Preventive Action Plan 2023 – 2027

MS Denmark - Gas

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Content

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General information

Preparation of the preventive action plan

The preventive action plan is an element in complying with the European security of gas supply EU Regulation ("the Regulation").[1] The preventive action plan is prepared by the Danish Competent Authority, the Danish Energy Agency, in close cooperation with Energinet who has the primary operational responsibility for security of supply.

In Article 8(2) of The Regulation it is stated that the national competent authority shall establish: "a preventive action plan containing the measures needed to remove or mitigate the risks identified, including the effects of energy efficiency and demand-side measures in the common and national risk assessments and in accordance with Article 9".

The preventive action plan shall, according to The Regulation, be updated every four years. The preventive action plan was first prepared and submitted on 28 February 2019, and it shall therefore now be updated in line with the Regulation. .

The preventive action plan covers both the period where the main gas production facility, the Tyra complex, is still closed due to reconstruction (1 November 2019 to winter 2023/2024) and after the complex is expected back in operation in January 2024.

Regional cooperation

In Article 3(7) it is stated: "In accordance with Article 7(2), major transnational risks to the security of gas supply in the Union are to be identified and risk groups are to be established on that basis. Those risk groups shall serve as the basis for enhanced regional cooperation to increase the security of gas supply and shall enable agreement on appropriate and effective cross-border measures of all Member States concerned within the risk groups or outside the risk groups along the emergency supply corridors."

The risk groups have been established, and Denmark participates in six risk groups. A thorough analysis of the work in the risk groups and compliance with the infrastructure standard for Denmark can be found in the national risk assessment for Denmark and the common risk assessment for the risk groups.

[1] REGULATION (EU) 2017/1938 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010.

The Member States in the risk groups are as follows:

Risk group Ukraine:
Bulgaria, Czech Republic, Denmark, Germany, Greece, Croatia, Italy, Luxembourg, Hungary, Austria, Poland, Rumania, Slovenia, Slovakia, Sweden

Risk group Belarus:
Belgium, Czech Republic, Denmark, Germany, Estonia, Latvia, Lithuania, Luxembourg, the Netherlands, Poland, Slovakia, Finland, Sweden

Risk group Baltic Sea:
Belgium, Czech Republic, Denmark, Germany, France, Luxembourg, the Netherlands, Austria, Slovakia, Sweden

Risk group North-Eastern:
Czech Republic, Denmark, Germany, Estonia, Latvia, Lithuania, Poland, Finland, Sweden

Risk Group North Sea (Merger of former risk groups 'Norway' and 'United Kingdom'):
Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Poland, Portugal, Spain, Sweden.

Risk Group Denmark:
Denmark, Germany, Luxembourg, the Netherlands, Poland, Sweden

Summary

Gas supply from Germany has been the main import source to the Danish and Swedish markets during the reconstruction of the Tyra gas complex. Increased biomethane production and injection into the Danish gas system together with increased energy efficiency has supported the Danish security of gas supply. With the commissioning of the Baltic Pipe in October 2022 and the Tyra complex back in operation by January 2024 the infrastructure standard will rise to more than 300 % and fully comply with the requirement for the N-1 infra structure standard of the Regulation. The prognosis in the preventative action plan shows that the Danish gas market will undergo radical changes in the years to come through decreased consumption for households, increased use of district heating and industry conversion to biomethane instead of fossil gas. Denmark will in future primarily be a gas transit country for export of Norwegian and Danish gas from the North Sea to the Netherlands, Germany, Sweden and Poland. The Danish transmission system is robust with two and tree pipelines crossing the belts and two gas storage facilities strategically placed in the Western and Eastern part of Denmark.
The increased Danish biomethane production contributes to a higher degree of decentralized gas supply across the country. Decentralization of the gas supply will to some degree protect the customers in case of technical incidents in the Danish gas system.

1 Description of the gas system

1.1 Description of the regional gas system for each risk group

To avoid duplication please see the description and data in the regional groups risk assessments.

1.2 Description of the Danish gas system

Infrastructure

The Danish gas system (Figure 1) consists of gas production facilities (Tyra is out for reconstruction until Winter 2023/2024), and 3 off-shore pipelines connecting the Danish gas fields and Europipe II to the Danish transmission system, supporting transit of the Danish and Norwegian production to Poland, Germany and Sweden, and a distribution system, where gas is delivered to the final gas customers. A gas treatment facility and a receiving terminal in Jutland are dedicated to handle the gas received from the Danish gas production fields in the North-sea and for gas from Norway via Europipe II. The gas is treated at the site and delivered into the transmission system.

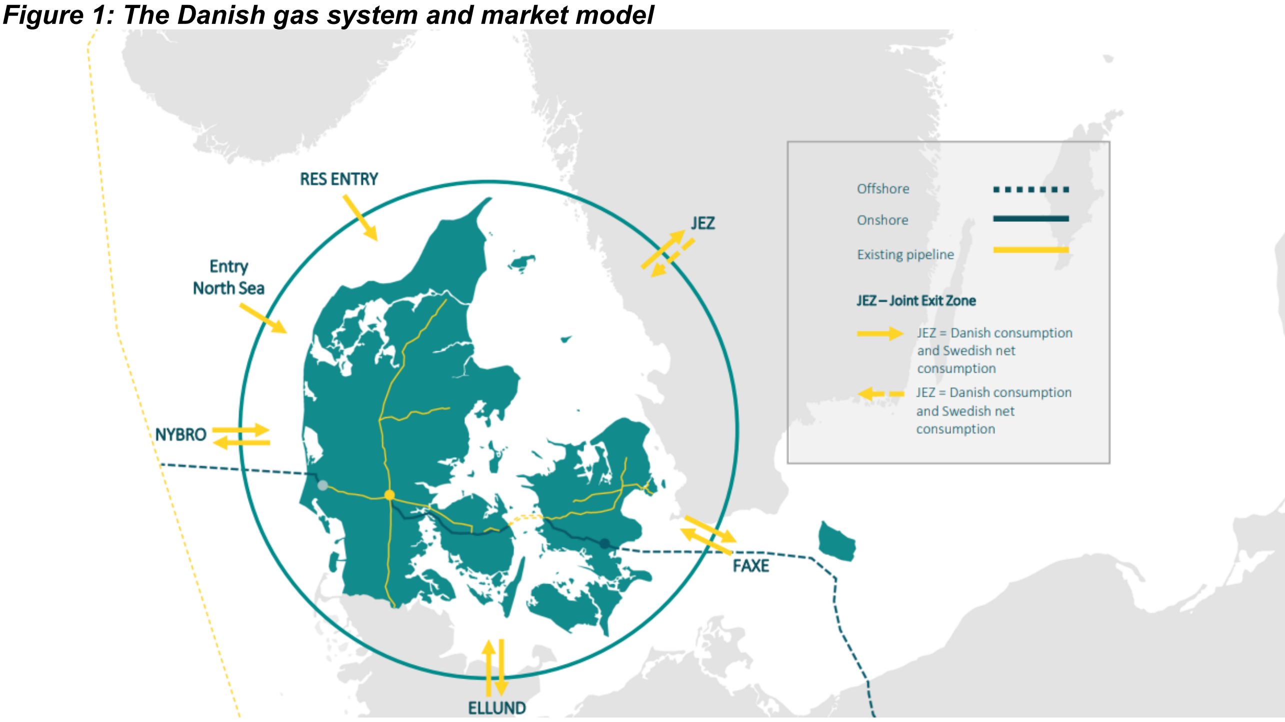
The underground storage facilities (Zealand aquifer and North Jutland salt caverns) have the capacity of approx. 10 TWh (2023) corresponding to 50% of the Danish consumption in 2022.

The gas system has two compressor stations: One in Jutland (2013) and one in South Zealand (2022). The compressor station in Jutland supports the transport of gas from Germany and to Germany. The compressor station in South Zealand supports the gas transport to Poland via Baltic Pipe. The Danish gas system has two pipelines in the offshore crossing between Funen and Zealand and three pipelines between Jutland and Funen to the benefit of the security of supply in case of a subsea disruption of one pipeline.

The Danish gas distribution system distributes gas via 18,000 km gas pipelines. The distribution companies are responsible for operating and maintaining the gas distribution system, which transports gas to the customers. The gas distribution system was originally designed to receive natural gas from the transmission system, but the increasing production of biomethane in Denmark has created a new situation where biomethane plants deliver locally produced gas directly to the distribution system.

Denmark has 58 biomethane production sites connected to the gas network delivering app. 39% of the Danish gas consumption (August 2023). The local domestic production strengthens the security of supply for Danish gas customers making them less dependent on a single supply source.

Figure 1: The Danish gas system and market model



Source: Energinet

<u>The market model</u>

The gas market plays a key role in the Danish security of gas supply. Denmark has a security of supply model which is based on the framework of the Regulation. The overall intention is to avoid situations in which the market is unable to supply gas to customers.

The Danish gas transmission system is based on a simple entry-exit model, which allows market players to commercially move gas in and out of Denmark. The gas system has several entry/exit points where gas can be supplied as either import or export:

- Danish North Sea gas (Nybro Entry)
- Gas transit from Norway (North Sea Entry, part of Nybro Entry)
- German gas import and export (Ellund Entry/Exit)
- Gas transit to Poland (Faxe Entry/Exit)
- Joint Exit Zone[2]
- RES[3] Entry

[2] Single exit zone for delivery of gas to Danish and Swedish customers
[3] Renewable Energy Source i.e., biomethane

Ellund and Faxe are constructed with the possibility for physical reverse flow. Furthermore, there are virtual transfer points for gas traded within the system (bilateral contracts or gas exchange) and for upgraded biomethane (RES-entry).

In cooperation with the Swedish TSO (Nordion Energi), Energinet has established one common balancing zone (Joint Exit Zone) for the Danish and Swedish gas market. The common balancing zone brings the Swedish and Danish gas systems closer together, both in terms of physical operation as well as commercially.

Technical and commercial capacities at the different points are shown in table 1-3. Notice that the corresponding German capacities are shown in brackets for the Ellund Interconnection Point[4]. Also, the volume flow and the utilization rates are shown in table 6-8.

Table 1: Entry/Exit point's technical capacity (mcm/y)[5]

	2023-2027
Nybro Entry	17,055
- North Sea Entry	10,387
Ellund Entry	5,736 (4,409)
Ellund Exit	5,736 (597)
Joint Exit Zone	9,399
Faxe Entry	2,945
Faxe Exit	10,396

Source: Energinet

The technical capacity at North Sea Entry will be 27 mcm/d, corresponding to 10 bcm/y. North Sea Entry capacity is a part of the Nybro Entry capacity. The technical capacity towards Sweden is no longer calculated as a commercial capacity but is included in Joint Exit Zone capacity. Based on technical capacity in the past it is approximately 2.628 mcm/y.

[4] Source: Entsog Transparency Platform. Values for the points VIP DK-THE and Ellund are added together. The German capacities are shown because they differ substantially from the Danish capacities.
[5] Values are converted from GWh to MNm^3 using 12.1 kWh/Nm3 as calorific value

Table 2: Entry/Exit point's estimated volume flow (mcm/y)

	2023	2024	2025	2026
Nybro Entry	68	1,653	1,942	1,942
North Sea Entry	7,324	6,675	6,544	6,544
Ellund Entry	468	83	593	466
Ellund Exit	447	83	83	83
Joint Exit Zone-Denmark	1.638	1.736	1.736	1.736
Joint Exit Zone-Sweden	518	563	531	501
Faxe Entry	1	0	0	0
Faxe Exit	5.883	6.694	7.550	7.550

Source: Energinet

Table 3: Entry/Exit point's estimated technical utilization rates

	2023	2024	2025	2026
Nybro Entry	0,4%	10%	11%	11%
North Sea Entry	71%	64%	63%	63%
Ellund Entry	8%	1%	10%	8%
Ellund Exit	8%	1%	1%	1%
Joint Exit Zone-Denmark	24%	26%	26%	26%
Joint Exit Zone-Sweden	20%	21%	20%	19%
Faxe Entry	0%	0%	0%	0%
Faxe Exit	57%	64%	73%	73%

Source: Energinet

Gas sources

Tyra offshore platform complex

Since 1 October 1984, the Tyra complex has been the most important source of supply for Danish and Swedish gas customers. The Tyra complex has sunk since its establishment coursing the previous owners of the Tyra complex DUC (Danish Underground Consortium) to reconstruct the complex in order to be able to continue producing gas in the Danish part of the North Sea in the future.

The decision to reconstruct the Tyra complex was taken in 2017. Since the end of 2019 the Tyra complex has been shut down for reconstruction, and is expected to be back in production by the Winter 2023/2024.

In the period where the Tyra complex is under renovation, Denmark is supplied with gas from Germany (Ellund IP), Norway (North Sea Entry), reverse flow from Poland (Faxe Entry) and from biomethane facilities.

When the Tyra complex is back in operation the Danish production of natural gas in the North Sea will either be exported directly to the Netherlands or transported to Denmark where it is either consumed by Danish customers, stored in storages, or exported to Sweden, Poland and Germany.

The commercial withdrawal capacity is 185 GWh/d. The withdravel capacity decreases with low inventory level. Provided the gas storage inventory is at least 25 %, the Danish consumption when the temperatur is minus 4 can be covered by storage withdrawal capacity and biomethane production.

The gas production forecast (gas for sale i.e., without offshore use) for the Danish North Sea production are shown in table 4. *Fejl! Henvisningskilde ikke fundet.*

Table 4: Gas production estimates, billion Nm^3

	2023	2024	2025	2026	2027
Gas production	0.8	2.6	3.0	2.9	3.3

Source: Danish Energy Agency, yearly forecast for oil and gas production.

The Baltic Pipe corridor

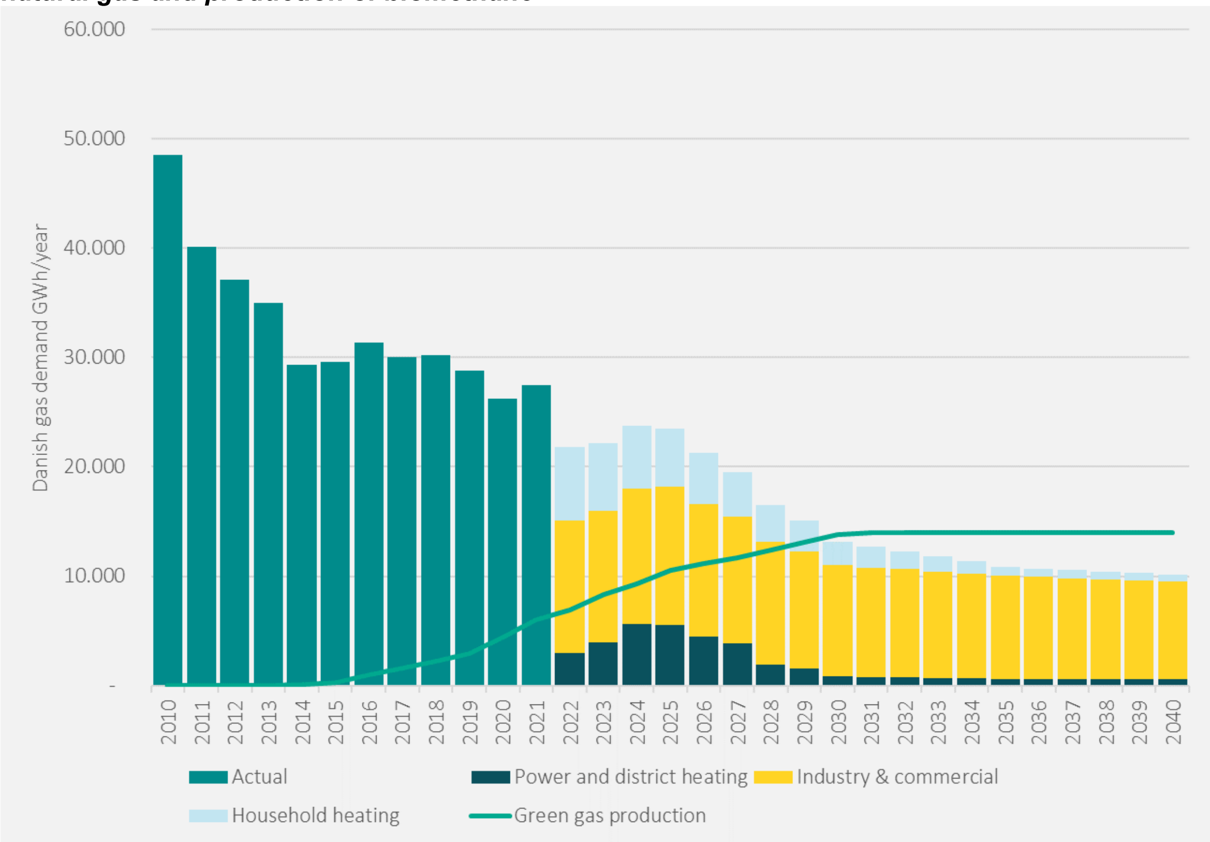
The Baltic Pipe has been in operation since October 2022. The Baltic Pipe will allow transport of gas from Norway to the Danish, Swedish and Polish markets, as well as to customers in neighboring countries in the Baltic Region and Eastern Europe via Poland. At the same time, the Baltic Pipe enables the supply of gas from Poland to the Danish market, which will contribute to the security of supply in Denmark and Sweden as more supply points are introduced to the Danish Gas system. With the new connections in Nybro and Faxe, new supply points are added in both the eastern and western part of the gas system.

Renewable Energy Sources (RES) – Biomethane

Since 2005, the consumption of natural gas in Denmark has been decreasing. The Danish Energy Agency projects the production and consumption of biomethane phasing out fossil gas consumption for households,and district heating, while converting the industry to consume more biomethane to reduce emissions from the use of fossil fuels.

The amount of biomethane in the Danish gas system along with the future projected consumption until year 2035 is shown in Figure 2 below.

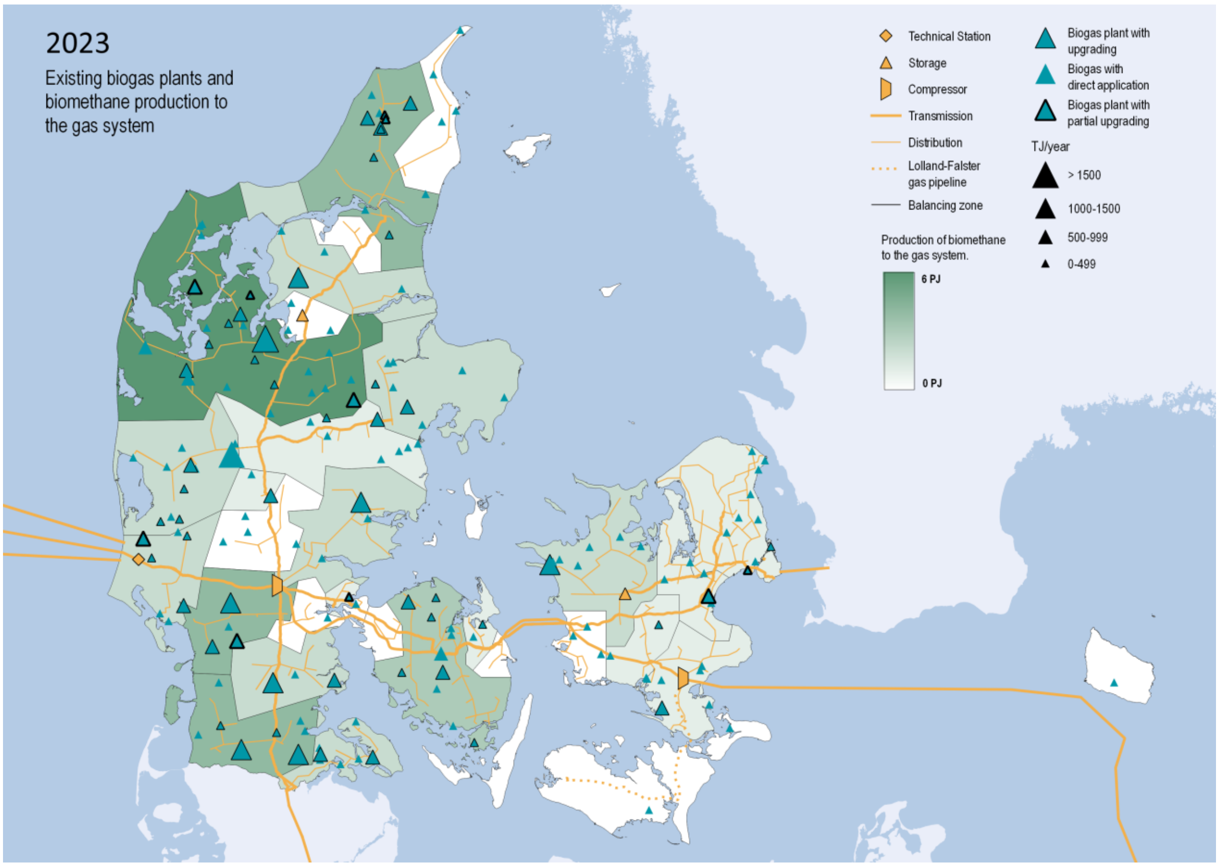
Figure 2: Historic and projected development in Danish consumption of natural gas and production of biomethane



Source: Energinet based on data from the Danish Energy Agency

The amount of biomethane in the Danish gas system is expected to grow significantly over the coming years and the current projection indicates that 100% of the gas consumption in Denmark will be covered by biomethane already in 2030. By August 2023, approx. 39% of the Danish gas consumption is covered by biomethane.

Figure 3: The Danish gas system including biomethane plants connected to the gas system (2023)



Source: Danish Energy Agency

The biomethane production in Denmark is a significant contributor to the security of supply both due to the increasing share of the total gas consumption covered by biomethane and due to the location of the biomethane plants. Biomethane contributes to a more decentralized and dispersed gas supply to the Danish gas customers. Decentralization of gas supply will, to a certain extent, help protect customers in the event of supply shortages of gas, as they are not dependent only on the primary sources of supply from the Danish North Sea and import from Germany and Norway and Poland (reverse flow from Baltic Pipe).

<u>Gas quality</u>

Biomethane produced in Denmark may contain a higher concentration of oxygen in the gas quality compared to neighboring countries, Germany, Sweden, and Poland. The large quantities of biomethane fed back from the distribution grid to the transmission grid, pose challenges in relation to gas export from Denmark.

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The measures put in place to handle the concentration of oxygen is by sectioning the system and mixing the gas within the system, respectively. The gas system is sectioned to allow gas with a low concentration of oxygen from the North Sea to be sent to Germany, without being mixed with biomethane. In practice, this means that one of the transmission lines to Germany is kept free from biomethane. For the same reason biomethane is not supplied to the western transmission pipeline of the two-parallel pipelines towards Germany.

Gas from Norway (North Sea entry) is expected to flow all year round except for short periods due to planned maintenance, and it will be together with Danish North Sea gas a supplement to mix the gas to lower concentration levels of oxygen.

Biomethane and capacity constraints between the distribution and transmission grid
The instability in Europe due to the Russian invasion of Ukraine contributes to the acceleration of biomethane production in Denmark. The current system capacity cannot fully accommodate for the increased biomethane production. In hours with low demand the relatively constant production of biomethane exceeds the offtake. Different operational measures are taken to minimize the constrains until variable solutions is in place. Please refer to section 7 for a further description of the technical solutions.

Role of the Danish storage facilities
The Danish gas storages are located in Ll. Torup, in North Jutland, and in Stenlille, in Zealand (see map below). The underground gas storage facilities are usually filled during the summer when gas consumption is low. When it gets colder and consumption exceeds the daily gas deliveries from import sources, the deliveries are expected to be supplemented by gas from the storage facilities. In addition to seasonal leveling, gas trading may influence gas export and import and affect gas flows to the storage facilities. The storage facilities are also used to secure emergency supply. The injection and withdrawal capacities of the Zealand aquifer and North Jutland salt caverns storage facilities are shown in table 5.

Table 5: Injection/Withdrawal capacity (mcm/day)

	Injection	**Withdrawal**
Zealand aquifer	4,8	8,2
North Jutland salt caverns	3,6	8,0

Source: Energinet
The storage capacity is dimensioned conservatively in relation to the “normal” pressure in the gas transmission system. When the pressure occasionally increases, it is possible to inject more gas into the storage facilities than the specified injection capacities shown in table 4. The commercial withdrawal capacities of the Zealand aquifer and North Jutland salt caverns are today at 8,2

mcm/d and 8,0 mcm/day, irrespective of whether the storage levels are 100% (full storage level) or 30% (end of season level). This would be sufficient to cover the Danish gas consumption corresponding to temperatures down to -10 ˚C and warmer.

The storage facilities provide security of supply to the Danish gas customers. In the event the supply to the Danish market from all external sources is reduced, the storage facilities and bio-methane production can partly or fully maintain the gas supply, depending on the offtake and the storage inventory gas level. The storage facilities also support security of supply to the northern sub-system in case the transmission pipe north of Egtved is interrupted and to the eastern sub-system, in case the pipe east of Kongsmark is interrupted. Energinet buys emergency storage (emergency gas) to ensure sufficient inventory gas level during the winter. Emergency storage consists of emergency gas owned by Energinet and individual filling requirements, where storage customers are paid to store gas during winter and Energinet has contractual right to purchase the gas from the storage customer in case of a declared Emergency.

During the storage year 2022-2023, 75% of the injection capacity is available when the gas storage facility is filled 95% above. All injection capacity is available when the storage filling is below 95%. Withdrawal restrictions are imposed when filling levels go below 20% (close to the System Operator emergency volume). Thus at 20% filling level, 85% of the withdrawal capacity is available, at 15% filling level, 75% of the withdrawal capacity is available and so forth.

Gas consumption

According to Denmark's Climate Status and Outlook 2023[6] the total energy consumption in Denmark was 750 PJ in 2022, equivalent to 17 bcm natural gas, distributed across several energy sources, such as oil products, renewable energy and gas. The consumption of pipeline gas was 69 PJ, which corresponds to around 9 percent of the total energy consumption.

Table 6: Gas consumption figures by year (bcm/year)[7]

	2018	2019	2020	2021	2022
Natural gas incl. biomethane	2,27	2,17	1,93	2,07	1,59
Biomethane[8]	0,16	0,22	0,33	0,45	0,52

Source: Danish Energy Agency, Klimastatus- og fremskrivning 2023 (Document "KF23 National Energibalance", "Ledningsgas)

[6] Klimastatus og -fremskrivning 2023 | Energistyrelsen (ens.dk)
[7] Gas consumption in oil and gas production is not included.
[8] The share of Biomethane is included in the natural gas figures

Gas is consumed by different sectors in Denmark: Households, industry (including service industries), district heating and electricity generation. In 2022, the total Danish gas consumption excluding the gas used for production in the North Sea was 1,87 bcm.

The gas consumption divided by sectors is shown in Table 7.

Table 7: Danish gas consumption and utilization figures by sector (bcm/year (percent))[9]

	2018	2019	2020	2021	2022
Households	0,58 (26%)	0,58 (27%)	0,56 (29%)	0,55 (26%)	0,48 (30%)
Industry	0,90 (40%)	0,88 (40%)	0,86 (45%)	0,99 (48%)	0,87 (54%)
Electricity and heat generation	0,76 (34%)	0,69 (32%)	0,48 (25%)	0,51 (25%)	0,22 (14%)
Transport	0,01 (0%)	0,01 (0%)	0,01 (0%)	0,01 (0%)	0,01 (1%)
Other	0,02 (1%)	0,02 (1%)	0,01 (1%)	0,01 (1%)	0,01 (1%)

Source: Danish Energy Agency, Klimastatus- og fremskrivning 2023 (Document "KF23 National Energibalance", "Ledningsgas")

The peak demand are shown in table 7.

Table 8: Peak demand (mcm/day) the 95% fractile for the daily Danish gas consumption for each year

	2018	2019	2020	2021	2022
Denmark	12.9	10.9	9.1	11.9	8.7

Source: Energinet

The European Regulation on coordinated demand-reduction measures[10] sets out requirements to Member States to voluntarily or mandatorily (Union Alert) reduce gas consumption by at least 15% in the period from 1 August 2022 to 31 March 2023 compared to the average gas consumption for the same period the five previous years. The regulation has been prolonged for one more year.

In 2022, the consumption in Denmark has decreased around 23% compared to 2021 as a reaction to the high gas prices and the security of supply situation. The

[9] Gas consumption in oil and gas production is not included.
[10] REGULATION (EU) 2022/1369 of 5 August 2022 concerning coordinated demand reduction measures for gas.

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reduction of consumption of natural gas alone (without offshore and biomethane) was 61% in the period from August to October 2022. Consumption reached a level corresponding to the needed demand-reduction already in the reference period 2021-2022, and a further decrease in consumption has been observed throughout 2022.

The role of gas in electricity production

The electricity production in Denmark is based on different fuels. Energinet's environmental declaration for electricity production shows that gas constitutes 5,2% of the energy used to produce the electricity consumed in Denmark. The largest share of Danish electricity production is made up from wind (41,8%) and biofuel (18,6%). In terms of electricity, Denmark is well connected to our neighbouring countries, and the consumption is not covered by Danish electricity production alone.

In relation to security of supply, power plants that use only gas constitute 26% of the total thermal production capacity. Some of the larges centralized gas-fired power plants, can use gas together with other fuels, e.g., biomass or waste. All gas-fired power plants can produce both electricity and heat.

In the Danish Energy Agency's "Analysis Assumptions 2022", it is estimated, that the future use of gas for both electricity and heating production gradually decreases towards 2040 and therefore continuously reduce the effect on electricity production as well as district heating plants' heat production caused by a gas supply disruption.

In addition to the phasing out of thermal electricity production, there are several climate benefits to phasing out oil and natural gas in district heating. Although the risk of less power adequacy might be increased, power shortages in Denmark are relatively rare. The lack of power has not yet led to interruptions in Denmark or neighboring countries connected to Denmark through power cables.

Table 9: Electricity production by source

Wind	**41,8%**
Biofuel (mainly biomass)	18,6%
Hydro	11,7%
Coal	10,8%
Natural gas	5,2%
Waste	4,6%
Solar	3,9%
Nuclear	2,3%
Oil	0,8%

Lignite	0,4%

Source: Energinet's environmental declaration for electricity, 2021

2 Summary of the risk assessment

2.1 Conclusions from the Danish risk assessment

The single largest infrastructure as per 1 October 2022 is identified as the North Sea Entry point. During the period, Tyra is still out for construction and is expected back in operation in the winter 2023/2024.

The identified main risks during the assessed period are:

- Incidents that can affect the supply to Denmark. Geopolitics have a special focus within Europe due to the war in Ukraine as well as prior to the Russian invasion. The ultimate consequence of the war could be an EU Gas Supply Crisis.

- Other mentionable risks which could potentially influence the security of supply could be IT related, especially seen in the light of an increased level of crime, espionage, activism, and terrorism as well as destructive cyberattacks in the aftermath from the Russian invasion of Ukraine and increased level of threats from China.

The Danish Energy Agency and Energinet work closely with the Danish Centre for Cyber Security to accommodate relevant threats. The task of the Danish Centre for Cyber Security is to advise Danish public authorities and private companies that support functions vital to society on how to prevent, counter and protect against cyberattacks.

In addition to the identified risks in the risk assessment incidents that affect the functioning of the Danish gas system are also a main risk. This risk and preventive measures for the risk are described in section 5.

2.2 Conclusions from regional risk groups

2.2.1 Risk Group Denmark

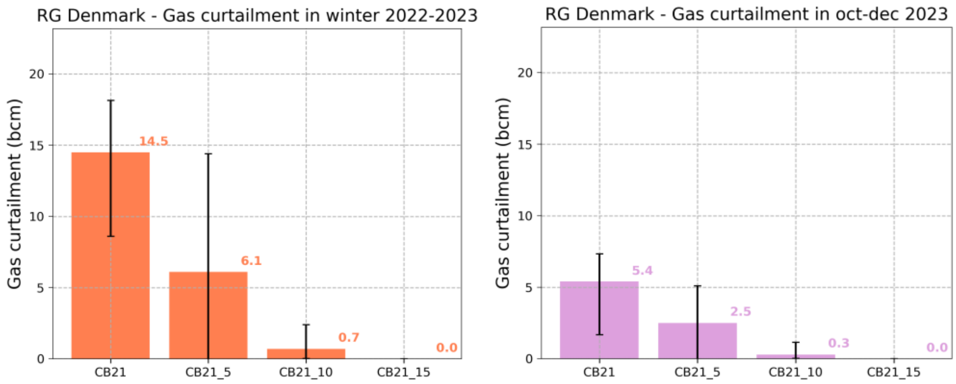
Risk Group "Denmark" consists of six interconnected countries: Denmark, Sweden, Germany, Poland, Luxembourg and The Netherlands. Even though there is some gas-production in these Member States, primarily in the Netherlands and Denmark, the Risk Group is as the major part of the European Union, extremely dependent on gas imports. Historically this import has come primarily from Russia. After the Russian invasion of Ukraine and the following reductions in gas imports from Russia to EU, MS of Risk Groups: Denmark, Caspian, Libya, Trans-Balkan and Ukraine agreed with the JRC that the far most critical risk to handle for the common risk assessments where a scenario of no Russian gas supply to the European Union (S-1).

The common risk assessment is made with calculations on scenarios for both a technical and a volume incident:

- The calculation of the technical incident is based on the infrastructure standard (N-1). The result of the calculation for the risk group is 196.3%, being well beyond the required 100%. The volume incident calculation is based on a S-1 incident; being a complete halt of the largest supply source to the region – Russia). The conclusions of this assessment shows a need for regional demand reduction of at least 5-15% (compared to the Commission's Joint Research Center' expectations) to avoid curtailment in the MS of the group. This scenario has been carried out by most MS in the Risk Groups in common understanding, including the European Commission as a scenario with a high risk due to disruption of gas supplies from Russia to the EU.

- The results of the scenario deemed most plausible is visualized in Figure 4, where there is a need for 15% demand reduction to avoid curtailment in RG Denmark.

Figure 4: One of eight scenarios for a halt in Russian gas import to Risk group Denmark



Source: JRC 2022

- The range of reduction needs depends on if the gas storages must be emptied to maintain security of supply in the short term, or must be kept at a certain level to secure the long-term security of supply. The results indicate that a higher level of storage filling decreases the risk of curtailment in the region.
- Furthermore, the assessment also concludes that there is a need for cooperation and solidarity between Member States to avoid further curtailments.

2.2.2 Risk Group North Sea

The conclusion from the risk assessment is that the reduction in Russian gas imports to the European Union has reduced the flexibility for gas supply in the risk group. Nevertheless, it is still possible to cover gas demand in the risk group in case of disruption of a major segment of infrastructure supplying Norwegian gas. Lower consumption of gas and new gas infrastructures should be instrumental in increasing flexibility in the group. No infrastructural issues were identified based on the N-1 calculation for the group.

2.2.3 Risk Group Baltic Sea

The conclusion on the work in the Risk Group Baltic Sea is based on a best case and worst-case analysis. In the best-case, there is no restrictions on use of storage gas, and all storage gas can thus be used in 2023. Assuming continuous normal demand it will cause either limited curtailment, up to 112 TWh, or no interruption of gas customers at all. In the worst case, with a lack of cooperation between MS and a reduced accessibility to storage gas, there will in 2023, be a need for large reductions in the group of up to 437 TWh. There will most likely be need for reductions among non-protected gas customers.

No infrastructural issues were identified based on the N-1 calculation for the risk group.

2.2.4 Risk Group Belarus

The conclusion of the work in Risk Group Belarus is based on a best case and worst-case analysis. In the best-case, there is no restriction of the use of storage gas, and all storage gas can thus be used in 2023. There will be no need for curtailment, assuming continuous normal demand. In the worst case, with a lack of cooperation between MS in exchanging gas across borders and a reduced accessibility to storage gas, there will in 2023, be a need to reduce demand in the risk group significantly by up to 336 TWh.

No infrastructural issues were identified based on the N-1 calculation for the risk group.

2.2.5 Risk Group North-Eastern

The conclusion of the work in Risk Group North-Eastern is based on a best case and worst-case analysis. In the best-case all storage gas can thus be used in 2023. Despite this there can - assuming continuous normal demand (no reductions in gas demand) be either limited curtailment of up to 134 TWh, or no interruption of customers. In the worst case scenario, with a lack of cooperation between MS and a reduced accessibility to storage gas, there will be a need to reduce demand of the region by up to 325 TWh in 2023.

The infrastructural N-1 calculation of the risk group is yet to be finalized.

2.2.6 Risk Group Ukraine

The conclusion of the work in Risk Group Ukraine is based on a best case and worst-case analysis. In the best-case all storage gas can be used in 2023, and will - assuming normal gas consumption – result in very little to no curtailment. In the worst case scenario, with a lack of cooperation between MS to exchange gas across borders and a reduced accessibility to storage gas, there will be a need to reduce demand of the risk group by up to 381 TWh in 2023.

No infrastructural issues were identified based on the N-1 calculation for the risk group.

3 Infrastructure standard (Article 5)

3.1 The single largest infrastructure in Denmark

This preventive action plan covers a period where one of the main sources of gas in Denmark, the Tyra complex, is still under reconstruction and the gas supply capacity to Denmark is therefore significantly reduced. However, already from the winter 2023/2024 the Tyra gas complex is expected to resume operations.

The main gas supply route to Denmark is gas transit from Norway (North Sea Entry). The system supports main capacity via North Sea Entry to Poland via Faxe Exit IP but the connection in addition offers reverse-flow capacity from Poland to Denmark via Faxe Entry IP. The Tyra Complex is expected to be back in operation in the winter 2023/2024.

3.2 Calculation of the N-1 formula for Denmark

The N – 1 formula:

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

The parameter values based on the current capacities are shown in table 9.

Table 10: Demand and capacities before realization of initiatives. Values can be converted to energy (kWh) by multiplying with 12.157

Parameter	Mcm/d	Description
Dmax	17,2	Total daily gas demand on an exceptionally cold day (20 year-incidence with an average temperature of -13ºC).
EP_m (excl. Tyra)	58,3	The value covers the entry capacity on the Danish side of Ellund, Nybro (excl. Tyra) and Faxe
EP_m (incl. Tyra)	66,5	The value covers the entry capacity on the Danish side of Ellund, Nybro (incl. Tyra) and Faxe
P_m	2,0	The value covers the expected Danish Biomethane production in 2023.
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 Ll. 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.
LNG_m	-	Maximum technical capacity at all LNG facilities. There are no LNG

		facilities connected to the gas grid in Denmark.
I_m	27,4	Technical capacity of the single largest infrastructure, North Sea entry.

Source: Energinet

Table 11: Parameters used in the N-1 calculation – with North Sea Entry as per 1st October 2022 (excl. Tyra) (* The Ellund Entry capacity used in the calculations is the entry capacity into Denmark. The Ellund exit capacity from Germany to Denmark on the German side is lower, about 2,2 mio. Nm³/d. In the calculations below it is the Danish entry capacity used in Ellund.

Parameter	Capacity (mcm/d)	Description
D_{max}	17,2	The value covers the expected daily gas demand in Denmark
EP_m	58,3	The value covers the entry capacity on the Danish side of Ellund(*, Nybro (excl. Tyra) and Faxe
P_m	2,0	The value covers the expected Danish biomethane production in 2023
S_m	16,2	The value covers the total withdrawal capacities at the Danish gas storage facilities.
LNG_m	-	There are no LNG facilities in Denmark, thus LNG_m = 0
I_m	27,4	Technical capacity at North Sea Entry

Table 12: Parameters used in the N-1 calculation – with North Sea Entry as per ultimo 2023 (incl. Tyra)

Parameter	Capacity (mcm/d)	Description
D_{max}	17,2	The value covers the expected daily gas demand in Denmark
EP_m	66,5	The value covers the entry capacity on the Danish side of Ellund, Nybro (incl. Tyra) and Faxe
P_m	2,0	The value covers the expected Danish biomethane production in 2023
S_m	16,2	The value covers the total withdrawal capacities at the Danish gas storage facilities.
LNG_m	-	There are no LNG facilities in Denmark, thus LNG_m = 0
I_m	27,4	Technical capacity at North Sea Entry

Result for the N-1 scenario excl. Tyra

$$〚N\text{-}1[\%]〛_{(excl.\ Tyra)}=(58{,}3+2{,}0+16{,}2+0-27{,}4)/17{,}2\cdot 100=\underline{285\ \%}$$

Result for the N-1 scenario incl. Tyra

$$〚N\text{-}1[\%]〛_{(incl.\ Tyra)} = (66{,}5+2{,}0+16{,}2+0-27{,}4)/17{,}2\cdot 100=\underline{333\ \%}$$

Table 13: Results of the N-1 calculations for the Danish Gas System, where the largest entry point North Sea Entry is excluded.

Largest infrastructure: North Sea Entry	I_m (mcm/d)	N – 1
N – 1 excl. Tyra	27,4	285 %
N – 1 incl. Tyra	27,4	333 %

3.2.1 Explanation of the main results from the N-1 calculation

The N-1 calculation for Denmark shows that N-1 equals 285% in the scenario with North Sea Entry in operation and excluding the full contribution from the Nybro Entry (i.e., excluding Tyra). In the scenario where Tyra is back in operation after the winter 2023/2024, the N-1 equals 333%. This means the N-1 criteria is fulfilled in both scenarios.

The technical capacities used in the analysis have been checked by hydraulic simulations considering the system integrity and operational requirements of the transmission system.

The conclusion is that the N-1 results show compliance with the infrastructure standard, without the need for further investment in measures.

The hydraulic simulations show that gas customers can be supplied according to the requirements of the Regulation. Therefore, in an emergency with a disruption of the single largest infrastructure, the response time of the system operator and the facilities in the transmission system, along with the shippers' reaction time will be the limiting factors in order to timely accommodate for at situation with a disruption.

Prior to the rebuilding of the Tyra-complex, the withdrawal capacity of Lille Torup was expanded from 8.0 to 9.6 mcm/d to ensure security of supply to the Danish market. The extra 1.6 mcm/d withdrawal capacity is not offered as commercial withdrawal capacity to the market and additional storage volumes are required to ensure the additional withdrawal capacity that is reserved for use when emergency is declared.

Danish Energy Agency

Table 14: Storage withdrawal capacity after expansion of Ll. Torup storage facility

Parameter	Mcm/d	Description
S_m	**17.8**	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 Ll. Torup 9.6 mcm/d. The maximum withdrawal capacity of 9.6 mcm/d requires 75% filling of Ll. Torup.

Source: Energinet

3.3 Bi-directional capacity

Bi-directional capacity is established between the Danish and the German gas system in Ellund Entry/Exit, as well as between the Danish and the Polish gas system at Faxe Entry/Exit. The maximum capacities of bi-directional flows are shown in Table 14.

Table 15: Maximum capacities of bi-directional flows (mcm/day)

	Entry	**Exit**
Ellund	14,6	14,6
Faxe	8,2	27

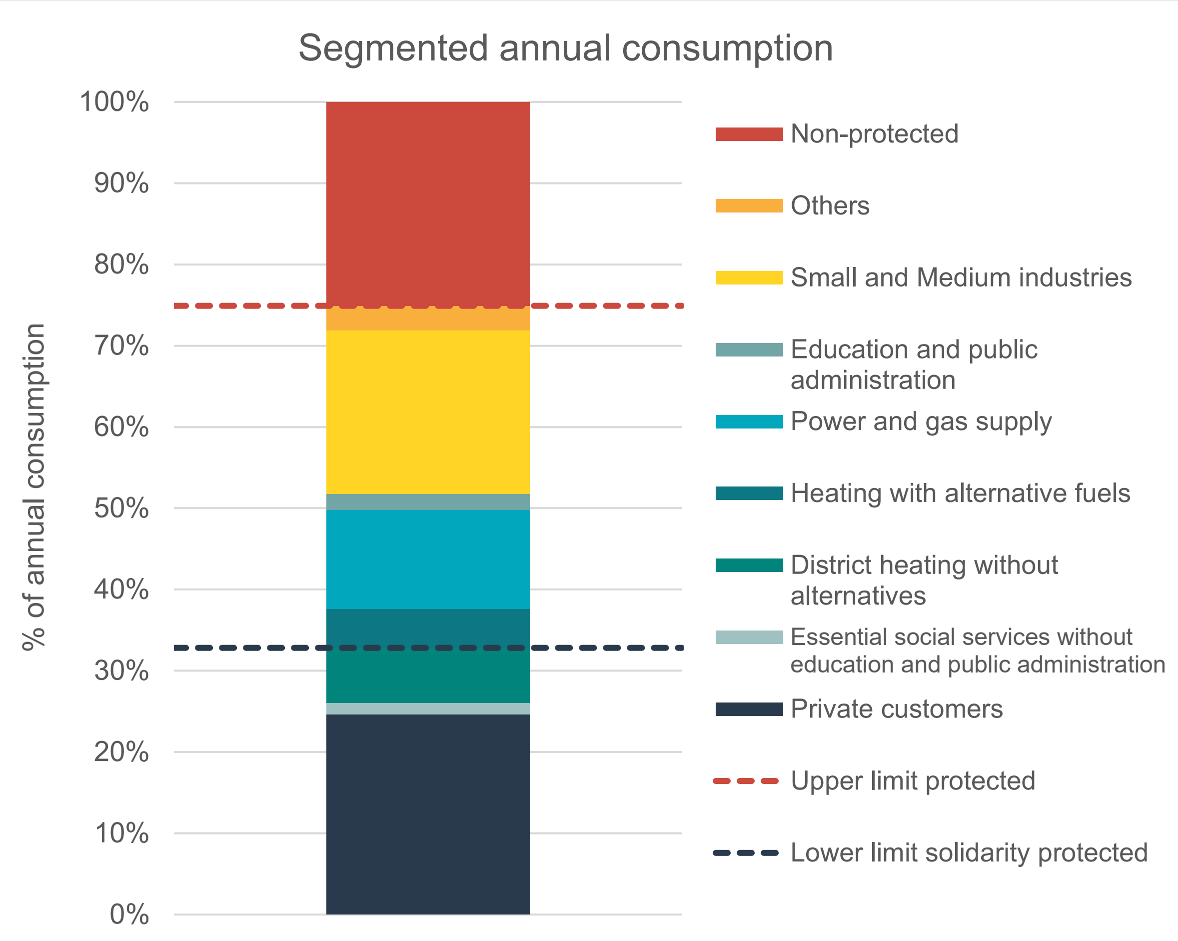
Source: Energinet

4 Compliance with the supply standard (Article 6)

4.1 Protected customers in Denmark

Regardless of the crisis level, protected customers shall be ensured gas supplies according to the supply standards of the Regulation. All private households are per definition protected customers. Other customer groups may be included in order to achieve the best possible protection of the gas customers. In Denmark, the Danish Energy Agency (competent authority) has decided that small and medium-sized enterprises, district heating installations, and essential social services such as hospitals and public institutions should also have the status of protected customers.

Figure 5: Segmented annual consumption in Denmark



Source: Energinet (Based on historic consumption data from 2020-2021)

Protected customers account for approximately 75% of the annual gas consumption (of which approx. 33% are solidarity-protected) while non protected customers account for the remaining 25% of the annual gas consumption.

4.2 Capacity and gas volumes needed to supply the protected customers

According to the Regulation (Article 6(1)) the protected customers shall be ensured gas in the following three cases:

a) extreme temperatures during a 7-day peak period occurring with a statistical probability of once in 20 years
b) any period of 30 days of exceptionally high gas demand, occurring with a statistical probability of once in 20 years
c) for a period of 30 days in the case of disruption of the single largest gas infrastructure under average winter conditions

As the Danish Emergency storage is presently set with the assumption of no inflow from ny of the external entry-point, including Ellund, which is an onshore connection, the period is still 30 days for disruption of supply in case of a volume incident.

4.2.1 Analysis of the three cases of supply to the protected customers

The three cases in Article 6(1) of the Regulation where the protected customers shall be ensured gas are analyzed for the Danish gas market below.

A general assumption in the three cases is that the protected customers in Denmark and Sweden are supplied with gas. The Danish "protected consumption" is 75 % of the Danish consumption as stated above and the Swedish "protected consumption" is 2 % of the Swedish consumption.

Furthermore, it is assumed in the calculations below that the market is supplied with gas from Ellund (import), Syd Arne (North Sea) and biomethane and that these supply sources are fully used before gas is withdrawn from storage. The analysis thus calculates the storage volumes needed to cope with the demand and if the capacities are available in the system to access necessary gas to supply the protected customers.

4.2.1.1 Case a) 7 days peak period (1 in 20 years)

This case a) assumes seven consecutive days with a daily demand equal to the peak day with exceptionally high gas demand applied in the N – 1 calculation (Article 5). The demand used is equal to the demand for the protected customers on a day with an extreme mean temperature of -13 ^{o}C for all seven days, which is equivalent to 75 % of Dmax in table 11 and 12 above. The Swedish demand of the protected customers is assumed to be 0.2 mcm/d.

Table 16: Expected daily flow in case a)

Point	Daily flow (mcm/d)	Volume for 7 days (mcm)
Danish protected customers' demand	-14	-96
Swedish protected customers' demand	-0,2	-1
Net demand	-14	-98
Ellund)*	14,7	103
South Arne	0,2	1
Faxe	8	57
Biomethane	2	14
Storage withdrawal	16	113
Net inflow	**27**	**191**

Sources: Danish protected customers' demand from "Prognosemodellen": See Energinets winter-outlook in the Security of gas supply report: https://en.energinet.dk/Gas/Security- of-Supply; Expected production from "Analyseforudsætninger 2022":) The capacity on the list is the entry capacity to the Danish gas system.*

Table 16 shows the demand from the protected costumers in the Danish and Swedish market. The table above indicates that the supply can be maintained without withdrawing gas from the storage facilities.

4.2.1.2 Case b) 30 days exceptionally high gas demand (1 in 20 years)

This case b) assumes 30 consecutive days with an exceptionally high gas demand. The demand used is equivalent to the highest daily demand in a year with exceptionally high gas demand. The Danish demand is equivalent to the protected customers' consumption. The demand of the protected customers in Sweden is assumed to be 0.2 mcm/d.

Table 17: Expected daily flows in case b)

Point	Daily flow (mcm/d)	Volume for 30 days (mcm)
Danish protected customers' demand	-14	-413
Swedish protected customers' demand	-0,2	-6
Net demand	-14	-419
Ellund	15	441
North sea Entry	27	810
South Arne	0,2	6
Faxe	8	246
Biomethane	2	60
Storage withdrawal	16	486
Net inflow	54	1630

Source: Danish protected customers' demand and expected production from "Analyseforudsætninger 2022": https://ens.dk/service/fremskrivninger-analyser-modeller/analyseforudsaetninger-til-energinet

The table shows the demand of the protected costumers in the Danish and Swedish market. The results in the table indicate no need for gas withdrawal from storage and that consumption by the protected customers can be covered by gas from Syd Arne, biomethane and imported gas from Ellund. However, the storage facilities can supply up to 15,2 mcm/d.

4.2.1.3 Case c) 30 days average winter with disruption of the single largest gas infrastructure

This case c) assumes 30 consecutive days under average winter conditions. In the example, the demand used is equivalent to the highest daily off take in a year with an average winter. The Danish demand in the table below is equivalent to the protected customers' consumption. The demand of the protected customers in Sweden is assumed to be 0.2 mcm/d.

Table 18: Expected flows in case c)

Point	Daily flow (mcm/d)	Volume for 30 days (mcm)
Danish protected customers' demand	-7	-216
Swedish protected customers' demand	-0,2	-6
Net demand	-8	-249
Ellund	15	441
North Sea Entry	0	0
South Arne	0,2	6
Faxe	8	246

Biomethane	2	60
Storage withdrawal	16	486
Net inflow	33	990

Source: Danish protected customers' demand and expected production from "Analyseforudsætninger 2022": https://ens.dk/service/fremskrivninger-analyser-modeller/analyseforudsaetninger-til-energinet

The table shows the demand of the protected costumers in the Danish and Swedish market under average winter conditions. The calculation indicates a storage need of 7,2 mcm/d or 216 mcm over the 30 days period which can be covered by Ellund Entry, South Arne, Faxe Entry, Biomethane and Storage withdrawal. In the case of the two largest supply point to Denmark were disrupted, North Sea Entry and Ellund, there would still be sufficient gas to cover the consumption of the protected customers in Denmark and Sweden.

4.3 Measures to comply with the supply standard

This section describes the measures put in place in order to ensure the gas supply to the protected customers and compliance with the supply standard. The Danish TSO has used the following measures to secure gas for security of supply:

1. Emergency storage volume
2. Filling requirements

Energinet uses the measures under the guidance and instructions from the Danish Energy Agency who has the overall political responsibility for deciding on the level of security of supply and the assumptions and scenarios on which the measures shall be based.

4.3.1 Emergency storage

There are two storage facilities in Denmark at Stenlille (Sealand) and Ll. Torup (Jutland). The total storage capacity is approx. 10 TWh and presently (2023) a total withdrawal capacity of 7,5 GW. The two physical storage facilities owned by Gas Storage Denmark and operated as one virtual storage point in the Danish market model.

Energinet buys storage capacity and stores gas for Emergency alongside with the gas capacity reserved by commercial storage customers. Energinet has priority access to storage capacity for security of supply purposes. In case of Emergency, Energinet needs both volume and withdrawal capacity in the gas storage facilities. Energinet reserves sufficient storage volumes to secure the necessary withdrawal capacity for hydraulic and volume incidents and long term Emergency situations. The actual need for emergency gas depends on the supply and demand situation. In the event where supply to a subsystem is interrupted, the delivery point for emergency gas is critical. For instance in the event that the supply to the eastern part of Denmark east of Kongsmark is interrupted, it is critical that the Stenlille storage facility can deliver the necessary amount needed to supply the protected customers located east of Egtved until the connection to the eastern part of Denmark is reestablished. The measure will ensure the gas supply to the protected customers and help to mitigate the situation. Mitigation of the situation also depends on the supply from commercial storage customers. The decision to use emergency storage and withdrawal capacity is made by the actual crisis manager. During an Emergency the dialogue between Energinet and the gas storage company will be continuous to ensure the supply to the customers and the integrity of the system. If relevant, Gas Storage Denmark will balance the necessary withdrawal between the two physical storage facilities.

4.3.2 Filling requirements

Energinet concludes contracts with commercial customers regarding volumes and period for the stored volumes. Energinet purchases filling requirements in tenders open to all storage customers. An agreement on filling requirements is an agreement between Energinet and the storage customers. Energinet pays storage customers to keep gas in the Danish storage facilities for defined periods (normally from November to March), which will be made available to Energinet in case of Emergency is declared. The filling requirements are a way of utilizing synergies between the gas stored for normal supply and for security of supply. The gas stored under filling requirements contributes to maintaining the required withdrawal capacities during the period with peak demand. Gas stored under filling requirements will be made available to Energinet with an option to buy in case of Emergency. Energinet shall contact the storage customers and inform them that Energinet needs to take over the gas. There also needs to be a dialogue with the gas storage company to ensure that Energinet has full right of disposal over the stored gas. Taking over the stored gas will contribute to the security of supply to protected customers. The degree of mitigation also depends on the supply from commercial storage customers. The decision to use filling requirements can affect the commercial storage customers' use.

The filling requirement has a high level in the cold months and are reduced day by day in the period from last part of winter to early spring. This releases daily amount of gas to the market and prevents critical reduction of storage level in early spring.

Due to the present supply situation of gas to Europe, the method to calculate the necessary Emergency storage is under revision. The method used to calculate the Emergency storage for 2022/2023 and 2023/2024 is to assume that there is no inflow of gas to Denmark from Norway, Germany and Poland and the Danish marked has to be supplied solely from biomethane and the Danish storages. The method for calculating the need for Emergency storage for 2024/2025 is not decided yet.

Energinet can include natural gas volumes in storage covered by the storage customers in the security of supply model as so called filling requirements.

The filling requirements are a way of utilizing synergies between the gas stored for normal supply and for security of supply. Energinet uses filling requirements to ensure that the storage customers keep certain volumes of gas in storage at certain points in time. It is common practice that the storage customers keep excess quantities of gas in the storage facilities, and it is not until the end of the storage season (March) that filling requirements restrict the actual use of the storage facilities. Filling requirements and emergency gas owned by Energinet are substitutable and fulfill the same function.

Energinet pays storage customers to keep gas in the storage facilities for a given period of time, normally from November to March. The gas will be made available to Energinet in Emergency in case of gas deficit in the system (volume incident). The maximum total filling requirement in the period November-March 2023/2024 is approx. 26 mcm.

4.4 Increased supply standard or additional obligation

According to the Regulation, gas supply to protected customers must be ensured for a period of 30 days in case of disruption of the single largest gas infrastructure. If the North Sea is interrupted, the Danish customers can still be supplied through Ellund and Faxe entry during a period of 30 days under average winter conditions.

5 Preventive measures

In accordance with the Regulation, this preventive action plan describes the preventive measures adopted in accordance with the risk assessment.
The main risks identified for Denmark are summarized below. Risk no. 2 is not explicitly described in the national risk assessment but is still a main risk.

1. Incidents that affect the supply to Denmark:
   a. Technical incidents in the northern German transmission system, North Sea, Norway, Poland (reverse flow) (low possibility due to higher number of supply routes)
   b. A Union/regional gas supply crisis
2. Incidents that affect the functioning of the Danish gas system:
   a. The Stenlille Storage Facility
   b. The Egtved compressor station
   c. The pipeline Egtved to Dragør
   d. Failure in the Everdrup Compressor station affecting Poland (see the Polish risk assessment plan)
   e. Failure of the Interconnection point Dragør (supplies to Sweden, see the Swedish risk assessment plan)
   f. Failure of biomethane production (low risk due to the high number of production sites)
3. IT-related risks

In the Danish natural gas system, a great number of measures have already been taken, both with regard to the configuration of the gas infrastructure and to the design of a market model etc. in order to address the most significant risks. The already implemented measures as well as those planned will have a positive impact on the main risk scenarios identified in the risk assessment.
The preventive measures are described in section 5.1 (preventive measures in accordance with the risk assessment), 5.2 (measures adopted for other reasons than the risk assessment), and 5.3 (non marked based measures). The economic impact, effectiveness, efficiency and impact on customers are described.

5.1 Preventive measures in accordance with the risk assessment

5.1.1 Preventive measures specific to the gas system

The compressor station at Egtved (2013) was built to support flow in any direction with its location in the crossing of the north-south and west-east transmission pipeline. In in the period from 2019 to 2022 where the supply to Denmark and Sweden relied mainly on supply from Germany, the compressor station has constantly been in operation supporting flow from Germany to Denmark.

With the connection to Norway and Poland (Baltic Pipe) the Danish Infrastructure has been hugely reinforced to support transit from Norway to Poland. The reinforcement includes new pipelines from Egtved to Nyborg and from Korsør to Faxe where the new compressor station in Everdrup compresses the gas to Poland. The existing compressor station in Egtved has been rebuild to adapt to the new infrastructure where the flow from West is bypassed the compressor station in Egtved and the compressors is reserved mainly for import from Germany. The rebuilding of the Egtved station at the same time allows for more biogas in the Danish transmission system without limiting the transmission capacity to Germany do to gas quality restrictions.

The Danish gas system has two pipelines in the offshore crossing between Funen and Zealand and - with the latest reinforcement in 2022 - three pipelines between Jutland and Funen. The division of the capacity between multiple subsea pipelines gives additional security of supply in case of a disruption of one pipeline. Transit flows from Norway to Poland result in a higher utilization of the capacity in the Danish transmission system and full transit capacity from Norway to Poland cannot in any case be supported along with supply of Danish and Swedish gas consumption in case of a subsea disruption of any of the two belt crossings.
The connection towards Poland allows for reverse capacity of 3,8 GW (per year) which is higher than the total Danish gas consumption and, in addition to the import capacity from Norway, Ellund and local biomethane production also provide supply possibilities for Danish and Swedish customers.

The strategic location of the two storage facilities in Northern Jutland and in Zealand respectively strengthens the technical security of supply in the Danish gas system in case of a disruption of one of the internal pipelines from Egtved to Northern Jutland or from Egtved to Zealand.

The Danish gas storages facilities are owned and operated by Gas Storage Denmark which is a subsidiary company (LTD) of the Energinet Group. The two storages with different geology (salt cavern and aquifer storage) provide flexibility which is used to optimize the withdrawal and volume capacity to the actual market and supply situation.

5.1.2 Reverse flow between Denmark and Poland

The Baltic Pipe connection is constructed to support physical reverse flow from Poland to Denmark. The reverse capacity is 28% of the capacity from Denmark to Poland, and the reverse flow capacity alone exceeds the total Danish gas consumption.

5.1.3 Monitoring and maintenance

The gas transmission infrastructure in Denmark is robust and has a high level of reliability, because of the high monitoring and maintenance standards. The high level of monitoring includes onshore and offshore constructions, and both observed and potential damages are repaired immediately. All onshore transmission pipelines are belowground and marked above ground with marking poles to prevent unintended interference. The offshore transmission pipelines are buried in the seabed or protected by rock dumping. All pipelines are inspected/surveyed at regular intervals to ensure a high level of system integrity. All pipelines in Denmark are constructed, manufactured, maintained, and operated in accordance with the requirements of the Danish Work Environment Authority. Approx. every 10-20 km along the transmission pipeline there are remotely operated line-valve stations. These stations can isolate parts of the pipeline and relieve pressure, should there be a need, e.g., in case of a pipeline rupture.

Energinet continuously provides information to external parties on planned repairs and maintenance activities on the gas transmission infrastructure. If there are activities that affect the transport capacity, the affected shippers will be notified directly via the ENTSOG Transparency Platform.

Construction work in the vicinity of Energinet's gas pipelines is carefully monitored and controlled by Energinet's in-house surveyors. In Denmark, the Danish Register of Underground Cable Owners (LER) is available to seek information on underground cables, to ensure construction work can be performed safely and without causing damage to the pipelines. The purpose of LER is to prevent accidental damages to underground cables, lower administration costs in the contracting sector and to increase the security of supply.

5.1.4 Preparedness plans and exercises

Energinet has been delegated the responsibility for the general coordinating tasks, both with regards to planning and operation. Therefore, Energinet has worked out a collection of plans containing instructions for the handling of incidents in the Danish gas system. Instructions are worked out and maintained on the basis of the existing infrastructure and the market conditions applicable at any time. The plans are therefore revised whenever there are relevant changes – however, as a minimum every three years, cf. the Danish executive order no. 821 of 14 August 2019 concerning preparedness in the natural gas sector.

In accordance with the Danish executive order No. 821 of 14 August 2019, exercises based on the use of the Sector Preparedness Plans shall held at least once every 2 years and, over a 5-year period, exercises shall be held to cover all essential elements of the sector's preparedness. Energinet is responsible for these sector exercises and annually revises its 5-year tentative exercise plan, which comprises sector exercises as well as the relevant company's own exercises.

Furthermore exercises with adjacent systems cross borders are coordinated between TSO´s.

5.1.5 Emergency plans

The preparedness of the Danish gas system is described in the Emergency Plan[11] for the Danish gas transmission system, which describes, for instance, the responsibilities and the roles of various actors of the sector. See the Emergency Plan for a detailed review of tools and instructions.

5.1.6 Gas reduction preventive measures

Preventive measures also include gas reduction measures.
The European Regulation on coordinated demand reduction (Regulation 2022/1369) introduces both a voluntary national demand reduction goal of 15 % and a mandatory demand reduction requirement in Union Alert of 15 %.
The Danish Energy Agency has in the context of national political agreements taken measures to reduce the Danish gas consumption. The measures include e.g. subsidies for district heating, subsidies for building improvements, subsidies for disconnecting individual gas boilers, future national plans for closing down and converting part of the gas distribution system. The political agreements also include increasing biomethane production.

The Emergency plan has a more detailed description of the measures.

5.1.7 Balancing prices

It has been identified as a risk that shippers do not have a strong enough incentive to secure supply for the end-customers through the whole winter season. In order to give shippers a stronger incentive to save gas and to have sufficient gas quantities for delivery during a cold winter, and thereby reduce the identified risk, Energinet has introduced specific rules for market based balancing prices during the European crisis levels. The price for balancing gas under normal operations follows the volume-weighted average price for all trades executed on the EEX ETF Within-day market during the given gas day. Additionally, Energinet takes an adjustment fee of 0.5 % of the neutral gas price to ensure that shippers has an economic incentive to maintain their balancing obligations in the gas system.
In a situation where Denmark has declared 'Early Warning', 'Alert' or 'Emergency', the percentages of the adjustment fee can increase up to 100 %. If/when Energinet raises the adjustment fees it gives shippers an extra strong incentive to balance their supply and offtake in the Danish gas system.

[11] The current emergency plans is published online by the Danish Energy Agency: https://ens.dk/ansvarsomraader/gasforsyning/forsyningssikkerhed-naturgas

5.1.8 The Balancing model

From 1 October 2022 with the introduction of Baltic Pipe in the Danish gas system, Energinet has implemented some additions to the Danish balancing model that mitigate the risk that shippers don't balance their supply and offtake in the system which potentially can pose a short-term risk of deliveries to end-customers.

Energinet has as a preventive measure introduced within day obligations in the balancing model. This means that if in each hour the accumulated imbalance in the Danish gas system goes above or below a certain threshold (the green zone), Energinet will within that hour automatically trade the exceeding amount of gas on the within day exchange, and thereby force the gas system back into the green zone. Shippers can thereby not create an accumulated imbalance that is so large that it will create a risk to the Danish gas system.

Further, Energinet operates the balancing model with a 'The causer pays' principle. This means that if Energinet has made a trade because the imbalance has exceeded the green zone, the cost for that trade is passed on to the shippers who have caused the imbalance in any given hour. Shippers will thereby have an economic incentive not to cause the imbalance to cross the green zone, because they will have to pay for such an imbalance.

5.1.9 Preventive measures for Cyber security and IT

Energinet is handling processes concerning risk and vulnerability assessments in the cyber and information security area. These processes are supported by internal and external audits on the IT/OT and cyber and information security areas by external auditors (EY) and "Ekspertgruppen" (an expert group from the Danish Ministry of Climate, Energy and Utilities), with which Energinet has a good and well-functioning collaboration. The internal and external assessments have led to awareness on areas in which Energinet has followed up with action plans to improve. These have all been presented to and accepted by the auditors. These actions and the general cyber and information security level in Energinet are additionally supported by a comprehensive and competent Cyber and Information Security strategy, consisting of initiatives that holistically secure the elevation and maintenance of the cyber level for Energinet. Energinet furthermore support this with the rollout of a program (Infrastrukturprogrammet) that addresses additional areas in which Energinet wishes to improve over the coming years. These areas have been identified on a risk-based approach. Energinet also has a SOC-program that secures proactive control in the cyber and IT areas. Energinet has furthermore established close and productive work relations with the (national) Centre for Cyber Security.

5.1.10 Operational optimization

The operating balancing agreements between Energinet and the neighbouring systems Interconnetion Points Europipe II (Norway), Nybro (Danish North sea), Ellund (Germany), Faxe (Poland), and virtual gas stroages (Gas Storage Denmark) specify certain buffer limits and principles for the maximum permitted differences between physical supplies and commercial orders. The difference between physical and commercial nominations is calculated every hour and send to Gas Storage Denmark, and the size of the buffer is determined once a day and send to neighboring system operators.

The buffer is used to optimize the operations and in special cases for a short period based on agreement the limit may be exceeded.

The measures contribute to mitigating inbalances in the gas system.

5.1.11 Reduced capacity

If for physical or operational reasons, capacity is temporally reduced in all or part of the transmission system, Energinet may issue a notice of reduced capacity to the shippers. When a capacity warning has been issue, Energinet has the possibility to reduce or completely interrupt supplies and consumption in the Danish gas system on the Pro rata-basis as long as the capacity is reduced.

Reduced capacity may be used if it is deemed necessary in order maintain operational stability on the transmission system for example due to a pipeline break which only affects parts of the transmission system.

The measures contribute to mitigating imbalances in the gas system.

5.1.12 Information to gas market actors

The Danish Energy Agency commits, in the event of gas supply crisis, to provide the actors on the gas market with the necessary information to deal with the situation. The information will include information on the assessment of the supply situation and security of supply, including scenarios based on the Danish Energy Agency’s data. The aim is to clarify the current and expected supply situation as well as the distribution of roles and responsibilities in the event of a supply crisis.

The Danish Energy Agency’s information flows to the actors on the gas market can be increased in Alert and Emergency.

The Danish Energy Agency informs the actors in the gas market about the security of gas supply and the actors roll. The Danish Energy Agency asses the need for information with regard to the supply situation.

The measures contribute to mitigate the situation and prevent the lack of matching expectation between the authorities and actors in the gas market in the event of a gas supply crisis.

5.1.13 Dialog with gas customers with non-protected consumption

The Danish Energy Agency requests non-protected gas customer to describe their gas consumption. They collect data in a database, which the Danish Energy Agency has created and manages. The Danish Energy Agency will use the database for determining the non-protected gas consumer's reduction-level in an Emergency. If a non-protected gas consumer does not report information of gas consumption to The Danish Energy Agency, The Danish Energy Agency will based on the general data and available information discretionary determine the company's reduction-level in an Emergency.

The collected data from the non-protected gas customers is treated as company-sensitive data. During an Emergency, it will for the sake of handling the supply situation be necessary to share data with Evida and Energinet.

To ensure understanding of the gas supply situation, the handling of a potential crisis-situation and to give opportunity of direct dialog of challengers between The Danish Energy Agency and gas customers with non-protected gas consumption, the Danish Energy Agency can invite to dialog meetings. These meeting can take place with individual non-protected gas customers or they can take place as common-meetings with participation of all gas customers with non-protected gas consumption.

Common-meetings will primarily focus on the general supply situation and the potential consequences for all gas customers with non-protected consumption. Individual, bilateral meetings between the Danish Energy Agency and non-protected gas customers will give The Danish Energy Agency the opportunity to uncover significantly challenges of decreased gas supply of the non-protected gas consumer, as well as receiving information of supply chains and potential cascading effects.

5.2 Preventive measures adopted for other reasons than the risk assessment

5.2.1 Integration of biomethane

The amount of biomethane is expected to significantly grow over the coming years, and the current projection indicates that 100% of the Danish gas consumption will be covered by biomethane in 2030. By August 2023, approx. 39 % of the Danish gas supply is covered by biomethane.

The Danish biomethane production is a significant contributor to the security of supply both in relation to the increasing share of the total gas consumption and in relation to the location of the biomethane plants. Biomethane contributes to a more decentralized and dispersed gas supply to the Danish gas customers. Decentralization of gas supply will, to a certain extent, help protect customers in the event of supply shortages of natural gas as they do not become dependent only on the primary sources of supply from the Danish North Sea and import from Germany and Norway, respectively.

5.2.2 Gas reduction preventive measures

In section 5.1.6 it is described that the Danish Energy Agency has implemented measures to reduce the Danish gas consumption. Some of the measures was implemented before the risk assessment was prepared and therefore also implemented for other reasons than the risk assessment. Please refer to section 5.1.6.

5.3 Non marked based measures

5.3.1 Emergency gas volumes

Energinet stores gas and buys storage filling requirements for possible use in an Emergency. Energinet uses the measures under the guidance and instructions from the Danish Energy Agency who has the overall political responsibility for deciding on the level of security of supply and the assumptions and scenarios on which the measures shall be based.

Please refer to section to section 4.3.1 and 4.3.2 for a further description of emergency storage and filling requirements.

5.3.2. Interruption of non-proteched customers

In case of Emergency at national level or Union or Regional level, supply to non-protected customers will be maintained unless it is deemed to interrupt the supply to them in order to safeguard the supply to protected customers.

Depending on the development and duration of the Emergency, it may be necessary to fully or partial interrupt the non-protected customers. The decision on possible interruption of customers will be based on the following considerations:

- Define whether it is a national Emergency or a Union or Regional Emergency
- The expected duration of the Emergency, as well as the likeliness of the situation to develop either in a positive or negative direction
- The ability to supply both the Danish and the Swedish protected gas customers
- The ability to also supply the non-protected gas customers in Denmark and Sweden
- The options for reducing the consequences of potential interruptions, both the direct consequences for the affected gas customers, and also the indirect consequences for the society, and on the basis of overall considerations for the society.

The following procedures are followed in respect of non-protected customers:

- Every year Energinet identifies the non-protected customers based on metered data from the distribution companies and town gas companies. The list of non-protected customers is based on a cubic meter limit for annual consumption defined by the Danish Energy Agency.
- In case it becomes necessary to interrupt supply to the non-protected customers, a 72 hours' notice will be given. The exact level of interruption will be communicated to each non-protected customer at the earliest possible time during the notice period.
- Interruption of non-protected customers will be based on the priority model and a pro rata model. The model is described in more detail in the Emergency plan.
- The distribution companies and town gas companies can physically interrupt the non-protected customers' gas supply if they fail to reduce or stop their gas consumption at Energinet's request.

Based on the specific supply situation, the volume of gas to be interrupted is decided in order to maintain the supply to protected customers.

Interruption of non-protected customers is expected to have significant economic impact both for the specific non-protected customers and the Danish society.

6 Infrastructure projects

6.1 Cross-border projects

After the commissioning of the PCI project Baltic Pipe in November 2022, Energinet is currently not working on any cross-border methane based gas projects.

6.2 National projects

The Danish Government has approved the construction of a new pipeline, partly transmission and distribution to Lolland-Falster (common term for the two islands Lolland and Falster), thereby securing gas to substitute coal and oil for some of the islands largest energy consuming industries, and securing large reductions in carbon emissions. The pipeline will further serve as distribution infrastructure for the transport of the growing amount of biogas produced locally. The 115 km long gas pipeline will be built from Everdrup on southern Zealand run south to the Nordic Sugar factory in Nykøbing Falster and continue to Nakskov where it will supply the Nordic Sugar factory there as well.

The capacity of the Lolland-Falster gas pipeline project at full utilization is 290 million m^3 of methane gas per year. The total length of the pipeline route is projected to be approx. 115 km, of which approx. 4 km of the route is in Danish waters in Storstrøm and approx. 1.5 km in Danish waters in Guldborg Sound. The pipeline will be built with a 10” pipe diameter. Energinet owns the gas pipeline from Everdrup to Nørre Alslev on North Falster, and Evida owns the gas pipeline on the remaining stretch from Nørre Alslev to Nakskov. Construction work for laying the pipeline has started in Q1 2023 with a view to being ready for gas transport in Q3 2024.

The Lolland-Falster gas pipeline will be connected to the Baltic pipe Transmission line at MR Everdrup.

Figure 6: Map of Lolland-Falster gas pipeline

A rise in biomethane production and a decreasing gas consumption are expected towards 2030, based on the political climate objectives. This means that the transmission system must be adapted to better handle biomethane production and ensure the system balance. For Energinet, these adaptations involve reverse-flow plants being established to ensure that biomethane can be transported via the gas transmission system, stored in the large gas storage facilities, and used anywhere in the gas infrastructure.

Due to the current energy crisis, the rise in biomethane production and the drop in gas consumption have accelerated, Energinet has begun the construction of seven reverse-flow projects around Denmark. The Danish biomethane production will increase national security of supply by diversifying supply sources, and the reverse-flow capacity will also support the regional security of supply by increasing the access to biomethane. The plants are expected to be commissioned between 2025-2027. The project is included in the latest TYNDP.

The capacity of the reverse-flow plants will be evaluated continuously until all plants are commissioned to ensure they mirror the expected developments. With full utilization of all the plants (operation all year around), they can deliver 634 mcm/year (2022 data). It is possible to increase the plants' capacity individually in some cases.

Energinet has also launched several construction projects which are the result of third-party enquiries. This involves relocating certain sections of gas transmission pipelines near Kildedal on Zealand and in west Funen to make room for urban expansions and a new railway line, respectively. After construction of these two projects, the capacities in the transmission system will remain the same.

7 Public service obligations related to the security of supply

No public service obligations are imposed on the unregulated market actors. However, certain public service obligations are imposed on Energinet as Danish system operator. These obligations include the purchase of Emergency storage and operational tasks in relation to security of supply. Gas Storage Denmark is also legally obliged to make its capacity available for security of supply purposes.

8 Stakeholder consultations

The Preventive Action Plan has been in public consultation in the Regional Risk Groups and among Danish stakeholders in the period July 6 to August 17. No concrete comments were received from the Regional Groups but Danish stakeholders' comments has been taken into consideration and/or implemented.

9 Regional dimension

According to the Regulation, each Member State shall ensure that in the event of a disruption of the single largest infrastructure the necessary measures are taken in order to continue to supply the gas market. This is the infrastructure criteria. It should be noted that Sweden has an exemption from the infrastructure criteria. Sweden has only one supply source, which is a single offshore pipeline (Øresundsledningen), connected to Denmark. If this pipeline fails Sweden is not able to supply the whole market but only the protected Swedish market (2% of the-Swedish gas demand).

9.1 Calculation of regional N-1 for risk group Denmark

Data for all listed relevant parameters has been collected and categorized by the coordinator of the Risk Group Denmark and the JRC, for the calculation of the technical capacity of the gas infrastructure to satisfy total gas demand through the N-1 formula. An example of this calculation is shown below for the 2022 scenario.

$$\mathrm{N-1}[\%] = \frac{(8355.4\ + 836.4\ + 10309.39 + 931.2 - 1394.8)\ GWh/d}{9698.15\ GWh/d} \cdot 100 = 196.3\%$$

A full overview of the determined N-1 and collected relevant data is shown in the table below.

Table 19: Demand and capacities

Parameter	2022	2022-09	NR 2022	NR 2022-09
D_{max} [GWh/d]	9698.15	9698.15	9698.15	9698.15
EP_m [GWh/d]	8355.4	8348.3	5936.1	5918.8
P_m [GWh/d]	836.4	836.4	836.4	836.4
S_m [GWh/d]	10309.39	10309.39	103009.39	10309.39
LNG_m [GWh/d]	931.2	931.2	931.2	931.2
I_m [GWh/d]	1394.8	1394.8	955.9	955.9
N-1 [%]	196.3	196.2	175.9	175.7

Furthermore, the IP Wilhelmshaven LNG terminal must be considered in the event of the project providing additional capacity for the RG Denmark system. The resulting changes in N-1 calculations are presented in the table below.

Table 20: Demand and capacities with Wilhelmshaven

Parameter	2022	2022-09	NR 2022	NR 2022-09
D_{max} [GWh/d]	9698.15	9698.15	9698.15	9698.15
EP_m [GWh/d]	8355.4	8348.3	5936.1	5918.8

P_m	[GWh/d]	836.4	836.4	836.4	836.4
S_m	[GWh/d]	10309.39	10309.39	10309.39	10309.39
LNG_m	[GWh/d]	1290.59	1290.59	1290.59	1290.59
I_m	[GWh/d]	1394.8	1394.8	955.9	955.9
N-1	[%]	200	199.9	179.6	179.4

These calculations of the regional N-1 formula for the calculated area in the RG Denmark show that N-1 > 100% by a significant margin for all scenarios considered. Therefore, the calculated regional area complies with article 5 (infrastructure standard) of the regulation in all relevant 2022 scenarios.

9.2 Calculation of regional N-1 for risk group Ukraine

Tables below are calculated taking into account the following hypothesis:

- Interruption of Velké Kapušany-Uzhgorod entry point as the single largest infrastructure (I_m) as requested by the SOS regulation;
- Total disruption of Russian gas. Even if not requested by the Regulation, this is the relevant scenario which we may incur in;
- Forthcoming LNG regasification plants sensitivity

As provided by the Regulation, the N-1 formula has been computed taking into account the 100% of underground storage working gas volume.

Even If in each case the index results far above the 100%, given the actual rerouting of the main gas supply flows following the February 2022 invasion of Ukraine by Russia, the result doesn’t mean that regional gas infrastructures are properly dimensioned in order to cover maximum demand of the involved Member States.

However, N-1 index doesn’t take into account possible existence of internal bottlenecks or problems induced by malfunctioning of internal interconnection points or due to lack of available capacity to attract gas. All these risks are evaluated in the following risk analysis.

The following tables summaries the data set used for N-1 formula calculation.

Table 21: N-1 calculation and results fir RG Ukraine

					With forthcoming LNG			
	2022	**2022-09**	**No RU* 2022**	**No RU* 2022-09**	**2022**	**2022-09**	**No RU* 2022**	**No RU* 2022-09**
N-1	**189,7 %**	**189,7 %**	**166,7%**	**166,4%**	**194,6 %**	**194,7 %**	**171,7%**	**171,4%**
				14554,31				14554,31

D_{max}	14554,31	14554,31	14554,31		14554,31	14554,31	14554,31	
EP_m	13692,60	13702,00	10352,70	10310,90	13692,60	13702,00	10352,70	10310,90
P_m	729,09	729,09	729,09	729,09	729,09	729,09	729,09	729,09
S_m	14022,61	14022,61	14022,61	14022,61	14022,61	14022,61	14022,61	14022,61
LNG_m	1072,29	1072,29	1072,29	1072,29	1794,66	1794,66	1794,66	1794,66
I_m	1913,60	1913,60	1913,60	1913,60	1913,60	1913,60	1913,60	1913,60
D_{eff}	0	0	0	0	0	0	0	0

* In this particular case, capacities of IPs that carried mostly Russian gas and no longer have physical flow (Greifswald, Kondratki, Tieterowka, Wysokoje, Orlovka) were removed and they were not considered as the largest regional infrastructure. It should be noted that the Drozdovichi (UA-PL) and Uzgorod-Velké Kapušany (UA-SK) points still show flows. Velké Kapušany remains the largest capacity infrastructure.

9.3 Calculation of regional N-1 for risk group Belarus

Creation of two separate subregions: East-Baltic and Middle-west countries, for the working purpose of the report, follows from the fact that the Baltic States remain isolated from the wider EU gas system. This means that N-1 formula should be applied separately for each sub region. Two levels of the maximum working volume is taken into consideration – 100% and 30 %.

Table 22: Result of N-1 calculation for RG Belarus

	2022	2022-09	No RU* 2022	No RU* 2022-09	With upcoming LNG 2022	2022-09	No RU* 2022	No RU* 2022-09
N-1	172,7%	171,1%	159,7%	158,1%	177,1%	175,5%	164,0%	162,4%
Dmax	12404,25	12404,25	12404,25	12404,25	12404,25	12404,25	12404,25	12404,25
EPm	8955,10	8756,40	7 338,00	7 136,20	8955,10	8756,40	7 338,00	7 136,20
Pm	843,84	843,84	843,84	843,84	843,84	843,84	843,84	843,84
Sm	11 937,55	11 937,55	1 1937,55	11 937,55	11 937,55	11 937,55	1 1937,55	11 937,55
LNGm	1 601,86	1 601,86	1 601,86	1 601,86	2 140,94	2 140,94	2 140,94	2 140,94
Im	1 913,60	1 913,60	1 913,60	1 913,60	1 913,60	1 913,60	1 913,60	1 913,60
Deff								
N-1 w/ Deff								

The Belarus Risk Group countries do not specify the market-based demand-side measures (Deff'). It is impossible to determine the part of Dmax 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 9(1) and Article 5(2). There is no such market-based demand-side relevant measures. Therefore no N-1 results with D_{eff} were obtained.

9.4 Calculation of regional N-1 for risk group Baltic Sea

Data for all listed relevant parameters has been collected and categorized by the coordinator of the Risk Group Baltic Sea and the JRC, for the calculation of the technical capacity of the gas infrastructure to satisfy total gas demand through the N-1 formula. An example of this calculation is shown below for the 2022 scenario.

$$\mathrm{N}-1[\%] = \frac{(8869.4 + 746.8 + 14574.39 + 2504.78 - 1913.6)\frac{GWh}{d}}{14066.2\frac{GWh}{d}} \cdot 100 = 176.2\%$$

A full overview of the determined N-1 and collected relevant data is shown below:

Danish Energy Agency

Table 23: Result of N-1 calculation for RG Baltic Sea

Parameter	2022	2022-09	NR 2022	NR 2022-09
D_{max} [GWh/d]	14066,20	14066,20	14066,20	14066,20
EP_m [GWh/d]	8869,40	8659,30	6783,10	6636,40
P_m [GWh/d]	746,80	746,80	746,80	746,80
S_m [GWh/d]	14574,39	14574,39	14574,39	14574,39
LNG_m [GWh/d]	2504,78	2504,78	2504,78	2504,78
I_m [GWh/d]	1913,6	1913,6	1913,6	1913,6
N-1 [%]	176,2%	174,7%	161,3%	160,3%

Furthermore, the IP Wilhelmshaven LNG terminal must be considered in the event of the project providing additional capacity for the RG Baltic Sea system. The resulting changes in N-1 calculations are presented in the table below.

Table 24: Result of N-1 calculation for RG Baltic Sea (including IP Wilhelmshaven LNG terminal)

Parameter	2022	2022-09	NR 2022	NR 2022-09
D_{max} [GWh/d]	14066,20	14066,20	14066,20	14066,20
EP_m [GWh/d]	8869,40	8659,30	6783,10	6636,40
P_m [GWh/d]	746,80	746,80	746,80	746,80
S_m [GWh/d]	14574,39	14574,39	14574,39	14574,39
LNG_m [GWh/d]	2864,17	2864,17	2864,17	2864,17
I_m [GWh/d]	1913,60	1913,60	1913,60	1913,60
N-1 [%]	178.7%	177.2%	163.9%	162.9%

These calculations of the regional N-1 formula for the calculated area in the RG Baltic Sea show that N-1 > 100% by a significant margin for all scenarios considered. Therefore, the calculated regional area complies with article 5 (infrastructure standard) of the regulation in all relevant 2022 scenarios.

9.5 Calculation of regional N-1 for risk group North Eastern

The N-1 calculation for risk group North-Eastern is yet to be finalized.

9.6 Calculation of regional N-1 for risk group North Sea

For EPm, interconnection between member states within the Risk Group and interconnection with Switzerland have not been considered. Indeed, these calculations do not take into account the possible limitation of flow within the Risk Group due to limited available capacity of key pipeline flow routes trough Switzerland.

For the N-1 calculation, the disruption of the largest pipeline infrastructure has been considered:

- Disruption of the Norpipe pipeline (from Norway to Germany).

Table 25: Result of N-1 calculation for RG North Sea

		2022	2022-09	No RU* 2022	No RU* 2022-09
	N-1	**182%**	**181%**	**168%**	**168%**
'D_{max}': 1-in-20 years' daily demand (in GWh/d)	D_{max}	19183	19183	19183	19183
'EP_m': technical capacity of entry points (in GWh/d)	EP_m	13298	13250	10709	10652
'P_m': maximal technical production capability (in GWh/d)	P_m	976	976	976	976
'S_m': maximal technical storage deliverability (in GWh/d)	S_m	16119	16119	16119	16119
'LNG_m': maximal technical LNG facility capacity (in	LNG_m	5409	5409	5409	5409
'I_m': the technical capacity of the single largest gas	I_m	956	956	956	956
'D_{eff}': market-based demand response	D_{eff}				

The N-1 results are well above 100%, meaning that in a case of disruption of a major segment of infrastructure supplying Norwegian gas, other entry capacities would be sufficient to cover peak demand as it may occur with a 1-in-20 years' probability.

9.7 Mechanisms developed for cooperation

Denmark is a member of the risk groups Denmark, Ukraine, Belarus, North-Eastern, Norway and Baltic Sea. Denmark is directly connected to the Swedish, Polish and German gas systems at the respective interconnection points at Dragør, Faxe and Ellund. From a regional cooperation point of view close cooperation with Sweden, Poland and Germany is important to mitigate risk of curtailment of national gas supply and across the borders and to ensure an effective functioning of the internal gas market.

The Danish TSO has entered into operation agreements with the German TSO (Deudan), the Swedish TSO (Swedegas) and the Polish TSO (Gaz-System). These agreements include among other things mutual obligations with regard to exchange of information and measures to tackle situations where the security of gas supply might be threatened on each of the three crises levels.

It is the intention to continue with regular consultations between the three competent authorities, regulators, and TSO's in order to exchange information and discuss all relevant issues in relation to security of gas supply. The Danish Energy Agency is responsible for the cooperation and contact between authorities. Energinet has regular operational meetings with connected system operators.

ReCo

Denmark is a member of the Regional Coordination Group for Gas (ReCo) North-West. The North West team covers incidents in the North West supply corridor with gas from Norway and the North Sea. ReCo provides procedures for communication between TSO's in the event of a gas supply crises in order to support efficient crises management between TSO's.

Solidarity

According to the Regulation, Denmark shall conclude solidarity agreements with Germany and Poland for delivery of solidarity gas in both directions and an agreement with Sweden for delivery of Danish solidarity gas to Sweden. Denmark signed a bi-directional solidarity agreement with Germany in 2020. In 2023, an agreement between Denmark and Sweden, providing solidarity gas from Denmark to Sweden, was signed. Denmark and Poland are currently in the initial phases of negotiating a solidarity agreement.

9.8 Preventive measures

9.8.1 Infrastructure

All N-1 calculations in every risk group Denmark participates shows results well above 100%. In the scope of the preventive action plan, no addition preventive infrastructural measures are deemed necessary.

9.8.2 Supply

The S-1 simulations in all risk groups which involves Denmark, shows a need for demand reduction of between 5-15%, in case of a complete halt of Russian gas to Europe (S-1). In June 2022, The MS of the European Union has agreed upon a preventive action to voluntarily reduce demand by 15%. In case of declaration of 'European Alert', these reductions become mandatory for all MS.

According to Eurostat, the EU consumption of natural gas has dropped by 17.7% in the period August 2022 - March 2023. As these measures to save gas on a European scale seem to function, no further preventive measures are deemed necessary.

The Danish government have an ambition of getting 100% of the Danish gas usage covered by nationally produced biomethane by 2030. Furthermore, the Danish government have an ambition to phase out all gas in Danish households towards 2035. This, combined with the finalization of the Tyra complex renovation will make Denmark a net-exporter of natural gas, therefore further increase the security of gas supply in all of the regional groups in which Denmark participates.

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