-day period occurring with a statistical probability of once in 20 years – corresponding in energy terms to 13 $GWh_h$ of gas;

b) for a period of 30 days of exceptionally high gas demand, occurring with a statistical probability of once in 20 years – corresponding in energy terms to 47 $GWh_h$ of gas;

c) for a period of up to 30 days in case of the disruption of the single largest gas infrastructure (the Öresund pipeline) under average winter conditions – corresponding in energy terms to 34 $GWh_h$ of gas.

## 4.2 Measures to comply with the supply standard

The measures available to Sweden as of 1 January 2018 for meeting the supply standard are described below.

### 4.2.1 Supply of protected customers for 7 days during extreme temperatures, Article 6(1)(a)

When demand is high, the pressure in the transmission system may fall if the input pressure in Dragør is insufficient. In the event of pressure levels lower than around 45 bar, the connections of customers with high pressure requirements are 'automatically' shut off. The categories of customers whose connections are shut off first are cogeneration power plants and large-scale industrial customers. Customers with low pressure requirements can continue to be supplied with gas when the pressure levels in the transmission system fall. Protected customers are among the group with the lowest pressure requirements.

The conclusion is, therefore, that no preventive action is required in order to meet this part of the supply standard.

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[5] Where Sweden is concerned, protected customers are customers who are connected to the gas distribution system, i.e. household customers and those only using gas for cooking purposes, a total of around 33 000 customers.

#### 4.2.2 Supply of protected customers for at least 30 days of exceptionally high demand, Article 6(1)(b)

In the Swedish gas system, exceptionally high gas demand is expected to occur when extreme temperatures are experienced during the winter. When demand is high, the pressure in the transmission system may fall if the capacity in Dragør is insufficient, but the protected customers can continue to be supplied with gas.

The conclusion is, therefore, that no preventive action is required in order to meet this part of the supply standard.

#### 4.2.3 Supply of protected customers for at least 30 days in the event of the disruption of the single largest gas infrastructure under average winter conditions, Article (6)(1)(c)

The requirements of supplying the protected customers for 30 days under average winter conditions amount to 34 $GWh_h$, However, the repair time in the event of complete failure in the single largest infrastructure, the undersea pipeline between Denmark and Sweden, could be 40-50 days according to ref. 4. The supply standard requirement is *at least 30 days*, however, several of the incidents that could cause leakage in/failure of the undersea pipeline have a significantly shorter repair time than 40-50 days. This means that it is reasonable for the protected customers' requirements to correspond to 30 days' gas consumption.

No decisions have been made concerning investments in the infrastructure in order to reduce the likelihood or consequences of an N-1 incident occurring.

The measures and conditions that are able to contribute to comply with the supply standard comprise:

- using gas in the transmission system (line pack);
- using the biogas that is supplied to the western Swedish natural gas system;
- promptly reducing consumption by the non-protected customers manually or by ordering them to reduce consumption within the specified time period;

The above measures are described in more detail below.

*Use line pack*

The measure involves the system balancing operator ensuring that the operating pressure level in the transmission system does not fall below 45 bar during normal operation. This level is in line with previous practice.

The normal pressure level (zero point) in the transmission system is 60 bar, whereas the lowest operating level is 45 bar. In the latter case, around 41 $GWh_h$ of gas (3.4 $MNm^3$) can be used before the pressure reaches 7 bar, which, with some spare capacity, is sufficient pressure to provide the protected customers with gas[6].

*Use biogas*

In 2017 total production capacity for biogas for injection into the distribution and transmission networks was 66 $MW_l$, of which approximately 28 $MW_l$ may be allocated to protected customers.

During an emergency, biogas producers are expected to continue to supply gas to the western Swedish natural gas system in accordance with the business agreements they have entered into with gas suppliers.

The biogas supplied to the western Swedish natural gas system at the pressure level of the distribution network over and above that needed to cover the requirements of the protected customers is to be used for customers in the order of priority set out in the national emergency plan (ref. 6), on the assumption that the gas cannot be fed into the transmission system.

*Order a reduction in consumption by non-protected customers*

The system balancing operator may order a reduction in gas consumption by non-protected customers via the operator of the distribution pipeline. The operator of the distribution pipeline must be able to implement the decision to reduce consumption within the time limits indicated in the national emergency plan.

As a result of these time limits, consumption by non-protected customers – assuming the reduction in consumption is implemented in a linear fashion within the respective time limit – will amount to approximately 29 $GWh_h$ during the period of disconnection.

The requirements are tailored to the gas consumption of the various categories of customer and to the capacity to read meters remotely – thereby being able to verify relatively easily that consumption has been reduced.

*Summary of the capacity of the current measures to meet the supply standard*

The results of the measures and prerequisites described above are summarised in the following table for the year 2017:

**Table 1. Summary of the capacity of the current measures to comply with Article 6(1)(c).**

| Phase/measure | Supply/consumption ($GWh_h$) | Remarks |
|---|---|---|
| Use line pack | 41 | Based on the 'worst case scenario', i.e. from lowest operating limit (45 bar) down to 7 bar. |
| Use biogas | 28,1 | Based on 30 days' production. |

[6] The distribution networks following directly after an M/R station have a maximum pressure of 4 bar and a minimum pressure of 1 bar, but protected customers may be connected at an even lower pressure (0.1 bar) after pressure reduction in control stations. From 56 bar to 7 bar there is approximately 53 $GWh_h$ available in the system.

| Phase/measure | Supply/consumption ($GWh_h$) | Remarks |
|---|---|---|
| Consumption by non-protected customers | -29,8 | Taking into account the time required to carry out disconnection in accordance with the national emergency plan. |
| Consumption by protected customers | -34,1 | |

# 5 Measures and volumes for compliance with the standards and for dealing with risks identified (preventive measures)

The strategy, measures and volumes for dealing with the risks and scenarios described in the previous sections are outlined below. The measures are prioritised first and foremost in order to endeavour to meet the infrastructure standard and to comply with the supply standard and, secondly, in order to improve the general situation.

## 5.1 Basis for selecting measures to comply with the infrastructure and supply standards

### 5.1.1 Concerning interconnections, cross-border flows, etc.

The western Swedish natural gas system is only connected to the Danish natural gas system. The interconnection consists of one connection, the Öresund pipeline, which, as a result, is the single largest infrastructure. There have been no decisions to establish alternative supply routes.

The flow of gas in the Öresund pipeline is unidirectional from Denmark to Sweden. It is currently not technically possible to reverse the direction of flow so that the gas flows from Sweden to Denmark. Sweden does not have any natural gas production or any significant gas storage, nor does it have any significant biogas production, even though decisions have been taken and plans made for a gradual increase in biogas production. This means that Sweden cannot contribute to safeguarding the security of supply in the Danish or European gas system, and there is therefore no need for a reversal of the direction of flow through the connection to Denmark.

There are currently no agreements concerning access to storage facilities in Denmark in order to be able to supply Swedish customers in an emergency. However, there is no formal obstacle to entering into such agreements. Nevertheless, any agreements concerning access to storage capacity in Denmark are without prejudice to the fulfilment of the infrastructure standard or the part of the supply standard based on a failure of the Öresund pipeline (Article 6(1)(c)).

### 5.1.2 Concerning public service obligations that relate to the security of gas supply

No operator on the Swedish gas market is responsible for providing any public services linked to the security of gas supply.

Certain cogeneration power plants and some large industrial customers have the technical capacity to use an alternative fuel. However, there are no requirements for customers to store an alternative fuel in proportion to their gas use.

#### 5.1.3 Capacity and plans in respect of border points, gas storage and LNG supply

The transmission capacity from Denmark to Sweden is 95 $GWh_l$/day (8.6 $MNm^3$/day).

At present, there have been no decisions to increase the number of border points to the natural gas systems of other countries.

There have been no decisions to connect LNG facilities to the western Swedish natural gas system, but preparations are ongoing, including consultation under the Environmental Code, for an LNG terminal and gas pipeline at the Port of Gothenburg, see ref. 7.

### 5.2 Measures to comply with the infrastructure standard

Sweden has been granted an exception from the infrastructure requirement (Article 5.9).

#### 5.2.1 Use biogas in the distribution network

As a result of the decisions taken and plans made concerning facilities for supplying biogas to both the distribution network and the transmission network, the supply capacity will gradually improve. In 2017 total production capacity for biogas for injection into the distribution and transmission networks was 66 $MW_l$. This corresponds to 2.0 per cent of the maximum requirements of the gas system.

#### 5.2.2 Market-based measure

There has been a market-based demand-side measure[7] in place since 2014, under which large Swedish gas customers can participate in the Danish system for commercially interruptible customers. Agreements are entered into with large gas customers to the effect that, in return for financial compensation, they are prepared to rapidly reduce their gas consumption if ordered to by the Danish TSO. This type of agreement is also referred to as a hyper-interruptible contract. The

[7] A market-based measure is a measure taken by the market operators themselves to increase robustness and flexibility during normal operation and at all crisis levels. Market-based measures can be regulated via agreements concerning financial compensation and/or require the 'alert' crisis level to have been declared. Measures that are not market-based may only be used when the market-based measures can no longer ensure the security of supply, in particular to protected customers. A non-market-based measure is mandatory for the operators. Use of non-market-based measures requires an 'emergency' crisis level to have been declared.

measure will help, to a large extent, to maintain gas supplies to more than just the protected customers in the event of a disruption in gas supplies from Denmark.

### 5.2.3 Calculation of the N-1 formula following measures

The degree of compliance with the standard is demonstrated by means of a technical calculation of the capacity of the facilities responsible for the country's natural gas supplies in relation to the needs of the natural gas customers. As far as Sweden is concerned, the relevant facilities are the Öresund pipeline, and biogas production.

Calculation according to the formula in Annex 1 to the Security of Supply Regulation indicates that, for Sweden, N-1 is 2,5%, based on the input data in Table 2. The standard requires 100 %.

**Table 2. Input data for N-1 calculation for 2017.**

| Parameter | Value ($MNm^3$/day) | Remarks |
|---|---|---|
| $D_{max}$ | 7.2 | The total daily gas demand of the calculated area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years. |
| $D_{eff}$ | 0 | The part of $D_{max}$ that, in the event of a supply disruption, can be sufficiently and timely covered with market-based demand-side measures. |
| $EP_m$ | 8.6 | Technical capacity of entry points, other than production, LNG and storage facilities covered by $P_m$, $S_m$ and $LNG_m$: the sum of the technical capacity of all border entry points capable of supplying gas to the calculated area. |
| $P_m$ | 0.18 | Maximal technical production capability: the sum of the maximal technical daily production capability of all gas production facilities which can be delivered to the entry points in the calculated area. |
| $S_m$ | 0 | Maximal technical daily capacity of storage facilities. |
| $LNG_m$ | 0 | Maximal technical LNG facility capacity. |
| $I_m$ | 8.6 | Technical capacity of the single largest gas infrastructure. |

## 5.3 Measures for maintaining gas supply to all customers

In accordance with Article 9, the preventive action plan is to set out the other preventive measures that are required to maintain gas supply to all customers to the greatest extent possible.

No appropriate measures are available for reducing the likelihood of disruptions in gas supplies from Denmark.

- Biogas injections to the western Swedish gas network may increase in order to reduce dependence on gas from Denmark.

## 5.4 General impact assessment of the measures to fulfil the supply standard

*Order a reduction in consumption (disconnection)*

The basic measure in the event of serious emergencies (‘emergency’ crisis level) is a reduction in consumption through disconnection of non-protected customers. This is a drastic measure, but at present it is an essential measure to safeguard supplies to protected customers. Disconnection is a measure that has been in place for some time for serious emergencies, but the disconnection time requirements have been formalised in this plan.

The disconnection times selected have been counterbalanced by the use of line pack, biogas and strategic gas storage, so that it has been possible to prolong the deadline for disconnection to give the operators a chance for a certain amount of forward planning before carrying out the disconnection.

The largest customers will be disconnected first. Where cogeneration and heating plants are concerned, it is expected that, to a relatively large extent, they will be able to switch to a different fuel (primarily fuel oil) for heat production, whereas the production of electricity that does not take place in cogeneration plants is primarily compensated for via normal trade on the electricity market. Certain large-scale industries can also replace natural gas with fuel oil for heating purposes. The industries that use natural gas as feedstock will be obliged to stop production. A switch from natural gas to fuel oil will increase environmental pollution as a result of increased emissions of carbon dioxide, sulphur dioxide and particulate matter. Disconnection of cogeneration and heating plants and industrial gas customers (industries) will result in increased costs in connection with switching to an alternative fuel and/or the halting of production. In the worst case scenario, damage to production equipment could occur in certain industries.

Gas-powered heavy vehicles (primarily buses) will, in the worst case scenario, be unable to fill their tanks with gas in certain places/areas connected to the western Swedish natural gas system, which will, at least initially, cause a great deal of disruption in the public transport system and give rise to increased costs, increased emissions of carbon dioxide, etc. Smaller gas-powered vehicles can refuel with oil-based fuel (which will give rise to increased emissions of carbon dioxide etc.) or potentially refuel with gas at a filling station that is not connected to the western Swedish natural gas system.

*Use line pack*

The measure involves the formalisation of an established practice and thus will not restrict the functioning of the market or procedures in general.

*Impact of the measures on the European market*

The Swedish measures will have no negative impact on the European natural gas market.

*Measures' link with crisis management principles*

Disconnection of non-protected customers will, where possible, be carried out according to an order of priority, taking account of both Sweden's recognised crisis management principles and the unique requirements of the natural gas market.

The supply situation will improve over the next few years, when biogas production is expected to make up an increasing proportion of the gas supplied, and in a few years' time this alone may cover at least the requirements of the protected customers. In such a situation, certain other customers would also be able to obtain gas in the event of significant disruptions in natural gas supplies from Denmark.

# 6 Obligations of the system balancing operator, natural gas undertakings and customers

The requirements to be met by the system balancing operator, natural gas undertakings and customers as a consequence of the measures described in Section 4 are described below.

## 6.1 System balancing operator

The system balancing operator, Swedegas AB, is to act to ensure that the operating pressure level in the transmission system does not fall below 45 bar during:

- normal operation;
- an ‘early warning’ crisis level;
- an ‘alert’ crisis level.

Where necessary during an ‘emergency’ crisis level, the system balancing operator must, via the network operators, implement a reduction in consumption or disconnection of non-protected customers.

The system balancing operator must ensure that there is a sufficient quantity of gas in the Skallen storage facility to enable a controlled reduction in consumption/disconnection of non-protected customers to be carried out and to enable protected customers to obtain gas for 30 days in accordance with Article 6(1)(c) of the Security of Supply Regulation. Prior to each winter, the competent authority is to determine the quantity of gas that needs to be stored for that purpose.

## 6.2 Gas suppliers and balancing service providers

Gas suppliers are responsible, in cooperation with balancing service providers, for ensuring, both during normal operation and in a crisis situation, that protected customers in particular receive gas.

## 6.3 Operator of storage facilities

An operator of storage facilities must make available to the system authority the storage capacity which, according to the system balancing operator, is needed for strategic gas storage, as decided by the competent authority.

## 6.4 Operator of a natural gas pipeline

The operator of a natural gas pipeline must make sure that there is sufficient capacity to ensure that, following an order from the system balancing operator, non-protected customers reduce or stop their gas consumption by the deadlines stated in the national emergency plan.

## 6.5 Large-scale customers

Large-scale customers are to cooperate with the operator of the natural gas pipeline in order to reduce their consumption as soon as possible where necessary, in accordance with the circumstances and the instructions issued by the owner of the pipeline.

# 7 Infrastructure projects

No major infrastructure projects are currently active.

# 8 Public service obligations related to the security of supply

Sweden has no public service obligations related to the security of supply.

# 9 Stakeholder consultations

The energy agency arranged a consultation with relevant stakeholders on 24 January 2019 where the stakeholders had the opportunity to read the draft of the preventive action plan in its current state, and were given the opportunity to provide feedback.

# 10 Regional dimension

## 10.1 Calculation of the N-1 at the level of the riskgroup

### 10.1.1 Riskgroup Denmark

This common risk assessment for risk group Denmark covers a period, where the main source of gas in Denmark and Sweden, the Tyra facilities, will be rebuild and the gas supply to Denmark will therefore be significantly reduced.
The main gas source during the reconstruction period is imported gas from Germany. The single largest infrastructure of the area relevant for risk group Denmark is therefore the Ellund entry/exit point.

The Danish TSO Energinet is currently looking at different initiatives that can be implemented in order to strengthen the system and increase flexibility during the reconstruction of Tyra. Some of these initiatives include an increase of the storage withdrawal capacity at Lille Torup storage facility and an increase of the import capacity at Ellund by reinforcement in the northern German gas transmission system. The calculation of the regional N – 1 in the risk group was therefore calculated based on the current capacities and with the expected increased capacities.

As for the national risk assessment the calculation of N – 1 should be based on two different storage volume levels: 100 % and 30 %. However, the Danish gas storage facilities are able to yield the same withdrawal capacity irrespective of these storage volume levels. Energinet reserves strategic volumes for Emergency (less than 30% of the maximum storage volume) both for short and long-term incidents, in order to ensure that maximum withdrawal capacity is available at this level.

The parameter values based on the current capacities are shown in the table below.

**Table 3.1: Demand and capacities before realization of initiatives**

| Parameter | Mcm/d | Description |
|---|---|---|
| $D_{max}$ | 25.5 | Total daily gas demand on an exceptional cold day (20 year-incidence with an average temperature of -13 degrees Celsius). The Danish gas demand is expected to be 19.5 mcm/d (including BNG) and the Swedish gas demand is expected to be 6 mcm/d. |
| $EP_m$ | 10.3 | Total technical capacity for all entry points that can supply the calculated area, excluding production, storage and LNG facilities. The value of this parameter is equal to the entry capacity at the Danish side of the Ellund point based on the |

| Parameter | Mcm/d | Description |
|---|---|---|
| | | maximum existing capacity at the German side (the capacity at the Danish side is much higher). |
| **$P_m$** | 1.0 | Maximum technical production capacity. The forecast for the gas production in the Danish part of the North Sea is used instead of the maximum technical production capacity. In the period 2020-2022 the value of this parameter is expected to decrease significantly from 10.1 mcm/d to 0.5 mcm/d. Furthermore, this parameter includes the Danish biogas production, which is expected to be 0.5 mcm/d in 2020. |
| **$S_m$** | 16.2 | Maximum existing technical withdrawal capacity from all storage facilities. The value of this parameter is the sum of the withdrawal capacity at the two Danish storage facilities: Stenlille 8.2 mcm/d and Lille Torup 8.0 mcm/d. The withdrawal capacities for the two storages are the same irrespective of a storage level of either 30 % or 100 % of the maximum working volume. The capacity of the Swedish Skallen storage facility is not included as it mothballed and will only be commissioned again if it is commercially viable. |
| **$LNG_m$** | - | Maximum technical capacity at all LNG facilities. There are no LNG facilities connected to the gas grid in Denmark or Sweden. A LNG facility will be available in Gothenburg. However, it is not assumed connected to the Swedish transmission system |
| **$I_m$** | 10.3 | Technical capacity of the single largest infrastructure. Danish Ellund Entry point. |
| **$D_{eff}$** | 0.5 | The amount of gas demand that can be covered with market-based demand-side measures. The Danish concept of "commercial interruptibility" entails Energinet to pay gas customers in Denmark and Sweden to voluntarily reduce their gas consumption within 3 hours if the crisis level Alert has been declared in the Danish gas system. Today's level has been chosen as a conservative level. |

*Calculation of N – 1*

$$N-1[\%] = \frac{10.3\,mcm/d + 1\,mcm/d + 16.2\,mcm/d + 0\; - 10.3\,mcm/d}{25.5\,mcm/d} \cdot 100 = 67\%$$

*Calculation of N – 1 with market-based demand-side measures*

$$N-1[\%] = \frac{10.3\ mcm/d + 1\ mcm/d + 16.2\ mcm/d + 0\ - 10.3\ mcm/d}{25.5\ mcm/d - 0.5\ mcm/d} \cdot 100 = 69\%$$

The parameter values including increased entry capacity (EPm) and increased storage withdrawal capacity (Sm) are shown in the table below.

**Table 3.2: Demand and capacities after realization of initiatives**

| Parameter | Mcm/d | Description |
|---|---|---|
| **$D_{max}$** | 25.5 | Total daily gas demand on an exceptional cold day (20 year-incidence with an average temperature of -13 degrees Celsius). The Danish gas demand is expected to be 19.5 mcm/d and the Swedish gas demand is expected to be 6 mcm/d. |
| **$EP_m$** | **12.3** | Total technical capacity for all entry points that can supply the calculated area, excluding production, storage and LNG facilities. The value of this parameter is equal to the entry capacity at the Danish side of the Ellund point. |
| **Pm** | 1.0 | Maximum technical production capacity. The forecast for the gas production in the Danish part of the North Sea is used instead of the maximum technical production capacity. In the period 2020-2022 the value of this parameter is expected to decrease significantly from 10.1 mcm/d to 0.5 mcm/d. Furthermore, this parameter includes the Danish biogas production, which is expected to be 0.5 mcm/d in 2020. |
| **$S_m$** | **18.5** | Maximum existing technical withdrawal capacity from all storage facilities. The value of this parameter is the sum of the withdrawal capacity at the two Danish storage facilities: Stenlille 8.2 mcm/d and Lille Torup 10.3mcm/d. The withdrawal capacities for the two storages are the same irrespective of a storage level of either 30 % or 100 % of the maximum working volume. The capacity of the Swedish Skallen storage facility is not included as it mothballed and will only be commissioned again if it is commercially viable. |
| **$LNG_m$** | - | Maximum technical capacity at all LNG facilities. There are no LNG facilities connected to the gas grid in Denmark or Sweden. A LNG facility will be available in Gothenburg. However, it is not assumed connected to the Swedish transmission system |
| **$I_m$** | 12.3 | Technical capacity of the single largest infrastructure. Danish Ellund Entry point. |
| **$D_{eff}$** | 0.5 | The amount of gas demand that can be covered with market-based demand-side measures. The Danish concept of "commercial interruptibility" entails Energinet to pay gas customers in Denmark and Sweden to voluntarily reduce their gas consumption within 3 hours if the crisis level Alert has been declared in the Danish gas system. Today's level has been chosen as a conservative level |

*Calculation of N – 1 with expansions:*

$$N-1[\%]=\frac{12.3\ mcm/d+1\ mcm/d+18.5\ mcm/d+0\ -12.3\ mcm/d}{25.5\ mcm/d}\cdot 100=76\%$$

*Calculation of N – 1 with expansions and market-based demand-side measures*

$$N-1[\%]=\frac{12.3\ mcm/d+1\ mcm/d+18.5\ mcm/d+0\ -12.5\ mcm/d}{25.5\ mcm/d-0.5\ mcm/d}\cdot 100=78\%$$

A summary of the results from all the calculations are shown in the table below.

**Table 3.1: Results**

| **Largest infrastructure** | **Im (mcm/d)** | **N – 1 (%)** |
|---|---|---|
| N – 1 based on current capacities | 10 | 67 |
| N – 1 based on current capacities with demand-side measures | 10 | 69 |
| N – 1 based on new capacities | 12 | 76 |
| N – 1 based on new capacities with demand-side measures | 12 | 78 |

The calculation of the regional N – 1 for the calculated area in risk group Denmark shows that N – 1 < 100 % for all scenarios. Therefore, the calculated regional area does not comply with article 5 (Infrastructure standard) of the Regulation during the period of reduced Danish national production due to the reconstruction of the Tyra-complex.

However, it must be noticed that Sweden has an exemption from the infrastructure criteria and can only supply the protected market in case of a major incident.

From north to south the firm capacity is 8.2 MCM/day. From south to North the firm capacity is 10.3 MCM/day

### 10.1.2 Riskgroup Baltic Sea

As not all numbers have been provided by the members of the risk group, there is not yet a common N-1 result.

### 10.1.3 Risk group Norway

The calculation uses the following formula:

$$N - 1\ [\%] = \frac{EP_m + P_m + S_m + LNG_m - I_m}{D_{max} - D_{eff}} \times 100,\ N - 1 \geq 100\ \%$$

*Where*

- *EPm: technical capacity of entry points, other than production*
- *Pm: maximal technical production capacity*
- *Sm: maximal technical storage deliverability*
- *LNGm: maximal technical LNG facility capacity*
- *Im: technical capacity of the single largest gas infrastructure*
- *Dmax: total daily gas demand*
- *Deff: demand-side measures*

For EPm, interconnection between member states within the risk group and interconnection with Switzerland have not been considered. Those calculations do not take into consideration the possible limitation of flow within the risk group due to limited capacity trough Switzerland. Additional calculations have also been conducted considering only members states directly connected.
For the calculation it has been considered the disruption of largest infrastructures which supplies Norwegian:

- Disruption of Emden station (from Norway to the continent)
- Disruption of Langeled pipeline (from Norway to United Kingdom)

| | | | | Projected Data | | |
|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| | GWh/d | GWh/d | GWh/d | GWh/d | GWh/d | GWh/d |
| **Technical capacity of entry points (EPm)*** | 11 696 | 11 637 | 11 372 | 11 269 | 11 269 | 11 269 |
| **Maximal technical production capacity (Pm)** | 4 878 | 4 193 | 4 208 | 4 562 | 4 397 | 4 172 |
| **Maximal technical storage deliverability (Sm)** | 16 218 | 16 200 | 15 992 | 16 132 | 16 183 | 16 300 |
| **Maximal technical LNG facility capacity (LNGm)** | 5 945 | 6 464 | 6 464 | 6 464 | 6 464 | 6 464 |
| **1 in 20 gas demand (Dmax)** | 26 714 | 26 637 | 27 020 | 27 706 | 27 706 | 27 731 |
| **Market-based demand side response (Deff)** | 5 | 5 | 5 | 35 | 35 | 35 |

* only entry point from outside the risk group

| **Technical capacity largest gas infrastructures (Im)** | | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|
| DE/NL | Norway | Emden EPT | 989 | 989 | 989 | 989 | 989 | 989 |
| UK | Norway | Langeled | 770 | 770 | 770 | 770 | 770 | 770 |

| **N-1 for region** | Historical Data | | | Projected Data | | |
|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| | GWh/d | GWh/d | GWh/d | GWh/d | GWh/d | GWh/d |
| Emden EPT | 141% | 141% | 137% | 135% | 135% | 134% |
| Langeled | 142% | 142% | 138% | 136% | 136% | 135% |

N-1 results are well above 100% meaning in case of disruption of a major infrastructure supplying Norwegian gas the other entry capacities shall be sufficient to cover peak demand as it may occur 1 in 20 years.
Regarding the issue of transit trough Switzerland, both N-1 calculations for Italy on one side and the others member states in the risk group on the other side are above 100%.