ENERGINET

REPORT

SECURITY OF GAS SUPPLY 2019

GLOSSARY

Degree days:
Degree days are a measure of how cold it has been. The degree days in a 24-hour period are the difference between the average daily temperature and 17°C. For example, if the average temperature over the 24 hours is 4°C, there are 13 degree days in the given day. 24-hour periods with an average temperature above 17°C do not count. The degree days for the year are found by adding up the degree days of the individual 24-hour period.

Gas year:
A gas year is defined as the period from 1 October to 30 September.

Nm^3:
One Nm^3 (normal cubic metre) is the amount of gas which at 0°C and an absolute pressure of 1.01325 bar takes up 1 cubic metre.

Normal year:
A normal year is defined as and calculated at 3,113 degree days.

Biomethane:
Biomethane is upgraded biogas sent into the gas grid.

Front page photo: Stenlille Gas Storage Facility

INDHOLD

SUMMARY

80 % of the total capacity from Germany to Denmark has been sold to the market player for the two coming auction years.

The year has been characterized by preparations for the temporary shutdown of the Tyra complex in September and the increasing share of biogas injected into to the grid. In the past year, the Danish security of gas supply has been high with zero security of supply incidents.

Security of supply during the renovation of the Tyra complex
The renovation of the Tyra complex has been started. Since December 20th Denmark and Sweden have received most of their gas supply from Germany, trough the Ellund-Egtved-pipe, with supplement of gas from the storage facilities and an increasing share of biogas. This pattern is expected to continue until July 1st 2022, where gas once again will come from the Tyra platform to Denmark.

Energinet has been working in cooperation with players and authorities to ensure the best possible conditions for both infrastructure, operation and market, in order to maintain the best possible security of supply during the reconstruction of the Tyra platform.

Change of balance rules and specification of responsibility for security of supply

Change of balance rules and specification of responsibility for security of supply
The Danish Parliament has adopted a change in the Danish Natural Gas Supply Act, which specifies the transmission company's responsibility for security of gas supply. It specifies the common responsibility principle of the gas supply safety scheme, which means that both authorities and market players bear a shared responsibility for the security of gas supply within the area of competence of each party.

For this purpose, several preparatory measures have been taken regarding the market rules, including changes to the balancing rules, which were introduced on April 1st 2019. The new rules are to ensure that shippers have the right financial incentives to balance on a daily basis, while at the same time encouraging them to maintain sufficient gas in storage for the entire season.

Lille Torup Gas Storage Facility

Operations and infrastructural adaptations
The Egtved compressor station is the focal point for importing gas from Germany. It consists of four compressors, in which two units support the capacity from Germany. In addition, it may be necessary to use another compressor in case of large withdrawals from the Lille Thorup gas storage. As the compressors have become far more critical to operation, and will be used far more than before the supply from the Tyra platform was shut down, service contracts, security schemes, supply of spare part etc. has been changed, so any incidents can be dealt with more quickly. Another key element in ensuring gas supplies during the winter season and in special situations is the two Danish gas storage facilities. In order to ensure the supply in the best possible way, a minor plant modification has been carried out at Lille Torup gas storage facility, which means that the withdrawal capacity is increased by 15 % for use in extreme situations.

Capacity bookings to Germany
At the annual auction in July, the shippers on the gas market have booked capacity between Germany and Denmark. All tendered capacity from the German market area GASPOOL ended up being sold on the auction. Overall, approx. 80 % of the total capacity from Germany to Denmark has been sold to the market players for the two coming auction years.

Assessment of the Danish security of gas supply for the coming winter
The security of gas supply in Denmark has been high in 2019, and all preparations for the coming winter have been carried out. At the dawn of winter 2019/2020, Gas Storage Denmark has sold out their capacity, and the storage facilities are 97 % full.

Energinet continuously analyses the supply situation and the filling of the storages in order to prevent a crisis situation. As a new initiative, information is published to the market on the status of the situation in the 'Safe Storage Level' curve on Energinet's website. The information is updated daily with an illustration of the estimated storage emptying for the remainder of the storage season.

Closer connection to the European gas market
During the next three years, when the gas supply from the North Sea will be significantly reduced, Denmark is, for the first time since 1984, dependent on gas import from Germany. At the same time, the Danish gas market has become increasingly integrated in the wider European market over the years. For many years, it has been possible to trade gas across borders in virtual hubs and exchanges. This

One day in the summer of 2019 biogas injected in the gas grid constituted 35 % of the total gas consumption in Denmark. This measurement was registered on July 13th and is thus the record of the year.

has had an impact on the development of the Danish gas price, which currently follows the gas prices in north-western Europe.

The development of closer interconnections also extends to Sweden, where the Danish and Swedish gas systems are connected closer together with the merger of the two countries' balancing areas in April 2019. The merger supports the optimal utilization of the market and operational synergies between the two systems.

Denmark will to an even greater extent cooperate with other countries regarding energy, security of supply and new green gases to keep up with the development.

Access to new markets in the EU – Baltic Pipe
Energinet and the Polish Gas TSO GAZ-SYSTEM are working together to establish a new gas pipeline from Norway through Denmark to Poland, which is expected to be commissioned in 2022. When Tyra is up and running again, the new connection to Poland will be put into operation. Denmark's interest in the Baltic Pipe project is, amongst other things, to ensure low and stable gas tariffs in the years to come. When Danish consumption is expected to decline in the coming years, there will be fewer consumers to cover the costs of operating and maintaining the gas network.

At the same time, access to Norwegian gas is positive for Poland and other countries in Central and Eastern Europe, which today are predominantly dependent on gas from Russia. In addition to Norwegian gas, Baltic Pipe will give Denmark Indirect access to the global market for liquefied natural gas (LNG) via the Polish receiving terminal for LNG.

Green transition of gas system
The share of green gasses in the grid has grown rapidly in both 2018 and 2019. This is a continuation of the development where the biogas capacity that has been established over the past five years is equivalent to the accumulated capacity of the past 30 years. The gas system is thus increasingly becoming a part of the green transition, and biogas is now also contributing to the general security of supply.
One day in the summer of 2019 biogas injected in the gas grid constituted 35 % of the total gas consumption in Denmark. This measurement was registered on July 13th and is thus the record of the year, when you look at the added biogas to the grid in relation to the Danish gas consumption. The amount of biogas injected into the gas network will in the future constitute a growing proportion of the Danish gas consumption. Energinet has several projects concerning balancing the grid between distribution and transmission as a result of the increased number of biogas plants which adds gas to the grid.

In addition, hydrogen has received major focus both nationally and internationally in 2019. In 2019, a steadily increasing number of players have shown interest in Power-to-X projects (PtX) and thus hydrogen in Denmark. On basis of 'System perspective 2035' and the dialogue with the players, Energinet published the report ' PtX in Denmark before 2030 ' in April 2019. The report estimated that PtX plants can become a reality in Denmark during the next 5-10 years, if the right framework is created. The development of the gas system will therefore also include hydrogen in the coming years.

THE TIME AFTER TYRA IS PROCEEDING AS EXPECTED

The Egtved compressor station is in operation after the Tyra complex closed. The majority of the gas is now being importet and after the first three months everything is going according to the plan.

Gas supplies to Denmark from the Tyra complex in the North Sea stopped on September 21st. Tyra is being rebuild after the 35-year-old platform has sunk more than five meters and is now to be lifted back up to ensure a suitable distance to the surface of the water. It takes almost three years.

Energinet Gas TSO has for many years been preparing for the temporary shutdown of the country's largest supply of gas.

This includes, among other things, the preparation of the 10,000 square meter compressor station east of Vejle. The plant has four sizeable compressors. Each of them with capacity to push 350,000 cubic metres of gas per hour with a pressure of 80 bar. Two of the compressors are dedicated to support the German gas, which has now replaced the flow from the North Sea and is to flow until Tyra is back on its feet. Another compressor is ready for backup.

Good preparation and few faults
Employees at the Egtved compressor station have gone through most scenarios for the coming years, as they are placed on the main nerve in the gas system.

- This is the first time the station really is in operation as we have not had many hours of operation until Tyra closed. In fact, it is going better than we had expected. We have delivered what is required, says Per Stangholm Jakobsen, head of department in Operation and Maintenance of the compressor station.

This means that only minor flaws have appeared on the equipment after Germany opened the gas stream to Denmark. And no issues which could not be rectified quickly.

-The last year and a half, we have made an effort to prepare ourselves: Do we have everything under control? What do we need to get more control of? We tried to think outside the box regarding what we might encounter. We are fully aware of how critical it is if we start having problems with the import of gas and that we have gotten a completely new role in the gas system. We have, after all, built the station to be in operation and play a role. It is now doing so, and it is exciting, says Per Stangholm Jakobsen.

He gives the competent employees and good service agreements the credit for ensuring that he is completely calm when it comes to the station's great responsibility in the coming years.

High-price area with import
It is going according to plan on the market side. The export of gas has turned to import, and Denmark is now a high-price area for gas. Specifically, Denmark has imported seven times as much gas in the first month after Tyra closed, compared to the same period

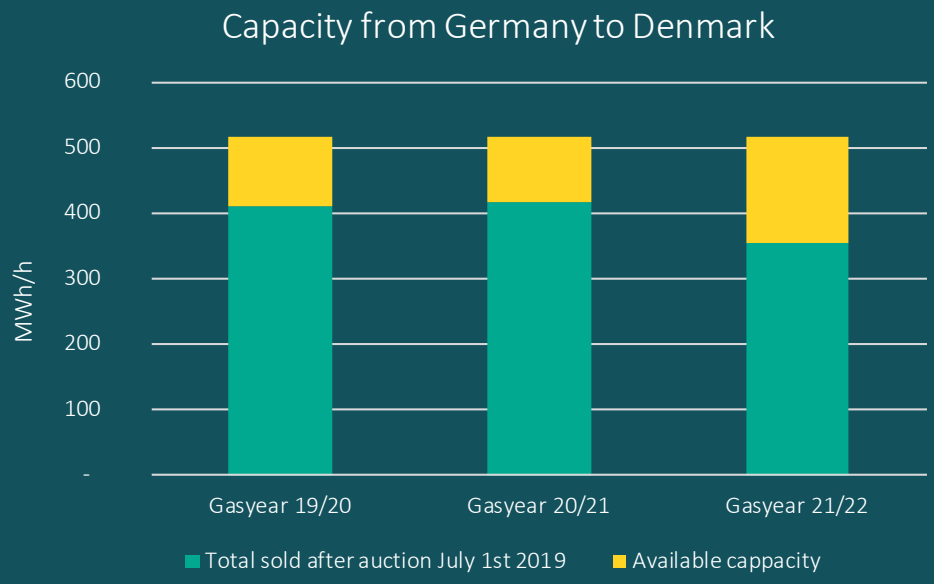
last year. Ahead awaits the factor which is difficult to predict and fully prepare for: the weather.

The biting cold, which extended the winter of 2018 well into March, resulted in an unexpected rehearsal of the uncertainty about the supply, as Energinet had to issue an Early-warning message to the gas market: a direct message to market players to retrieve more gas to Denmark.

Hope for a milder winter

-After a cold winter, the storage facilities must be filled again, and the price will increase with demand. The Summer-Winter spread will be less, and we expect to see less willingness to pay for the purchase of storage services. So, we hope for a mild winter, says Camilla Mikkelsen, who is economist in Gas Market Development at Energinet.

In the autumn-lukewarm climate in 2019, the storage facilities in the country have been filled in preparation for the coming winter. The gas storage facilities will play an important role in the coming years, and the collaboration between Energinet Gas TSO and Gas Storage Denmark has been close and will continue to be. In order to ensure sufficient capacity on a cold day in emergency situations, Gas Storage Denmark has expanded the withdrawal capacity of the gas storage facility in Lille Torup, so that more gas can be drawn from the storage facility.



Approx. 80 % of the total capacity from Germany to Denmark has already been sold to the market players for gas year 1 and (approx. 4 GWh/h out of approx. 5 GWh/h, see the graph). The remaining capacity of 1 GWh/h consists of the capacity that the TSO is legally required to withhold for short-term contracts (10%) as well as the still available capacity at the other German TSO at the Ellund border point: Open Grid Europe. For year 3 approx. 1.5 GWh/h is available at the two TSOs.

The 10,000 square meter compressor station in Egtved has fouir sizeable compressors, each with capacity to push 350,000 cubic metres of gas per hour with a pressure of 80 bar. Two of the compressors are dedicated to support the German gas, which has now replaced the flow from the North Sea

BIOGAS IS NO LONGER A PARENTHESIS IN THE GAS SUPPLY

In three years 25 % of gas used by danish consumers will be covered by biogas. Biogas is therefore contributing considerably to the security of supply.

While both politicians, business and climate-conscious citizens are challenging themselves and each other on solutions to the Danish Government's 2030 targets, the share of green gas is increasing. Gradually, the share of natural gas in the 18,000 km long gas grid - which constitutes the country's gas infrastructure – is reduced, and the share of green biogas is increasing.
It has moved so fast with biogas that the biogas industry sees a technical potential for covering the Danish gas consumption with biogas already in 2035.

- The entire gas industry and the gas system are on a different agenda than just five years ago, where large volumes of green gas were almost considered wishful thinking. However, as we already in three years' time expect that 25 % of the gas used by the Danish consumers will be green, we are now seeing how biogas actually contributes to the security of supply, says Jeppe Bjerg.

He is Chief Analyst at Energinet Gas TSO and points out that several others have also started to acknowledge that green gas may have some of the answers to the challenges regarding transitioning for instance the heavy transportation sector.

At the end of 2019, biogas injected in the gas grid amounts to more than 11 % of the gas consumption in Denmark. It is particularly in northern, central and western Jutland that the existing 35 biogas plants are located. Plants that are currently the backbone of the green gas paradigm shift and distributes the CO2-neutral gas to the local grids.

Even though in 2020, a stop is set for new plants on the current subsidies scheme, Energinet Gas TSO expects the curve for new plants to remain upward in the short term. Not least because up to 15 new plants at the time of writing are hastening to be completed under the existing subsidy scheme.

It is certain that in the next 12-13 years funding will still be granted to allow biogas to be injected to the grid. A time frame which provides space for technological development to take place at the same time.

- There has been large interest in building biogas plants and connecting to the grid. This will decrease, as Parliament wants to pause and consider how we get the most cost effective green transition, says Jeppe Bjerg, Chief Analyst, who is optimistic on behalf of biogas in the years to come:

- The situation now is that we have an asset in the form of a gas grid, which provides the opportunity for a direct transition of a lot of consumers, which can become green by injecting green gas. If 20-25 % of Danish consumption

At the end of 2019 biogas injected to the grid ammounts to more than 11 % of the danish gas consumption

comes from green gas, we are also less vulnerable to supply concerns from the North Sea and other countries, and this is a trend which is maintained.

This does not mean that it is smooth sailing for the biogas in the years to come. Green gas can be supplied to local consumers, but it should also be possible to inject it in the transmission grid when there is a local green gas surplus. This will happen more and more frequently in the local grids and especially in the summer when the gas consumption is generally low. For this reason, a reverse flow station has been built since 2018 in St. Andst between Vejen and Lunderskov, and the transmission pipeline from the gas storage facility in Lille Torup to Aalborg can contain surplus gas.

- The gas has always just been flowing in one direction; from high pressure to lower pressure. However, what is happening now is that the flow is about to turn because biogas is produced locally in the small grids, and the grid is not build for this situation, says Tine Lindgren, who is Chief Engineer in Gas System Analysis in Energinet.

Therefore, reverse flow stations are necessary so that the biogas can be injected to the transmission grid and be moved to other consumption areas. In 2019, Energinet has decided to invest in the establishment of two additional reverse flow stations. One on Funen, one in southern Jutland. There is no need to establish more stations than necessary, Tine Lindgren states.

- Together with the distribution company Evida, we are looking at several possibilities, e.g. connecting some of the distribution grids, so that a slightly larger local area can be used to purchase the gas before it is elevated in central locations and moved away. We need to think it through and find the most socio-economically sound solution for the future infrastructure.

At the new station in southern Jutland, a need for rerouting may arise at the neighbouring substation, but Tine Lindgren expects the solution to be a pipe leading the surplus gas to the reverse flow station, which will thus function as a hub.

Variations in oxygen limits challenge the gas flow

It is not only at national level that the increasing volumes of biogas challenges the system. To the south in Germany, the biogas is meeting an obstacle in the form of a stricter standard for how much oxygen the gas can contain when it is supplied to the gas grid.

This is a challenge, which is of high priority for Energinet Gas TSO. Chief System Analyst at System Operation, Jesper Bruun Munkegaard Hvid, is not only responsible for Energinet's process, but also a technical task force at EU level under CEN. Here, an attempt is made to create an overview of the technical aspects of oxygen in the gas, including an impact on the supply of biogas to the grid. Deadline for a Danish solution: Before the Tyra field returns in 2022.

- We have encountered the problem first in Denmark, and so it is our role to focus on this reality. We are working on it and listening to good solutions, but we must also recognize that there are not many people who can teach us these solutions, because we have come first in Denmark, says Jesper Bruun Munkegaard Hvid.

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In parallel with the work of the task force, knowledge is continuously gene-rated from relevant research projects, and the solution is not necessarily as simple as adopting a common best practice standard. Therefore, it may be a temporary solution until the best solution is found.

- We will probably have something that works in 2022, but whether it is the lasting solution depends on the trend in Europe. If there is a solution worth waiting for, we may be able to accept a temporary solution without significant construction costs, he says.

- The task can be solved at many levels, and we do not necessarily have to solve it as a TSO just because we can. We must solve it, where it is most efficient for society. In the international context we must remember that the solution that looks easy on paper, to place the task in one central place, is not necessarily the best for the whole, says Jesper Bruun Munkegaard Hvid.

1. SECURITY OF GAS SUPPLY

Gas is an important part of the Danish energy mix and is used for domestic heating, in industry and for electricity and district heating generation. Some Danish gas customers are vulnerable to gas supply failures, for example private house-holds on cold winter days.

1.1 Security of gas supply in Denmark

In cooperation with the Danish Energy Agency, Energinet is responsible for ensuring sufficient transport capacity in the transmission system. Energinet is also responsible for ensuring system integrity.

However, the responsibility for the availability of gas for supply of gas customers on the day of consumption rests with the market players, i.e. purchasers of gas on the whole sale gas market and gas suppliers which sell the gas to consumers.

Only in an emergency situation where the market no longer functions Energinet can step in and handle the gas supply. However, only to the extent that the market players are unable to meet their obligations, in order to avoid a breakdown of the transport system. At the same time, Energinet ensures continued gas supply to protected customers, for example private households, in an emergency supply situation.

The individual market players' responsibility is, for example, laid down in the Danish preventive action plan and emergency plan.

Energinet continuously monitors the supply situation and ensures that the market players are kept up to date on the development, so that they can take the necessary precautions to prevent any critical supply situations.

1.2 Reconstrucion of the Tyra complex 2019-2022

The primary source for supply of gas to Danish and Swedish consumers closed on 21 September. The Tyra complex in the North Sea is being rebuilt to ensure future gas production in the Danish part of the North Sea. The gas supply to Denmark is reduced significantly during the reconstruction, as approx. 90 % of the Danish gas supply has so far come through the Tyra complex.

The reconstruction is expected to be completed so that gas will again be supplied from the Tyra complex towards Denmark on 1 July 2022. In a historical context, it is significant that such a large proportion of the gas supplies to the Danish and Swedish markets is removed for an extended period.
During the reconstruction of the Tyra complex, Denmark and Sweden will be dependent on gas imported from Germany and use of the Danish gas storage facilities. To safeguard the supply of gas to Danish and Swedish consumers, it is necessary that the market players utilise the import capacity and store gas. The capacity bookings already made show that the market has provisionally secured both storage capacity and import capacity from Germany for the first two years of the Tyra reconstruction.

The latest analysis shows that, with the current capacity from Germany and the two Danish gas storage

DANISH AND EUROPEAN LEGISLATION ON SECURITY OF GAS SUPPLY

DANISH CONSOLIDATED NATURAL GAS SUPPLY ACT (THE DANISH NATURAL GAS SUPPLY ACT)

Energinet's tasks

The Danish Natural Gas Supply Act, primarily section 12(1), states that a TSO must:

- Connect, as required, plants to upgrade biogas to natural gas quality, distribution grids and consumers
- Ensure the quality of the natural gas supplied from the transmission grid.
- Handle a number of tasks concerning security of gas supply in Denmark.
- Cooperate with other TSOs towards the efficient interchange of natural gas.
- Develop plans to meet future transmission capacity needs.
- Ensure that there are sufficient volumes of natural gas in the overall natural gas supply system to maintain the physical balance in the grid.

Energinet's contingency arrangements

Under the Danish Natural Gas Supply Act, Energinet is responsible for making reasonable contingency arrangements. This means that Energinet must:

- Prepare risk and vulnerability analyses.
- Prevent risk, where possible.
- Prepare contingency plans.
- Practise the key elements in the contingency planning.
- Evaluate and learn from drills and incidents.

As a TSO, Energinet also has a coordinating role in the sector, both on a daily basis and during crises.

DANISH EXECUTIVE ORDER ON MAINTAINING SECURITY OF NATURAL GAS SUPPLY

Energinet's tasks

- Performing the general planning and operational functions required for maintaining security of natural gas supply in accordance with the Regulation of the European Parliament and of the Council concerning measures to safeguard the security of gas supply.
- Monitoring the security of natural gas supply. For this purpose, Energinet prepares and submits an annual report on security of gas supply to the Danish Energy Agency.

Protected customers

The Executive Order contains a description of protected customers in Denmark in accordance with the Regulation concerning measures to safeguard the security of gas supply.

REGULATION 2017/1938 CONCERNING MEASURES TO SAFEGUARD THE SECURITY OF GAS SUPPLY

The Security of Gas Supply Regulation primarily establishes a legal framework for the following:

- Definition of protected customers and solidarityprotected customers.
- Definition of infrastructure standard, supply standard and crisis levels.
- Distribution of responsibilities, solidarity, planning and coordination, both concerning preventive measures and reactions to actual disruptions of gas supplies at member state level, regional level and EU level.
- Preparation of risk assessments, preventive action plans and emergency plans, including establishment of exceptional measures that can be introduced when the market is no longer able to satisfy gas demand.
- The documents must be updated every four years
- Wellfunctioning internal market, even in situations of shortage of supply.
- Solidarity in supply crises.

facilities, Danish and Swedish gas consumers can continue to be supplied with gas during the reconstruction of the Tyra complex. However, the gas system will become more vulnerable and less flexible in the event of unusually high demand or the occurrence of a technical incident which may reduce the supply to consumers. Energinet is expecting more Early Warning declarations during the reconstruction of the Tyra complex than before.

Since the first announcement from DUC in April 2016, Energinet has worked on preparing the gas market and system operations for handling the situation and has implemented various measures aimed at improving the supply situation.

Energinet's compressor station in Egtved will be essential throughout the period, as constant gas imports from Germany are expected. To ensure maximum uptime of the compressor station, critical spare parts have been purchased and stocked, and certain maintenance works have been brought forward.

In cooperation with Gas Storage Denmark, the physical withdrawal capacity of the Lille Torup gas storage facility has been increased by approx. 2 million Nm3/day. Extra withdrawal capacity will thus be available in the event of, for example, disruption of supplies from Germany.

Other measures are improved information to and dialogue with the market players, such as regular system information on which they can act as well as the possibility of closer market monitoring and incentive-regulating market initiatives. Emergency workshops have been held with the market players in order to strengthen the knowledge about crisis situation mechanisms. Improved commercial products and mechanisms have been introduced for the import point from Germany (Ellund). Furthermore, work is being done to adapt and supplement Energinet's emergency supply tools and products. Information has been published to the market about the status of the storage situation in the 'Safe Storage Level' curve on Energinet's website. The information is updated daily with an illustration of the estimated storage level for the remainder of the storage season.

1.3 The security of gas supply regulation

The EU member states face a common challenge in that they consume far more energy than is produced in the EU. This is a strategic challenge, which has become particularly evident at a time when political relations with Russia are strained, given that Russia is the EU's largest source of supply. Security of gas supply in the EU is therefore a high political priority,

If a normal supply situation cannot be maintained and there is a risk of insufficient gas to supply gas customers, this constitutes a crisis situation.

which means that the framework for security of gas supply is defined in European legislation. The Security of gas supply regulation concerning measures to safeguard the security of gas supply (the 'Security of Gas Supply Regulation') sets the framework for members states' cooperation.

The purpose of the Security of Gas Supply Regulation is to safeguard that all necessary measures are taken to ensure gas customers uninterrupted supply of gas on cold days with unusually high gas consumption (the so called once-in-20-years event) and in case of gas system disruption. One of the fundamental elements in the Security of Gas Supply Regulation is to maintain a wellfunctioning internal market in the event of situations with gas supply shortage. This means that the market – at national, regional and European levels – helps to strengthen security of supply throughout the EU.

Both the Danish Natural Gas Supply Act and the EU Regulation use the concept of security of gas supply without making any further distinction between different security of gas supply aspects. Here, the concept can be divided into three interacting elements, reflected in Article 3(1) of the Security of Gas Supply Regulation, which is based on the gas supply undertakings having different responsibilities within the various players' respective areas of activity and competence:

1. Availability of gas on the day of consumption means that the gas volumes which the market players make available for supplying the gas customers, including stored gas, must be sufficient to meet the Danish gas customers' gas demand, both in connection with extraordinarily high demand and when seasonal consumption patterns are taken into consideration.

2. Sufficient technical capacity in the overall gas system presupposes sufficient transport capacity in the transmission and distribution systems, supplemented by storage capacity, to meet the gas customers' consumption needs within weather-dependent seasonal and daily variations.

3. System integrity means that the operational functionality of the system from production to consumer must be ensured, so that the overall gas system functions efficiently and reliably.

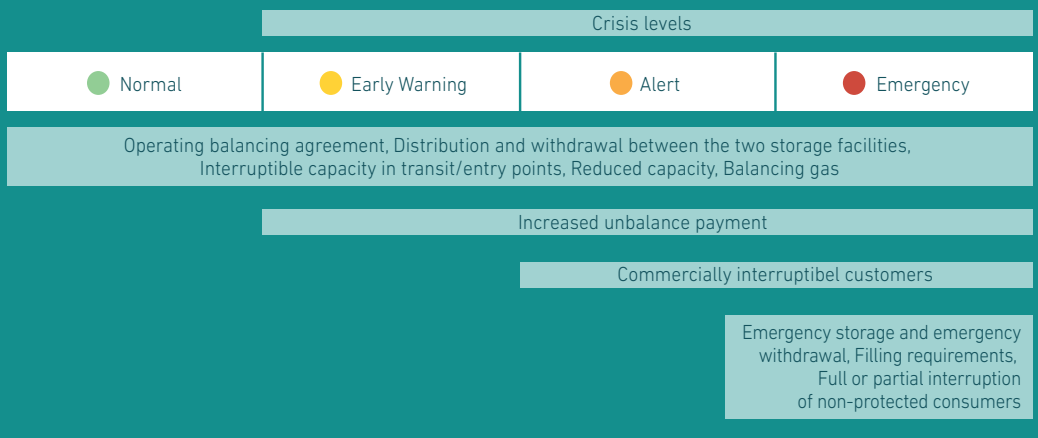
THE DANISH SECURITY OF SUPPLY MODEL

The gas market plays a key role in the Danish security of gas supply. Energinet supports security of supply by using the Danish security of supply model. The security of supply model is structured within the framework of the Security of Gas Supply Regulation

The model contains specific marketbased and non marketbased tools, which Energinet can use at the various crisis levels. The use of these tools will largely depend on the type of situation to be dealt with. The choice of tools therefore depends on both the effect and cost of the individual tool. Certain tools can only be used in certain situations.

Of course, Energinet's decision will take account of the wider circumstances in addition to the incident itself. It will often be more serious if an incident occurs in winter than in summer because gas consumption is highly temperature dependent.

TOOLS IN THE DANISH SECURITY OF SUPPLY MODEL



1.3.1 Crisis levels

If a normal supply situation cannot be maintained and there is a risk of insufficient gas to supply gas customers, this constitutes a crisis situation. The escalation of a crisis is divided into three crisis levels: Early Warning, Alert and Emergency. The declaration of the individual crisis level depends on the volume of gas available in the system and on whether the market can handle the crisis on its own.

Energinet may declare an Early Warning and an Alert if there is a risk of an incident resulting in a deterioration of the supply situation.

- An Early Warning is declared if there is a presumption that an incident may occur which will result in a deterioration of the supply situation and which may lead to an Alert or an Emergency being declared.
- An Alert is declared if an incident occurs that causes a significant deterioration of the supply situation, but where the market is able to handle the situation on its own without the need to resort to non marketbased tools.

In Early Warning and Alert situations, the market can handle the crisis situation on its own, and Energinet may make use of a number of market-based tools to support the market. If the crisis deteriorates to such a degree that the market is unable to handle the crisis on its own, Energinet may declare an Emergency.

- An Emergency is declared when all relevant market-based tools have been used and the gas supply is still not suf-ficient to meet demand.

In an Emergency, Energinet obtains access to 'non-market-based tools' in order to help maintain supplies to the protected customers.

1.3.2 Solidarity

The EU's objective is that vulnerable natural gas customers must be ensured gas in cases where insufficient gas supplies are available. In the latest version of the Security of Gas Supply Regulation, this has resulted in a formalised solidarity concept between the countries in the EU. The member states may, as a last resort in an Emergency, request a neighbouring member state to take solidarity measures.

The member state requesting solidarity must pay financial compensation to the neighbouring member states which supply gas under the solidarity mechanism. The compensation is calculated based, among other factors, on the loss incurred by enterprises as a result of the disruption of their gas supply.

The protected customers comprise around 400,000 private customers, public enterprises, CHP and district heating plants and small enterprises, which together account for approx. 75 % of the consumption. The nonprotected customers comprise approx. 45 large industrial enterprises and central power stations.

In the course of 2020, negotiations will be conducted on international agreements for use when requests are made for the supply of gas under the solidarity mechanism. In accordance with the Regulation, the agreements should already have been enforced, but the process is delayed due to the legal and financial complexity of the matter. Denmark is obliged to enter into agreements with Germany and Sweden. Under the Security of Gas Supply Regulation, Sweden is exempted from showing solidarity to Denmark, as Denmark is Sweden's only source of supply.

1.3.3 Protected customers

In accordance with the Security of Gas Supply Regulation, 'protected customers' must be guaranteed gas supply for minimum 30 days, regardless of crisis level, in the event of unusually high demand or in the event of disruption of the largest single gas supply infrastructure. In Denmark, before the shutdown of the Tyra complex, this comprised ruptures to the Tyra-Nybro offshore pipeline, which was the single largest gas infrastructure and source of supply. The supply period for protected customers in Denmark was extended to 60 days, which is the expected

Gas pipe

repair time for the submarine pipeline. Denmark thus has an increased supply standard than the standard defined bythe Security of Gas Supply Regulation. The Ellund pipeline is the largest single gas infrastructure, and the period in which protected customers are guaranteed supply has now been reduced to 30 days.

All private customers (households) are protected, but other customer types may also be included. In Denmark, the Danish Energy Agency determines which gas customers are protected customers. Today, essential social services such as hospitals and educational institutions, small and mediumsized enterprises and district heating installations have the status of protected customers. The enterprises which are categorised as protected customers will depend on the cubic metre threshold set by the Danish Energy Agency each year. The cubic metre threshold is set based on the criterion that maximum 20 % may be protected customers.

Gas customers which are not protected customers may risk having their gas supply interrupted in a crisis situation where Energinet declares an Emergency crisis level. Nonprotected customers are typically large enterprises. The need for disconnection of nonprotected customers will depend on the specific situation, and a minimum notice of three days will be given to allow the enterprises an orderly shutdown of processes for which natural gas is used.

To reflect the differential treatment of the different customer groups in an Emergency, two different tariffs apply to the security of supply. There is one tariff for protected customers and another lower tariff for nonprotected customers.

The protected customers comprise around 400,000 private customers, public enterprises, CHP and district heating plants and small enterprises, which together account for approx. 75 % of the consumption. The nonprotected customers comprise approx. 45 large industrial enterprises and central power stations.

1.3.4 Solidarity-protected customers

Solidarityprotected customers is a new definition provided in the revised Security of Gas Supply Regulation, and it includes the customers which it must always be possible to supply with gas, even during an extreme supply crisis where it is necessary to ask the neighbouring member states to supply gas under the solidarity mechanism. A request for solidarity must only be used as a last resort in the crisis level Emergency, and the likelihood that the national supply is reduced to the consumption level of solidaritprotected

customers' consumption is thus very small. All households are solidarityprotected customers. In addition, some significant social services such as hospitals (not educational institutions) and some district heating installations which supply heating to households and essential social services are also solidarityprotected customers.

Under the Security of Gas Supply Regulation, gas customers which are protected customers, but not solidarityprotected customers, must have access to financial compensation for the loss they may incur as a result of an interruption of their gas supply. This will typically be small and mediumsized enterprises as well as individual district heating installations and essential social services. The nonprotected customers which have already been disconnected in an Emergency are not entitled to compensation.

1.3.5 European or regional supply crisis

The crisis levels can also be used by the European Commission, which adopts crisis level decisions in the event of European or regional supply crises. After receiving the European Commission's decision, the Danish Energy Agency passes it on to the Danish system. From then on, Energinet handles the situation according to the Danish security of supply model.

In a national crisis, capacity restrictions may occur to safeguard gas supplies to protected customers. In the event of a supply crisis at EU or regional level, Denmark must not use tools excessively restricting the flow of gas in the internal market. The European solidarity principle ensures that the flow of gas is not restricted on an unjustified basis in an Emergency at EU level.

1.4 Documentation of security of supply

The Security of Gas Supply Regulation requires that the individual member state must prepare a number of documents describing the way crisis situations are handled. The documents are to contribute to ensuring uniform handling of supply crises in the EU. The documents have been updated in 2019 and are valid for up to four years, i.e. not the period after the reopening of the Tyra complex in 2022.

In the risk assessment, an assessment is made of whether the gas infrastructure is designed to cover total gas demand on a day with unusually high demand due to outage of the largest infrastructure.

1.4.1 Risk assessment

In the risk assessment, an assessment is made of whether the gas infrastructure is designed to cover total gas demand on a day with unusually high demand due to outage of the largest infrastructure.

Under the Security of Gas Supply Regulation, a full assessment must be made of the risks affecting security of gas supply in Denmark. The most recent risk assessment from October 2018 applies to the period 2018-2022, which is the period in which the Tyra complex is under reconstruction and in which Denmark and Sweden are therefore primarily supplied with gas from Germany. The connection in Ellund is also the largest infrastructure during the reconstruction.

The updated Security of Gas Supply Regulation also sets the framework for regional cooperation which is to result in regional risk assessments. The regional cooperation is based on risk groups defined in the Security of Gas Supply Regulation. Denmark is placed in the following groups: Denmark, Norway and Baltic Sea. The Danish Energy Agency coordinates the risk group Denmark, where a joint risk assessment is prepared for the Danish and Swedish gas markets. As stipulated by the Security of Gas Supply Regulation, the Danish Energy Agency leads the regional risk assessment with the authorities in the neighbouring member states, i.e. in particular the German Federal Network Agency and the Swedish Energy Agency, but also the Netherlands and Luxembourg.

1.4.1.1 National risk assessment

In the risk assessment for Denmark for 2018-2022, the scenarios with the greatest consequence for the supply can be summarised as follows:

1. Incidents which affect the supply to Denmark:
    a. Technical inncidens in the North German gas transmission system
    b. European supply crisis

2. Incidents affecting the operation of the Danish gas transmission system:
    a. Stenlille gas storage facility
    b. Egtved compressor station
    c. The pipeline from Egtved to Dragør

The national risk assessment forms the basis of these conclusions:

1. Supplies from Germany: Supplies from Germany may be interrupted both as a consequence of a European supply crisis and in the event of technical disruption in the North German gas transmission system. The German TSO Gasunie Deutschland has assessed that it most likely will always be possible to maintain at least 65 % of the anticipated supplies in Ellund, when the supply is lowered to what is accepted by Energinet. Together with an expansion of the withdrawal capacity in the Lille Torup gas storage facility, this will provide sufficient security of supply for the Danish gas market. However, there is low probability that it will be necessary to declare an Emergency and thus gain access to non marketbased tools.

2. Stenlille gas storage facility: In the event of an emergency shutdown at Stenlille gas storage facility in a situation with unusually high gas demand, a bottleneck will occur in the transmission grid between the supply sources in the west and the gas consumers in the east. In this case, it may be necessary to use the marketbased tools in the security of supply model, as action must be taken relatively quickly. As a last resort, it may be necessary to declare an Emergency and thus obtain access to non marketbased tools.

The national risk assessment incorporates the results from the risk assessments in the regional risk groups.

Lille Thorup

1.4.1.2 The joint risk assessment for risk group Denmark

Scenarios which affect the supply in Denmark will also affect the supply in Sweden. The reason for this is that Denmark is the only source of supply to Sweden, and Sweden thus depends on it being possible to supply gas via Ellund. In addition, the Swedish gas system is located east of the Egtved compressor station, and the same challenges of ensuring gas supplies to Eastern Denmark in situations with unusually high gas consumption are also relevant for Sweden.

In the risk group Denmark, it was decided to focus on the most likely scenario for outage of the largest infrastructure for the region (Ellund), which is a technical incident at the Quarnstedt compressor station in Northern Germany. Gasunie Deutschland has stated that, in the event of an outage of the compressor station, it will still be possible to supply 65 % of the firm capacity in Ellund, which will be sufficient to supply both the Danish and Swedish gas markets.

1.4.2 Preventive action plan

The preventive action plan, which was submitted to the European Commission in February 2019, contains a description of the tools needed to remove or mitigate the risks identified.
The preventive action plan contains: The results of the risk assessment; definition of protected customers; the tools, volumes and capacities needed to meet the infrastructure and gas supply standards; obligations imposed on natural gas undertakings and other parties; description of cooperation with other member states; information about existing and future infrastructure of importance in crisis situations; information about public service obligations concerning security of gas supply.

Regional sections have been incorporated in the individual national action plan.

The preventive action plan includes a description of why it has been decided to expand the withdrawal capacity of the Lille Torup gas storage facility, and why the reserved emergency storage volume is increased.

In July 2019, the Danish Energy Agency received comments on the preventive action plan, which must be adjusted accordingly before the final plan is presented.

1.4.3 Emergency plan

The emergency plan, which was also submitted to the European Commission in February 2019, contains a description of the measures to be taken to remove or mitigate the impacts of a gas supply disruption.

The emergency plan contains: Definition of roles and areas of responsibility; detailed procedures and measures to be followed for each crisis level, including arrangements for information flows; description of tools and cooperation with other member states and natural gas undertakings for each crisis level; description of the reporting obligations imposed on natural gas undertakings at Alert and Emergency levels; description of possible tools which can be used to supply gas customers in the event of an Alert or Emergency.

Regional sections have been incorporated in the individual national emergency plan.

An Emergency will not automatically trigger interruption of gas supplies to Danish nonprotected customers. A model may be used according to which nonprotected customers in Denmark and Sweden may be partly (pro rata) disconnected in the event of surplus gas being available after protected customers have been supplied.

In August 2019, the Danish Energy Agency received comments on the emergency plan, which must be adjusted accordingly before the final plan is presented.

1.5 Contingency planning

In the field of energy, the purpose of contingency planning is to ensure that the most important parts of society's energy supply are maintained and continued in crisis situations. Contingency planning is different from security of supply in that it primarily concerns potential crisis situations rather than normal operation.

In the gas sector, contingency planning also concerns the safety of the surroundings, and it is thus not just focused on maintaining security of supply. Natural gas is flammable and can explode, making it important for the contingency arrangements to work preventively and to react quickly to contain accidents.

The Danish Parliament has adopted a change in the Danish Natural Gas Supply Act, which specifies the transmission company's responsibility for security of gas supply. It specifies the common responsibility principle of the gas supply safety scheme, which means that both authorities and market players bear a shared responsibility for the security of gas supply within the area of competence of each party.

Contingency planning in the Danish electricity and gas sector is organised in relation to the sector responsibility principle. This means that the player with day-to-day responsibility for a given sector also has responsibility in the event of a crisis.

Emergency incidents are rare but can have major impacts on society, unless there is an appropriate rapid response. Emergency incidents often require cooperation with organisations outside the gas supply sector, e.g. the police, fire department and emergency response services.

2. THE GAS YEAR 2018/2019

The security of supply has been high in the past gas year, as there has been sufficient gas to supply gas consumers.

2.1 Security of supply incidents

There have been no security of supply incidents in the past year.

2.1.1 IT incidents

There have been no IT incidents in the gas system impacting the gas supply in the past year.

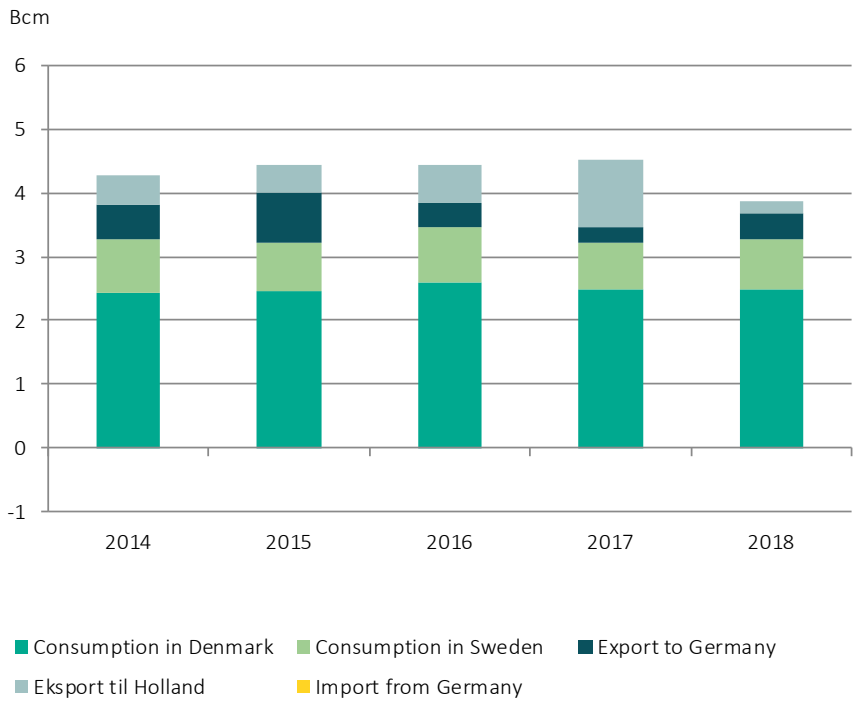
2.2 Use of the transmission grid

None of the peak day volumes came close to the capacity limits in the transmission system entry and exit points in 2018. Except for storage facilities, which exceeded the capacities sold in both Stenlille and Lille Torup for both injections and withdrawals. During the Early Warning in 2018, the commercial withdrawal capacities of both storage facilities were utilised for withdrawals. On 27 February 2018, Lille Torup exceeded the commercial withdrawal capacity with a withdrawal of 8.3 million Nm^3. On 28 February 2018, the daily withdrawal from Stenlille was 8.2 million Nm^3, i.e. the maximum daily commercial withdrawal capacity.

2.2.1 Gas supplies from the North Sea

Until September 2019, the majority of gas supplied to Denmark came from the Danish gas fields in the North

FIGURE 2: ANNUAL NET PRODUCTION FROM THE NORTH SEA DISTRIBUTED ON FLOW, 2013-2017



Sea. The gas was taken onshore at Nybro via two offshore pipelines and sold for consumption in Denmark and exported to Sweden and Germany. The gas can also be exported directly from the North Sea to the Netherlands. Until September 2019, Denmark was a net exporter of gas, but the flow reversed from 10 September, and gas is imported from Germany. Annual production distributed on consumption and exports is shown in figure 2.

Supplies to Nybro were approx. 3,500 million Nm^3 in 2018, exceeding the total Danish and Swedish gas consumption of approx. 3,260 million Nm^3. In the first six months of 2019, the Nybro supplies reached approx. DKK 1,710 million Nm^3, and the supplies are expected to be approx. 2,100 million Nm^3 for the whole of 2019 due to the temporary closure of the Tyra platform from September 2019. However, supplies will still be made from the Syd Arne-field.

2.2.2 Ellund

The flow direction between Denmark and Germany (Ellund) was primarily

TABLE 1: CAPACITIES AND UTILISATION IN THE TRANSMISSION SYSTEM, 2015-2018

			Maximum daily flow		
		Capacity Mcm/d	2016 Mcm/d	2017 Mcm/d	2018 Mcm/d
Nybro	Entry	32,4 [2]	13,2	14,0	9,7
Lille Torup Gas Storage facility	Injection/ Withdrawal	3,6/8,0 [3]	3,7/7,5	3,8/7,6	4,2/8,3
Stenlille Gas storge facility	Injection/ Withdrawal	4,8/8,2 [3]	4,8/6,8	4,8/6,3	4,1/8,2
The Danish Exit zone	Exit	25,5	17,5	16,7	16,6
Ellund	Entry/Exit	10,8 [4]/20,0	4,8/9,3	4,9/5,2	5,9/5,4
Dragør Border	Exit	8,6 [1]	6,0	4,7	5,7

Notes: 1. However, the Swedish system is not able to receive these volumes at the assumed minimum pressure in Dragør of 44 bar. The firm capacity is stated at 7.2 million Nm3/day.

2. Total capacity of the receiving terminals in Nybro. The potential supplies are smaller today as the Tyra-Nybro pipeline is subject to a capacity constraint of approx. 26 million Nm3/day, and large volumes cannot be supplied from the Syd Arne pipeline.

3. Guaranteed capacity. The Danish gas storage company dimensions the commercial injection capacity conservatively in relation to pressure in the transmission grid. When the pressure in the transmission grid occasionally increases, it is possible to inject more gas into the storage facilities than the specified injection capacity.

4. At a calorific value of 11.2 kWh/Nm3.

southbound in 2018. The flow was northbound only in March 2018 (during Early warning) and for a short while in August 2018.

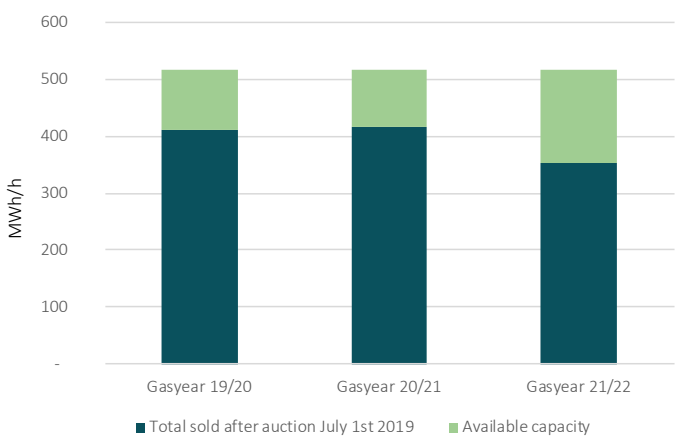
2.2.2.1 Capacity orders at Ellund

On Monday 1 July, annual auctions were held for capacity at PRISMA, where calls for tenders were invited for the Ellund capacity from Germany to Denmark for the three years in which Tyra is being rebuilt. The auction was for annual products, which always commence on 1 October just like the gas year.

TABEL 2: TENDERED AND SOLD BUNDLED CAPACITY FROM GERMANY TO DENMARK 2019-2023

	Mio. kWh/h				
Ellund entry	Gas year 2019	Gas year 2020	Gas year 2021	Gas year 2022	Gas year 2023
Tendered bundled capacity	1,1	1,4	1,7	2,1	2,1
Sold bundled capacity	0,5	0,8	0,5	-	-

FIGUR 2: CAPACITY FROM GERMANY TO DENMARK



The result of the auctions for capacity between Gasunie Deutschland and Energinet was positive, as there was excess demand for the volume offered in 2019/20 and 2020/21, and all capacity ended up being sold. Both the auction for the first and the second gas years ended up with five rounds, resulting in a supplement to the basic price for both years of EUR 0.44. The auction therefore did not end until the following day, 2 July, in the late morning. In total, the auction resulted in additional earnings of approx. DKK 2 million for Energinet. Capacity was also sold for year 3 (2021/22). However, there was no excess demand for year 3.

Overall, this means that approx. 80 % of the total capacity from Germany towards Denmark has now been sold to the market players for gas years 1 and 2 during the Tyra reconstruction (approx. 4 GWh/h out of approx. 5 GWh/h, see also graph below). The remaining capacity of 1 GWh/h consists of the capacity which the TSO has a statutory obligation to retain for shortterm contracts (10%) as well as capacity at the other German TSO at Ellund, Open Grid Europe, which still has unused capacity. The two TSOs have a total unused capacity of approx. 1.5 GWh/h for year 3.

The result is particularly positive as the lack of annual capacity bookings for Ellund at Gasunie Deutschland could potentially result in German capacity being moved from the border instead of supporting consumption in the North German system, with a resulting deterioration in the Danish security of supply. This risk has now been eliminated for years 1 and 2 and is regarded as having been minimised for year 3, as the market has shown a significant interest in capacity towards Denmark in these years. It must therefore be expected that further bookings will be made for

FIGURE 3: STORAGE WITHDRAWAL AND INJECTION PER MONTH, 2018 2019

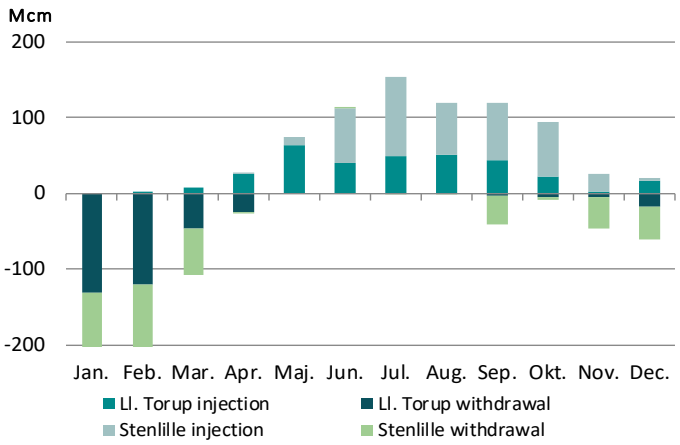
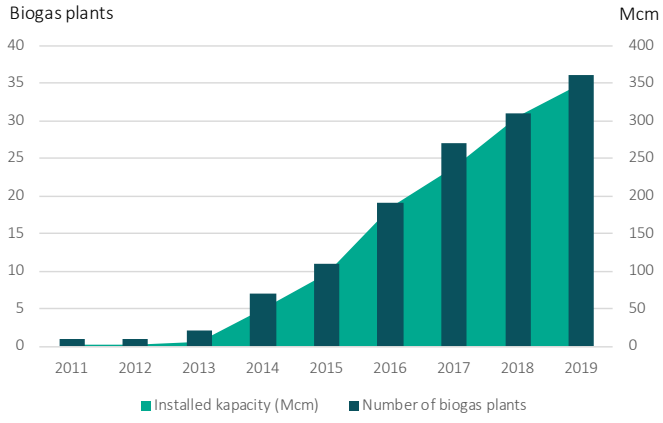


FIGURE 4: CONNECTED BIOGAS PLANTS AND INSTALLED CAPACITY (ACCUMULATED), 2011-2019



year 3 at the next annual auctions in July 2020 and 2021.

2.2.3 Use of gas storage facilities

The two Danish gas storage facilities, Lille Torup and Stenlille, have a total volume capacity of 890 million Nm^3. This corresponds to around one third of the Danish annual consumption. Energinet expects demand for withdrawal capacity in normal situations to vary between 12 million Nm^3/day and the current maximum withdrawal capacity of just over 16 million Nm^3/day.

Gas consumption varies over the year and over each 24-hour period. Market players can use the Danish gas storage facilities to store gas to exploit price differences, for example across seasons and markets, and to supply the necessary daily capacity. During the summer, when gas consumption is low, gas is injected into the gas storage facilities. In winter, when the supplies can no longer cover Danish consumption or exports to Sweden, gas is withdrawn from the storage facilities again; see figure 3. Especially in the coming three years, the gas storage facility capacity will be of great importance to the security of supply, as gas imported from Ellund cannot cover consumption on an average winter day.

The two gas storage facilities can also provide storage capacity for emergency supplies, for example in the event of a major supply failure.

Gas Storage Denmark has increased the withdrawal capacity at Lille Torup gas storage facility in 2019. The withdrawal capacity in Lille Torup has been increased from 8.0 to 10.3 million Nm^3/day, giving a total storage withdrawal capacity of 18.3 million Nm^3/day. The expansion is one of the initiatives

Energinet has implemented prior to the reconstruction of the Tyra complex.

Gas Storage Denmark does not offer the extra capacity on the market, but it is available in the event of an emergency supply situation.

In Sweden, the Swedish TSO, Swedegas, has decided to reopen Skallen gas storage facility for commercial operations from May 2019. The gas storage facility, which is the only one in Sweden, can thus again be used in normal situations or emergencies. The gas storage facility has a total volume of 10 million Nm^3.

2.2.4 Biogas in the grid

Increasing shares of biogas is being injected into the gas grid. Since the first commercial biogas plant was connected at the end of 2013, 36 biogas plants are today connected to the gas grid[1]. One plant is connected directly to the transmission grid at Bevtoft, while the other plants are connected to the distribution grid. The maximum connection capacity of the plants is approx. 350 million Nm^3/year.

The volume of biogas injected into the gas system has been increasing. Biogas amounted to 9 % of Danish gas consumption from the grid at the end of 2018 and is expected to exceed 11% at the end of 2019. In summer, when gas consumption is low, biogas constitutes an even higher share. In July, biogas in the gas grid constituted 20.1 % of total Danish consumption in the same month. On a single day in July, the biogas share even reached 35 %.

Energinet has knowledge of a number of projects which comprise either the expansion of existing or the establishment of new biogas plants which are likely to be realised and connected to the Danish distribution grid in the coming years. The Danish Energy Agency estimates that the total annual production may increase to DKK 510 million Nm^3 in 2021, which will correspond to 20% of the Danish gas consumption according to the analysis assumptions.

2.3 Gas consumption

After many years with decreasing gas consumption, there has been a slight increase since 2014, see figure 2. In 2018, gas consumption was approx. 2,500 million Nm^3, and consumption in 2019 is expected to be in the region of 2,400 million Nm^3.

In 2019, gas prices in Denmark and on the north western European market reached a recordlow level. Since June, gas prices on the Danish and north western European spot markets have been around EUR 10/MWh. For comparison, gas prices were just under EUR 25/MWh at the same time last year.

2018 was slightly warmer than average with 8% fewer degree days than in a normal year. 2019 also looks set to be a warm year. In the first six months of 2019, there have been 10% fewer degree days than in a normal year.

2.3.1 Peak day consumption

The temperature has a major impact on peak day consumption and hence on the load on the transport systems. In the first six months of 2019, the peak day consumption in Denmark was 14 million Nm^3. This was on 24 January 2019, when the daily mean temperature was -3°C. For comparison, in 2018, the peak day consumption was 16.6 million Nm^3.

2.4 The gas market

The primary focus of the gas market has been on preparations for the period with reconstruction of the Tyra complex. The lack of gas supplies from the Tyra until 2022 means that the Danish gas market will go from being primarily selfsufficient to being supplied with gas from Germany. Until this change of supply source, Denmark

[1] As at 1 October 2019

FIGURE 5: THE GAS PRICE (DAY-AHEAD) ON THE DANISH GAS MARKET, GAS YEARS 2017/2018 AND 2018/2019

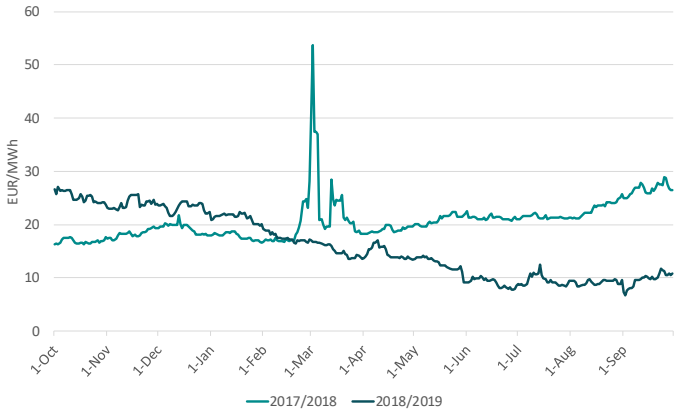
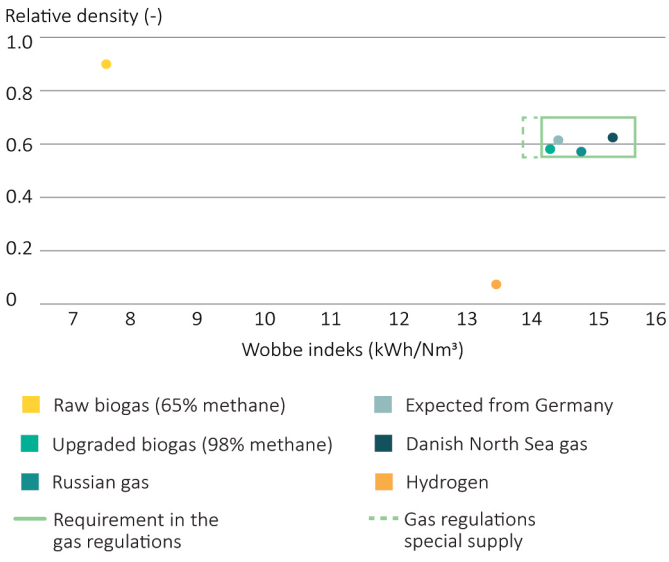


ILLUSTRATION OF GAS QUALITY FOR DIFFERENT TYPES OF GAS



NOTE: IN FUTURE, NEW TYPES OF RENEWABLE ENERGY GASES, SUCH AS HYDROGEN, MAY BE INTRODUCED INTO THE DANISH GAS SYSTEM. ENERGINET IS IN THE PROCESS OF INVESTIGATING HOW READY THE GAS SYSTEM IS FOR THE GAS QUALITY WHICH CHARACTERISES NEW RE GASES.

has been well supplied with gas, which has meant that the price level on the Danish gas market has been below the general price level on the northwestern. European gas market.

In 2019, gas prices in Denmark and on the north western European market reached a recordlow level. Since June, gas prices on the Danish and north western European spot markets have been around EUR 10/MWh. For comparison, gas prices were just under EUR 25/MWh at the same time last year.

In preparation for the period with reconstruction of the Tyra complex, it has been important that shippers have ensured that they store sufficient gas for use in winter. It is also important that the shippers have purchased much northbound transport capacity on an annual basis at the Ellund border point, which connects Denmark and Germany, so that they can transport gas to Denmark more freely. The 2019/20 winter season begins with extraordinarily full gas storage facilities.

The Danish and Swedish balance area was merged in the socalled Joint Balancing Zone on 1 April 2019. The merger took place in line with the EU's efforts to harmonise the internal gas market. It has thus become more attractive to be a player on both the Danish and Swedish markets. It also contributes to increasing the regional security of supply in Denmark and Sweden, as a prerequisite for the project was that the volume of gas in the Swedish gas system (linepack) was increased through the merger. There is thus more gas available in the system for supplying Danish and Swedish gas customers.

Lille Torup

2.4.1 Trades on the Danish gas exchange

The volumes traded on the Danish trading point Exchange Transfer Facility (ETF) have decreased during 2019 after a year with great activity on the exchange. The general market conditions are the primary reason for this. The winter 2018/19 was mild relative to other winters, resulting in a market with filled gas storage facilities at the end of the winter season. Therefore, the market has not been under pressure, which has meant that there has been less activity on the gas exchange. At the same time, many shippers have kept gas in the storage facility for the coming winter, thus reducing the need to purchase gas on, for example, the exchange.

2.5 Gas quality

Energinet is responsible for ensuring that the quality of the gas supplied from the gas transmission system complies with the Rules for Gas Transport and the Executive Order on Gas Quality at all times. The gas is supplied from different sources of supply (the North Sea, Germany, the Danish gas storage facilities and biomethane) with different gas quality.

Under normal supply conditions, it is a requirement that the upper Wobbe index for natural gas is in the range of 14.1-15.5 kWh/Nm^3 (50.76-55.8 MJ/Nm^3). The relative density of natural gas must be between 0.555 and 0.7.

The transported gas complied with the quality requirements in 2019.

2.6 Drills

Gas system drills are organised so that drills are performed in respect of all significant elements over a fiveyear period. The following are examples of drills and incidents in 2018. In addition, a few minor tests and drills, each practising subelements, are performed on a regular basis.

- On Thursday 25 January 2018, Energinet conducted the gas sector drill Tyra 2019-2022. The drill was conducted as a workshop for central gas shippers in the Danish gas system and for selected employees in Energinet's Gas Market Development and System Operation departments. The drill formed part of the preparation for handling the supply situation during the reconstruction of the Tyra complex.
- Energinet Gas TSO and Engineering and Construction performed a largescale drill, Starlight, at Nyborg on 18-19 September 2018. The drill entailed testing the repair time in the event of pipeline rupture to verify that it is possible to repair damage within 48 hours.

No major drills have been performed in the transmission system in 2019.

3. THE COMING WINTER 2019/2020

With the current capacity from Germany and the two Danish gas storage facilities, Danish and Swedish gas consumers can continue to be supplied with gas during the reconstruction of the Tyra complex. However, the gas system will become more vulnerable and less flexible in the event of unusually high demand or the occurrence of a technical incident.

3.1 Market initiatives during the Tyra complex reconstruction

The market players have continuously been involved in the market initiatives that Energinet has chosen to implement while the Tyra complex is being reconstructed.

It has been a fundamental view among the market players that the market must essentially be able to act in the same way as today and that interfering market measures should only be used in a crisis situation. This fundamental view is greatly reflected in the market measures that Energinet has decided to implement, and most of these measures can be regarded as preventive measures.

The following measures have been implemented or performed:

Communication
- Day-by-day display of the supply situation for the relevant season in a fixed graph online (called Safe Storage Level, or SSL).
- The holding of socalled Emergency Workshops in which crisis situations are discussed actively with the market players
- Increased focus on general market analysis and market monitoring, in cooperation with the Danish Utility Regulator.

Capacity utilisation – Ellund
- Introduction of new possibilities for shippers to trade capacity secondarily on PRISMA
- Introduction of a mechanism that allows shippers to nominate, without first booking, capacity.
- Focus on congestion management, depending on the competitive situation.

Balancing
- Removal of price cap/floor to ensure that the balance price always reflects the current supply situation
- New method for calculating imbalance price if there is an imbalance on the whole market on a given day
- New mechanism for calculating imbalance price in the event of an emergency supply incident.

In addition, there is a possibility for seasonal tariffs to strengthen the incentive for the market to book longterm capacity on an annual basis. However, this will potentially only become a reality in 2020/2021, as it requires method approval from the Danish Utility Regulator.

3.2 Capacity orders

Shippers must book capacity in the grid from Energinet when they want to transport gas in the transmission grid. Capacity can be booked as annual, quarterly, monthly, daily or withinday products.

Annual orders for the 2019/2020 gas year:
- Ellund Exit, exports of gas to Germany: Here, annual orders have not been placed for the 2019/2020 gas year. This is completely

expected in the coming period, with a constant need for gas imports

- Ellund Entry, imports of gas from Germany: The capacity order at Elland Entry is described in further detail in section 2.2.2.1. For the coming gas year, approx. 0.45 million kWh/h has been sold as bundled annual capacity, i.e. capacity at German Ellund Exit and capacity at Danish Ellund Entry. In addition, approx. 3.45 million kWh/h has been sold in advance (Open Season contracts[2] and capacity sales last year). The total capacity at Ellund Entry on the Danish side is 7.7 million kWh/h.
- Joint Exit Zone, supply of gas to end customers in Denmark and Sweden: In connection with the implementation of the Joint Balancing Zone with Sweden, the exit points towards Danish end users and Sweden are now gathered in one point, called Joint Exit Zone. Here, the annual capacity can be ordered all year round, which means that bookings are not necessarily placed towards the start of the gas year on 1 October. A smaller volume has been sold (just over 1 million kWh/h) for the coming gas year, as most capacity contracts run from January to January.
- Nybro Entry: Only a minor booking has been placed, which concerns supply of gas from the Syd Arne-field, which still supplies gas.
- RES Entry, biogas upgraded to natural gas quality and injected into the transmission system: In the same way as with the exit zone, annual capacity at Renewable Energy Source Entry can be purchased throughout the year. Sales of annual capacity at this point primarily take place from January to January, which means that only a few contracts have been booked from 1 October 2019.

3.3 The cubic metre limit

A cubic metre limit is set and published each year by the Danish Energy Agency prior to the gas year, and is used to decide which customers are protected.

[2] Energinet has expanded the transport connection from Ellund in the northbound direction. Prior to the expansion, Energinet invited tenders for capacity in a bidding process (Open Season) to determine the interest in the project. In the Open Season process, the companies must submit financially binding bids and may thereby acquire connection capacity.

ENERGINET'S WINTER OUTLOOK

To assess the supply situation, a reliability evaluation of the gas system is carried out. This evaluation looks at whether the system capacities are able to ensure supplies to consumers during each 24-hour period, i.e. an assessment of entry capacities, including storage volumes, in relation to consumption. The Winter Outlook assessment examines whether the system is able to provide the necessary capacity to meet an unusually high consumption based on a winter day with temperatures below -13°C.

Assessment for the coming winter 2019/2020:
The assessment indicates that there is sufficient capacity in the gas system to meet demand on a very cold day.
Exit zone: Consumption in Denmark is 19.8 million Nm3/day. For the exit zone, the offtake corresponds to Energinet's expectations at a daily mean temperature of -13°C.
Ellund: Ellund has net imports of 10.3 million Nm3/day.
Dragør: Dragør has exports of 5.6 million Nm3/day.
Storage facilities: Total withdrawal of gas from the storage facilities is estimated at 16.2 million Nm3/day, with 8.2 million Nm3/day coming from Stenlille and 8.0 million Nm3/day from Lille Torup. A distribution of withdrawals is used which supports the highest possible grid pressure.
Nybro: Supplies at Nybro are estimated at 0.5 million Nm3/day.
RES: 1.0 million Nm3 biogas/day is supplied to the gas system.

Assessment for winter 2020/2021
The assessment indicates that there is sufficient capacity in the gas system to meet demand on a very cold day. The Tyra complex is still under reconstruction.
Exit zone: Consumption in Denmark is 19.8 million Nm3/day. For the exit zone, the offtake corresponds to Energinet's expectations at a daily mean temperature of -13°C.
Ellund: Ellund has net imports of 10.3 million Nm3/day.
Dragør: Dragør has exports of 5.6 million Nm3/day.
Storage facilities: Total withdrawal of gas from the storage facilities is estimated at 18.5 million Nm3/day in normal situations, with 8.2 million Nm^3/day coming from Stenlille and 10.3 million Nm3/day from Lille Torup. The distribution of withdrawals is optimised to achieve the highest possible grid pressure.
Nybro: Supplies in Nybro, which only come from the Syd Arne field, are estimated at 0.5 million Nm3/day.
RES: 1 million Nm3 biogas/day is supplied to the gas system.

For the 2019/2020 gas year, the limit for protected customers is 3.6 million Nm3/year. In practice, this means that industrial enterprises and gasfired CHP plants will be protected if they have an annual gas consumption of less than 3.6 million Nm3/year.

3.4 Gas quality during the coming winter

Energinet expects that gas quality in the coming winter will still be based on a combination of gas from Germany, North Sea gas and biogas injected into the gas grid. Gas from Germany typically has a lower calorific value and a lower Wobbe index than Danish North Sea gas. The increased supply of gas from Germany may lead to greater variation in gas quality in the transmission grid in the coming winter, as the gas quality from Germany will differ more from the gas quality from the storage facilities than has been the case in the previous winters.

In the coming winter, Energinet expects gas quality to vary as follows:

- The Wobbe index for gas imported from Germany is expected to be lower than that for Danish North Sea gas. Energinet estimates that the average Wobbe index for gas from Germany will be 14.7 kWh/Nm3, varying from 13.9 to 15.5 kWh/Nm3.
- The Wobbe index for the Danish North Sea gas is expected to vary from 14.7 to 15.5 kWh/Nm3.
- The Wobbe index for upgraded biogas injected into the gas system is expected to be lower than that for Danish North Sea gas. Upgraded biogas is similar to chemical natural gas and consists primarily of methane with small quantities of carbon dioxide, nitrogen and oxygen. Biomethane typically has a Wobbe index at the lower half of the variation range permitted in the Gas Regulation, i.e. from 14.1 to 14.8 kWh/Nm3.

3.5 Distribution

Gas supplies to the individual consumers must be maintainable at very low temperatures in crisis situations, where demand is expected to be unusually high. The gas system must therefore be dimensioned so that it has the necessary capacity to supply the distribution areas at all times. This is ensured by assessing natural gas offtake from each meter and regulator station. The assessments are performed by Energinet on the basis of reporting from the distribution companies.

In 2019, Energinet acquired HMN Gasnet P/S, and all distribution companies have been legally gathered in one single company under the name of Evida as from 1 October.

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3.5.1 Evida

Energinet assesses that the meter and regulator stations and the distribution system throughout Denmark have sufficient capacity to cover the supply requirement for winter 2019/2020.

Before the end of 2019, a total of 17 biogas upgrading plants are expected to be connected to the distribution grid in Southern Jutland, Western Zealand and on Funen. A total capacity of 28,400 Nm3/h, corresponding to an annual capacity of 248 million Nm3, will then be connected in these areas. (In 2018, approx. 75% of the installed capacity was utilised).

In Central and Northern Jutland and in the Capital Region of Denmark, a total of 27 biogas upgrading plants are expected to be connected to the distribution grid. Here, a total capacity of 41,500 Nm3/h, corresponding to an annual capacity of 360 million Nm3, will be connected. (In 2018, approx. 69% of the installed capacity was utilised).

RISK ASSESSMENT OF THE EUROPEAN GAS MARKET

Twice a year, the European Network of Transmission System Operators for Gas (ENTSOG) prepares outlooks for the supply situation in Europe in the coming summer and winter (Summer Supply Outlook and Winter Supply Outlook).

In addition, as a new initiative based on the revised Security of Gas Supply Regulation, ENTSOG will prepare an analysis of the security of supply in Europe every fourth year to identify where and when problems with maintaining supplies to gas consumers may arise in the individual countries.

ENTSOG's outlook for the coming winter 2019/2020:

- There is sufficient flexibility in most of the European gas system to withstand a cold winter.
- In case of transit disconnections through the Ukraine, combined with days of large demand for gas, the security of gas supply will be severely exposed.
- Storage filling is at a recordhigh level as at 1 October 2019. The high level is attributable to extraordinary high storage filling already in April 2019 as well as favourable conditions on the gas market during the injection season.
- The European domestic gas production is still declining.

The European Commission is in dialogue with Russia and the Ukraine to secure a long term transit agreement based on EU rules.

ENTSOG's latest analysis of the security of gas supply in Europe from November 2017:

- If there is a cold winter, none of the European countries face the threat of supply failure.
- During a two-week period and a single day of exceptionally high demand in a cold winter, Denmark and Sweden may risk having to disconnect some gas consumers.
- In the event of outage of Ellund and exceptionally high demand during a two-week period or a single day, Denmark and Sweden may risk having to disconnect a major part of the gas consumers.

The result of ENTSOG's simulation cannot be compared directly with Energinet's own analyses. The reason for this is that ENTSOG's simulation runs over four years. The simulation does not take into account that extra firm capacity has been offered in OGE's grid at Ellund from 2019 and that consumption is expected to decline. ENTSOG's simulation thus paints a more negative picture than Energinet's own analyses, as described in the preventive action plan and emergency plan at the end of 2019.

4. DEVELOPMENT IN THE DANISH GAS TRANSMISSION SYSTEM

Energinet analyses the future trend for the supply situation to assess what might affect security of supply in the long term. The analysis contributes to identifying the need for further measures. The winter of 2019/2020 starts with relatively filled storage facilities both in Denmark and throughout Northern Europe.

4.1 Expected use of the gas system

Until summer 2022, imports from Germany are the primary source of supply for the Danish and Swedish gas markets. In addition, biogas production accounts for a small, but increasing, share of the gas supply. After the reconstruction of the Tyra complex, North Sea gas will again be transported with volumes.

4.1.1 North Sea production in a long-term perspective

Each year, the Danish Energy Agency composes a statement of Danish oil and gas resources as well as a longterm production outlook. Minor downward adjustments of the gas outlook have been made in relation to last year.

The Tyra field expansion has been established, but there is still great uncertainty about the expansion of a number of fields, thus the outlook have somes uncertainties.

Natural gas supplies to Denmark are determined by the proportion of North Sea production which is exported to the Netherlands (via the North Sea) and Germany (via Denmark), respectively. The market players decide the distribution.

4.1.2 Biogas production

So far, the contribution to security of supply from biogas has been low, as the share in the natural gas grid has been very small. Production of supplied biogas passed 10 % of the previous year's gas consumption in 2019, and, with an expected increase to about 25% in 2026, the contribution to security of supply will become more significant. In the first year during the reconstruction of the Tyra complex, biogas will contribute around the same security of supply volume as the Syd Arne field.

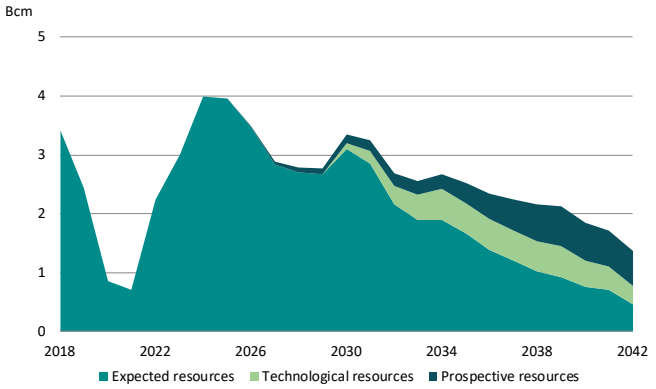
4.1.3 Gas storage capacity

The shippers are responsible for balancing their portfolios and thus safeguarding the supply of their connected Danish consumers (via gas suppliers). They thus have the responsibility for ensuring that there is sufficient gas in the system to prevent an Emergency declaration. It is therefore important for the security of gas supply that the storage customers ensure that sufficient gas volumes are stored to safeguard the supply of their connected Danish and Swedish consumers – even during prolonged and unusual cold spells.

Energinet purchases gas for emergency storage to be able to supplement supplies to protected customers in Emergency situations. So far, this emergency storage has been determined by the gas volume needed to ensure the maximum storage withdrawal capacity and a situation in which Tyra-Nybro fails for 60 days, but where the supply can be replaced with supplies from Germany. While Tyra is being recontructed, the emergency storage volume will be determined by a situation in which no gas is supplied from neither Tyra-Nybro or Germany. The market must instead be able to

supply protected customers from the storage facilities and the gas supplies coming from the Syd Arne pipeline and from biogas. In the period in which the Tyra complex is shut down, Energinet will increase its purchase of emergency storage from the previous approx. 100 million Nm3 to approx. 170 million Nm3.

FIGURE 7: EXPECTED RESERVES, 2019-2042



Note: The figure is based on data from the Danish Energy Agency in August 2019. The expected development is a forecast for extraction from existing fields and new sources with existing technology. The technological resources are an estimate of the extraction potential through the use of new technology. The exploration resources are an estimate of the extraction from future new sources as a result of ongoing exploration activities and future new calls for tenders.

Until summer 2022, the gas storage facilities will be a necessary prerequisite for supplies to the market being able to meet seasonal demand and for the ability to maintain supplies to gas consumers in the event of outage of Ellund. Energinet must ensure supplies to protected customers for up to 30 days in case of failure of the single largest source of supply, see the Security of Gas Supply Regulation.

In 2020-2022, the storage facilities will be filled with gas from Germany with a lower calorific value than gas from the North Sea. This means that the work volume in the storage facilities decreases by 10-12%, equal to approx. 100 million Nm3 compared with today.

4.1.4 Supply situation 2019-2040

The supply situation[3] during the period 2019-2022 requires special attention, and Energinet will regularly update the supply situation outlook. The supply

[3] The supply situation outlook 2019-2040 is based on the Danish Energy Agency's Analysis Assumptions (version from September 2019) and North Sea forecasts from 2019.

POWER STATIONS IN NORTHERN GERMANY AND IMPORTS OF GAS FROM ELLUND

Optimal capacity utilisation is necessary to ensure security of supply while gas imports from Germany constitute the main source of supply. The capacity on the interconnection from Germany to Denmark is limited by the capacity from Heidenau south of Hamburg towards Denmark. This means that gas consumption in Northern Germany is of importance to how much capacity is available for Denmark.

District heating companies in the cities of Kiel and Flensburg are phasing out the use of coal as a fuel for district heating generation. Part of the district heating from coal is being replaced with electrical heating, and another part is being replaced with heating from gasfired CHP plants. In Flensburg, a new gasfired power station has thus been built, and another is scheduled for operational startup in 2022 to replace coalfired power stations. In Kiel, a new gasfired power station has also been built, which will become operational in the autumn.

Together, it is expected that the two power stations can use up to 600 million m3 gas a year, primarily in the winter months. The operations will depend greatly on the price of electricity, gas and CO2 in Germany. As the power stations are supplied by the same pipeline from Heidenau which supplies Denmark, an increase in gas consumption for combined heat and power will reduce the possibility of importing gas to Denmark.

Energinet therefore monitors the development on the electricity and gas markets in Germany for a continuous assessment of the transmission capacity available for Denmark.

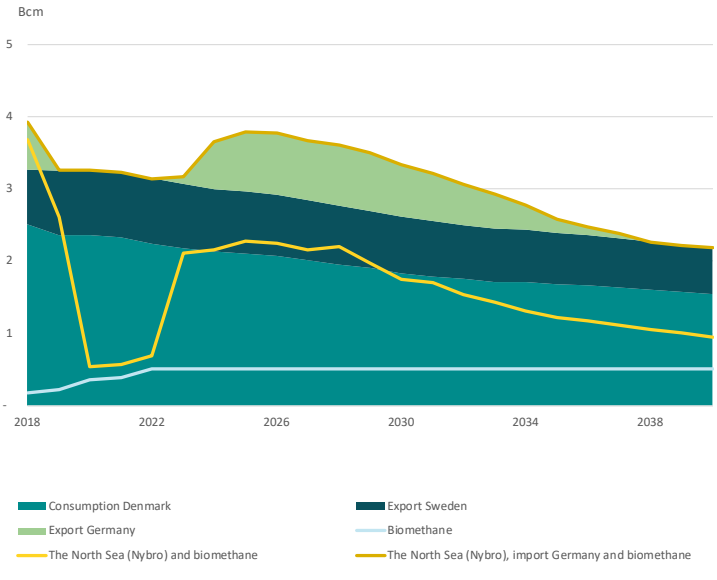
situation outlook is Energinet's best estimate of how the supply situation may be. It is an estimate with uncertainties in terms of both the market and the utilisation of the Danish storage facilities and the capacity in Ellund from Germany.

Even though the Danish gas system is more vulnerable during the reconstruction of the Tyra complex, the capacity between Germany and Denmark has been expanded sufficiently, which, together with the gas storage facilities, provides the requisite flexibility in the system to supply Danish and Swedish gas consumers.

Energinet has most recently updated the analysis of the supply situation in September 2019 with the Danish Energy Agency's outlook (Analysis Assumptions 2019) for Danish gas consumption in the period 2019-2040.

In 2022, when the transmission system is expanded with supplies from Norway and the supply to the Baltic Pipe, security of supply is expected to be just as high as before the reconstruction of the Tyra complex.

FIGURE 8: SUPPLY SITUATION, 2019-2040



Note: The North Sea excl. Trym. Consumption in Denmark includes biomethane.

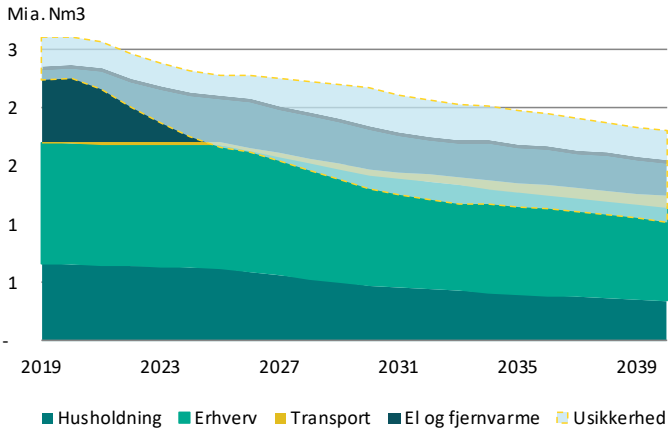
4.2 Development in consumption in Denmark and Sweden

The total gas consumption in Denmark, excluding field consumption in the North Sea, is expected to decrease to approx. 1,800 million Nm3 in 2030. Natural gas consumption in Denmark is expected to decrease to approx. 1,300 million Nm3 in 2030. The consumption of biogas added to the gas grid is expected to increase to approx. 500 million Nm3 in 2030. Green gas is thus expected to constitute 30% of the total Danish gas consumption delivered via the transmission and distribution grid.

4.2.1 Development in consumer segments

Gas consumption for electricity and heat generation is expected to continue to decline. The declining gas consumption is driven primarily by the cancellation at the end of 2018 of the basic amount paid to local CHP plants, which is expected to result in the

FIGURE 9: EXPECTED GAS CONSUMPTION DISTRIBUTED ON APPLICATIONS, 2019-2040, AS WELL AS SPECIFICATION OF THE OUTCOME SPACE FOR THE PROJECTION



Note: Gross calorific value 12.1 kWh/Nm³. Businesses include the service industries and comprise gas for heating and process heating.

decommissioning or conversion of CHP plants to biomass or heat pumps[4].

Consumption for individual heating systems is expected to decline by approx. 28 % up until 2030, due to energy savings and conversion to other forms of heating, and by a further reduction to less than half up until 2040. Gas consumption by businesses is expected to remain virtually unchanged for a number of years, but it will start to decline before 2030 as a result of energy efficiency improvements. The use of gas in industry is sensitive to market conditions, and may vary due to conversions or changes to the number of manufacturing companies.

The transport sector's gas consumption is expected to increase slowly in the entire period up until 2040. The growth in gas consumption is expected to be smaller at the end of the period as a result of increased electrification. The expected development is, however, subject to considerable uncertainty.

[4] The projection for the electricity and district heating sector, individual heating, industry and transport comes from the Danish Energy Agency's Analysis Assumptions 2019 (version from September 2019).

Swedish gas consumption is based solely on supplies from Denmark and a small proportion of biogas produced in Sweden. There are plans to construct an LNG receiving terminal in Gothenburg with possible connection to the transmission grid, but Denmark is expected to remain Sweden's primary source of supply.

Gas consumption in Sweden is expected to be just over 800 million Nm3 in 2019. Maximum 900 million Nm3 is expected in 2020, and it is assessed that the consumption will be reduced slowly in the period up until 2040. The assessment of the Swedish consumption is based on outlooks from Swedegas and from the Swedish Energy Agency.

4.2.2 Gas consumption outcomes

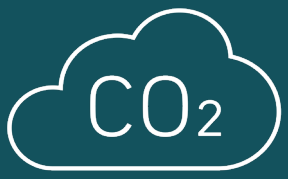
In the projection, gas consumption in Denmark is expected to be approx. 2,350 million Nm3 in 2020. The projection is based on model runs with fixed assumptions about climate, fuel prices, CO_2 prices and electricity prices, and is thus subject to uncertainty.

In 2018, gas consumption in Denmark was approx. 2,500 million Nm3, which means that the projection indicates a marked drop in gas consumption in the very short term. However, the market for gas and CO_2 has developed in another direction than the assumptions on which the projection is based. In specific terms, the gas price has dropped to a much lower level than expected, and the CO_2 price has increased to a somewhat higher level.

In summer 2019, the gas price fell on the wholesale market to less than DKK 0.75/Nm3, which is approximately one third of the price in the projection. During the summer, the CO_2 price reached a level of approx. EUR 25/tonne, which is just over 50% more than

EMISSIONS

Methane gas (CH_4) is a greenhouse gas which has a significant impact on the climate in connection with major emissions if the gas has previously been burnt, where the emissions are water vapour and carbon dioxide (CO_2). However, a certain level of emissions cannot be avoided in connection with the operation and maintenance of the gas transmission system. In 2018, Energinet has adopted a target that methane emissions must be reduced by 10 % in 2020 relative to the average of emissions for 2015-2017.



Energinet has carried out annual measurements of methane emissions at its own facilities since 2017. The emissions account for approx. 0.005 % of the total gas transport. In comparison, Marcogaz (Technical Association of the European Natural Gas Industy) states methane emissions in the European transmission grid at 0.05 % of total gas sales.

In total, all emissions of greenhouse gases can be converted into an equivalent volume of CO_2, which represents Energinet's CO_2 footprint. Since 2008, Gas TSO has focused on reducing its total CO2 footprint, i.e. both methane and CO2 emissions. This has been done both by reducing carbon dioxide emissions from own consumption of gas and by reducing direct methane emissions.

The primary sources of Energinet's CO_2 footprint are:

- Own consumption of gas for heating of gas supplied via the meter and regulator stations. Gas is used for heating because the gas is cooled when the pressure is reduced from transmission line pressure to distribution line pressure
- Fugitive methane emissions from meter and regulator stations (fugitive emissions are unplanned leaks from joints etc. in gas facilities)
- Maintenance activities and rerouting of transmission lines which require that plant sections be emptied of gas.

the price in the projection. Lower gas prices will obviously make it cheaper to use gas, and higher CO_2 prices change the relationship between the use of coal for electricity generation and the use of gas.

In 2019, Energinet can estimate that the consumption of gas for electricity generation is increasing, and gas consumption in 2019 may end up being at the same level as in 2018 if the gas and electricity markets continue the current trend, and if winter 2019/20 does not become warmer or colder than normally. The assessment is therefore that in the next years, in which the Tyra complex is shut down, the gas consumption will be approx. 150 million Nm3 higher due to the development on the electricity market alone. Correspondingly, a higher gas price or warmer winter may reduce the gas consumption. It is assessed that this could result in a gas consumption which is approx. 100 million Nm3 lower than the projection from the Danish Energy Agency (Analysis Assumptions 2019).

The gas consumption outcome until 2030 and 2040 depends significantly on how the green transition is handled in the gas sector. The Danish Government's target of a 70 % reduction in CO_2 emissions will result in a faster reduction in gas consumption. Either by the gas consumption being reduced through savings or conversion to other energy forms or by increasing the share of biogas injected to the gas grid. The longterm gas consumption indicates the use of different measures along with the green transition of the gas sector. Below, a number of trends are described which may give rise to higher or lower gas consumption than in the projection.

Trends which may result in lower gas consumption: A larger share of gasfired CHP plants changing operating patterns or closing down; energy savings; conversion to biomass and electricity in the process industry; faster reduction of natural gas consumption for heating; recession and offshoring of industry.

Trends which may result in higher gas consumption: Slower reduction of gas consumption for household heating; faster rollout of gas in the transport sector, for example shipping and transport; better conditions for gasfired combined heat and power, for example higher CO_2 prices and electricity prices or lower gas prices like now.

4.3 Gas market development

4.3.1 The Danish gas market

As long as the market is dependent on one primary source of supply from Northern Germany, the Danish gas market will be affected to an even greater extent than previously by the price development on the northwestern European gas market. There is an expectation in the market that the price level in Denmark will be on a par with the northwestern European market plus the cost of transporting of the gas. The size of the transport value will depend on the level of pressure on the market in the current situation.

There may be situations in which the demand only has few supply alternatives, and where there is insufficient supply competition to meet the demand. All in all, the activity may be smaller on the Danish gas market, and fluctuating prices will become more likely.

4.3.2 The European gas market

Winter 2019/20 begins with relatively filled storage facilities in both Denmark and northwestern Europe. The Netherlands has announced that its extensive domestic gas production field Gröningen will be phased out in summer 2022, which is sooner than initially expected. The Netherlands will therefore need to obtain gas from elsewhere in the future. They can either cover this need from gas production in the North Sea, Russia or LNG[5] (liquefied natural gas). This means that there will be greater demand on the market in Germany for gas which can be supplied quickly. This is also the source from which the Danish gas market is to be supplied.

North Stream II, which is to supply Central Europe, was scheduled to be commissioned on 1 January 2020. However, it is uncertain whether this deadline can be met. Until the commissioning of North Stream II, the gas must pass through Ukraine and Eastern Europe. However, an agreement is not yet in place between Russia and Ukraine permitting that gas can flow through Ukraine to Central and Western European customers. In addition, in September 2019, the EU Commission ordered Russian Gazprom to provide thirdparty access to one of the largest evacuation routes from North Stream to Eastern Europe. This has meant that the market has become even more concerned about whether the supply from North Stream is stable.

4.4 Long-term development of Danish gas infrastructure

In Energinet, work is being done on grid planning aimed at economically efficient development of the transmission system and with focus on solutions that can be used now in connection with the growing development in the biogas production and in the long term. It is important in this connection that the solutions chosen create as much value as possible for the gas system. To ensure timely and effective development of the transmission system, there is also a need to focus on the overall gas system.

The expansion of the transmission system up to 2022 has been carefully adapted to the expected gas transport and is based on longterm capacity agreements in the period 2022-2037, including the establishment of Baltic Pipe.

4.4.1 Condition of the transmission grid

The condition of the gas system is regarded as good, but, due to its age, increasing maintenance costs must be expected in the years ahead.

In 2019, Energinet Gas TSO has been recertified in ISO 55001 Asset Management. To be certified, Energinet Gas

[5] Liquified Natural Gas

TSO must be able to show that it has an effective management system for maintaining a uniform, high standard for the management of its assets. The certification means that Energinet Gas TSO is subjected to an annual audit by external certified auditors. Asset management must contribute to ensuring that we manage our physical assets effectively from commissioning to disposal, with the lowest possible service life costs.

The ongoing operation and maintenance of the transmission grid are therefore controlled via Gas TSO's asset management system. This is, for example, based on an annual cycle for preventive and remedial maintenance, where:

- The former is based on statutory requirements, technical standards, supplier recommendations and ongoing status reports. The condition assessment is based on the condition and age of the plants and facilities and their importance to system operations.

- The latter entails a riskbased approach because technical faults in plants and facilities may have major consequences for system operations.

This ensures that investments are constantly made based on the condition of the grid and the requirements for security of supply.

4.4.2 International infrastructure projects

Energinet is involved in two international projects: the Baltic Pipe project and the North Sea Wind Power Hub project, which is a development project, and gathers views from market players on the need for expansion of capacity (incremental capacity process).

4.4.2.1 Incremental capacity process

The incremental capacity process is a relatively new mechanism, which was entered in the European network code CAM NC (Capacity Allocation Mechanisms Network Code) in 2017 which describes how TSOs must offer and sell capacity at border points. The mechanism describes how TSOs must firstly collect nonbinding bids for any expansion of capacity, every other year. If the market signals that there is insufficient capacity at a border point, TSOs must start a maturation project and later offer new capacity, if required, which can then be created if there are sufficient binding bids in an auction.

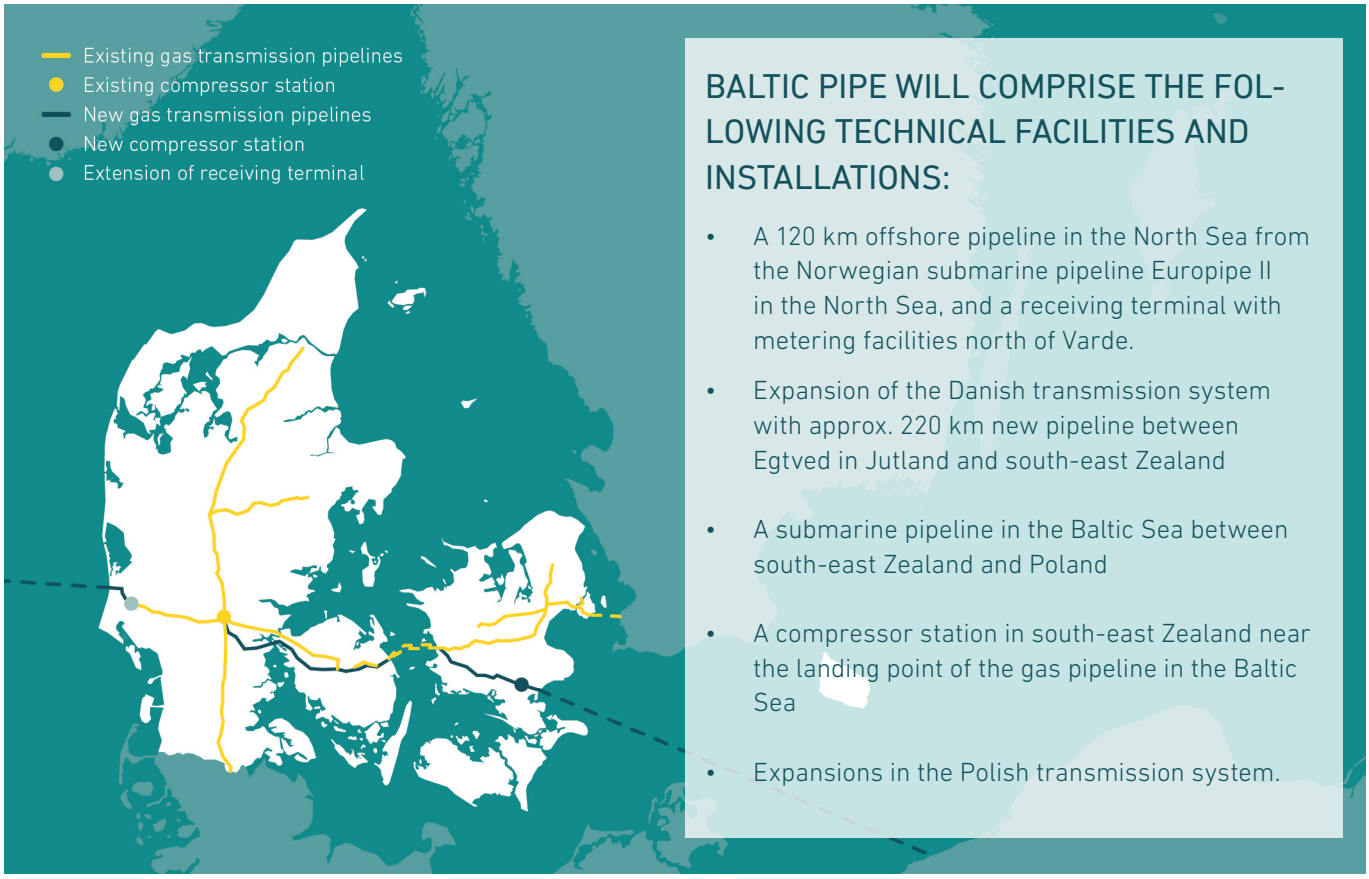
In summer 2019, Energinet chose to expand the concept so that the mechanism described in CAM NC is not solely used at the only official border point between Denmark and Germany (Ellund), but is also used to collect indications concerning any need for new capacity in the whole transmission system, for example towards Sweden. This is done to ensure that Energinet is sufficiently prepared for any new needs on the market which require expansions or rescheduling of capacities.
Relating to the collection of the nonbinding indications, Energinet has received signals about three potential needs for new capacity on the market:

1. At the border point to Germany, the German TSO Gasunie Deutschland has reduced the capacity on the German side, as renovation and continued maintenance are required to maintain it. Both Energinet and Gasunie have received signals from the market that there is still a need for capacity in the southbound direction in future
2. Players on the market have signalled a wish for an expansion of the existing gas grid towards Lolland-Falster, which today has no natural gas.
3. A signal has been submitted about the need for a new entry point for LNG to the transmission system.

4.4.2.2 Baltic Pipe

Together with the Polish TSO, GAZ-SYSTEM, Energinet is implementing the socalled Baltic Pipe project. The Baltic Pipe project is a new gas transport route which makes it possible to transport up to 10 billion Nm3 of gas per year from Norway through Denmark to Poland. The project will result in an expansion of the existing gas system in Denmark, making it possible to transport large volumes of gas through Denmark.

The final investment decision was made in 2018, and an EIA permit has been obtained for the project. In addition, a national planning directive has been adopted to support the planning. The project has required expropriation in accordance with the applicable rules. The actual construction work will be commenced in 2020, and the project will be completed by October 2022. Planning the project, Energinet has been in a dialogue with the approx. 500 landowners and has held a number of public meetings along the entire section affected with a view to completing the project in the best possible way. Concurrently, there has been a dialogue with the local agricultural organisations to ensure a joint understanding of how the agricultural sector is to be compensated for any loss.



BALTIC PIPE WILL COMPRISE THE FOLLOWING TECHNICAL FACILITIES AND INSTALLATIONS:

- A 120 km offshore pipeline in the North Sea from the Norwegian submarine pipeline Europipe II in the North Sea, and a receiving terminal with metering facilities north of Varde.
- Expansion of the Danish transmission system with approx. 220 km new pipeline between Egtved in Jutland and south-east Zealand
- A submarine pipeline in the Baltic Sea between south-east Zealand and Poland
- A compressor station in south-east Zealand near the landing point of the gas pipeline in the Baltic Sea
- Expansions in the Polish transmission system.

One of Denmark's interests in the Baltic Pipe project is to ensure low and stable gas tariffs in the years ahead. The Danish consumption is expected to decline in the coming years, and there will therefore be fewer consumers to cover the costs of operation and maintenance of the gas grid. If the project is realised, expectations are that the gas flow in Danish pipes will quadruple, resulting in stagnation or a drop in tariffs. One effect of this will be that it will remain possible to transport the increasing volumes of biogas in the Danish gas grid.

Access to Norwegian gas is a positive supply solution for Poland and other countries in Central and Eastern Europe, which are today predominantly dependent on gas from Russia. In addition to Norwegian gas, Baltic Pipe will also give Denmark indirect access to the global market for liquefied natural gas (LNG) via the Polish receiving terminal for LNG. The Baltic Pipe project has gained status as a project of common interest (a PCI project), as it boosts the diversification of European gas supplies and the integration of European markets. PCI projects must be prioritised nationally, and they can receive economic funding from the EU, for example for preparatory work. The project has already benefited from this.

The Security of Gas Supply Regulation has been revised, with one purpose being to strengthen the solidarity principle. Clarification of matters of principle is still pending. Following such clarification, it must be examined how Denmark can best handle security of supply in relation to Poland.

You can read more about the Baltic Pipe project on Energinet's website.

4.4.2.3 North Sea Wind Power Hub

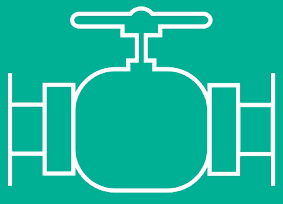
The North Sea Wind Power Hub (NSWPH) development project is a vision project for largescale coordinated expansion of renewable energy production in the North Sea region. The development project covers both the electricity and gas transmission systems, including possible synergies between the two as well as in relation to the overall energy system. The NSWPH consortium consists of electricity and gas TSOs in the Netherlands, Germany and Denmark. The project examines potential new offshore wind power solutions by combining grid connection of offshore wind turbines with interconnections via socalled hubs and spokes between the North Sea countries. Energinet's Electricity

SUCCESSFUL HYDROGEN TEST IN THE GAS SYSTEM

Together with the Danish Gas Technology Centre and IRD Fuel Cells, Energinet and Evida will test how large volumes of hydrogen the gas grid can handle. The gas grid is built for natural gas, and as hydrogen molecules are small relative to the molecules in the other gas in the grid, the injection is tested in a closed system. The project started in 2014 and takes place between the two disconnected gas stations Helle and Agerbæk at Varde. The tests were initiated in 2017 with 2 % hydrogen, and the share is now at 14 %. So far, the test facility has not lost hydrogen, and as the facility is constructed of the same components and pipes of the same type as the rest of the gas grid, the results indicate that hydrogen can be transported in the gas grid in the long term.

Both in the project planning and testing phases, considerable learning has been obtained about the handling of hydrogen mixture by the parties involved. The entire project will be evaluated at the end of 2019.

The reason for the interest in increasing the share of hydrogen in the grid is that the gas grid may become an important tool for transportation of solar energy and wind power in the energy system of the future. The expansion of renewable energy from fluctuating energy sources challenges the system, and part of the solution may be that electrolysis plants can convert the surplus electricity to hydrogen. If the gas grid can handle a larger share of hydrogen, it will improve the possibilities of utilising or storing the energy when solar energy and wind power production exceeds consumption.



System Operator and Gas System Operator have participated in the consortium since 2017.

Energinet participates in the development project for two principal reasons:

1. Firstly, to examine how a multiplication of offshore wind power in the North Sea up until 2040 can be integrated in the Danish and European energy systems in a manner that is both affordable for society and maintains a high security of supply level.
2. Secondly, to assess the prospects for a possible Danish electricity transmission connection to a wind hub in the North Sea and the positive effects that a coupling to the gas transmission grid, via Power-to-Gas (PtG), may have, for example in the form of reduced infrastructure costs and as a facilitator for the green transition in heavy transport and industry, among other sectors.

In July 2019, the consortium presented the conclusions from the prefeasibility phase, which show that the hub-and-spoke concept is technically possible, and that a massive expansion in the North Sea will offer major infrastructure savings compared with conventional grid connections. In addition, there are interesting perspectives in relation to the PtG technology. Specifically, in relation to PtG, the prefeasibility phase showed good perspectives for combining wind power expansion with hydrogen production, but also that there is a need for further development of the electrolysis technology to GW scale.

Energinet will participate in the next phase from 2019-2023, which will include work on a vision for further development of the hub-and-spoke

concept as well as a specification of a possible first energy island before 2030. Other players in the North Sea region are following the work with interest, and the consortium may be expanded with new partners.

4.4.3 Green transition

In line with the establishment of more biogas plants which are connected to the distribution grid, there will be cases in which biogas production exceeds local gas consumption, for example in the summer when gas consumption is generally at a low level. In some cases, this is handled by connecting distribution grids, while, in other cases, there is a need to be able to transport the biogas to the transmission grid so that it can be used to supply a larger area. This means a completely new way of operating the gas system, as excess gas in the distribution system must be compressed into high pressure (from 40 to 80 bar) to be transported in the transmission system.

Today, facilities have been established at Aalborg, Brande and St. Andst meter and regulator stations which can handle this process. Investments decisions has been made to establish facilities at two additional meter and regulator stations at Højby and Terkelsbøl. Furthermore, there is a need to handle excessive gas at Viborg meter and regulator station, where the development is monitored in close cooperation with Evida.

4.4.3.1 Collaboration with Evida

Energinet and Evida have established a grid planning collaboration aimed at cross sectoral cooperation in the Danish gas system; from connection of gas producers to operation of Energinet's transmission system. There is also focus on changes in the outside world which affect the gas system, to ensure that the system can handle the issues and to exploit the opportunities that it will face in the future.

One of the central topics in the collaboration is the increased need to return surplus gas to the transmission grid. The return of gas creates new challenges. For instance, the amount of oxygen in the gas system increases when more biogas is supplied to the gas grid. In addition, the return of gas to the transmission grid entails a need

POWER-TO-X (PTX) - GREEN POWER FOR GREEN MOLECULES

Energinet's System Perspective 2035 analysis showed that there is a great potential for PtX in Denmark in the slightly longer term. PtX is thought to have the potential to play an important role in incorporating large volumes of renewable energy electricity in the integrated energy system. In addition to the incorporation of renewable energy electricity, PtX can be the key to reducing emissions via eFuels in sectors which are difficult to electrify, such as heavy road transport, aircraft, ships, high-temperature processes in industry, as well as CO_2-neutral fertilisers in agriculture. Agricultural emissions can be utilised via biogasification and PtX.

During the past year, a number of players have shown interest in PtX projects in Denmark already in the course of the 2020s. Based on System Perspective 2035 and the dialogue with the players, Energinet published the report 'PtX in Denmark before 2030' in April 2019. The report outlines connection concepts and their various advantages and disadvantages. Moreover, generic financial models have been used on these concepts and they show that, for example, hedging between the production of electricity and hydrogen – when the electricity price is high and low, respectively – can make PtX plants profitable in a short-term perspective. It is estimated that PtX plants are not unrealistic in Denmark over the next 5-10 years if the right framework is created.

to be able to remove odor-ant[6] from the gas. Odorant removal is very costly in terms of both investments and operations. Energinet is responsible for developing the grid so that biogas is integrated effectively and contributes to a socioeconomic green transition of the gas system.

The gas market is changing, and unchanged or declining gas consumption combined with increased biogas production is generally expected. The changed use of the distribution systems creates new challenges in the gas grid, including the need tohandle situations in which the local production in the distribution grid exceeds consumption in the same grid.

4.4.3.2 Oxygen from biogas in the gas grid

Biogas supplied to the Danish gas grid contains a higher level of oxygen relative to the other gas. Oxygen is a byproduct from sulphur removal from biogas before it is injected into the gas grid. The permitted oxygen content in the gas grid is primarily regulated via national rules and, to some extent, standards, and the requirements may vary between different countries.

In Denmark, it is a requirement that the oxygen content in biogas supplied to the gas grid must not exceed 0.5 %. The requirements to oxygen content in German legislation depend on the pressure level and on whether the transmission grid in question has sensitive installations, including gas storage facilities, in which oxygen in the gas may potentially result in an increased risk of corrosion. Today, with a steadily increasing biogas volume in the Danish gas system, the different requirements represent a challenge for gas exported to Germany, where the North German gas storage facilities refuse to receive gas with an oxygen content in excess of 0.001 % (10 ppm).
After recommissioning of the Tyra complex in 2022, it will likely be difficult to meet the German requirements for the oxygen content of the exported gas. Energinet is therefore working to find a flexible European gas quality solution, together with European partners, which ensures the continued expansion of green gases without compromising the wellfunctioning internal gas markets in the EU. Among other measures, a task force has been set up under the European standardisation body CEN, which works with the limit value for oxygen in gas and evaluates the technical basis for allowing higher oxygen content in the gas grid in the future. Concurrently, Energinet is looking into various operational solutions in a close dialogue with Danish stakeholders and the North German TSO, Gasunie Deutschland.

4.5 Tariffs for use of the transmission system

Energinet's financial breakeven principle means that income and expenses must balance. Differences in income and expenses are called excesses or deficits and are, as a general rule, transferred to the budget for the coming year. Most of the income is collected in the form of tariffs.

The transport tariffs are set so that they cover costs for the operation of the transmission system and grid expansion and consist of a fixed part (capacity tariff) and a variable part (volume tariff). The transport tariffs are charged to shippers which use Energinet's gas transmission infrastructure. In addition to the transport tariffs, an emergency supply tariff is charged, which covers

[6] Odorant is an odorous substance which is added to the gas when it is routed from Energinet's meter and regulator stations out into the distribution system. The odorant is added for safety reasons, so that any gas leaks can quickly be detected by persons in the vicinity.

Photo: TOTAL

Energinet's costs for security of gas supply. This tariff is charged directly to end customers on the gas market via the distribution companies.

4.5.1 Transport tariff

Energinet had a new tariff method approved in 2019. This is the implementation of the network code on harmonised transmission tariff structures for gas (TAR NC), which was published in mid-March 2016. The aim of the network code is to strengthen the internal gas market by harmonising tariff methods across national borders, increasing transparency and reducing transaction costs for consumers. The approved tariff method entered into force with the 2019/2020 gas year. The accepted tariff method entails:

- Uniform capacity tariffs in all points of the transmission system.
- A division of the transmission tariff into a capacity share and a volume share, which is distributed with 70% on the capacity tariff and 30% on the volume tariff, respectively.
- A 100 % discount on the transmission tariff to and from the Danish virtual storage point.
- Energinet's tariff method must be assessed by the Danish Utility Regulator every third year.

In the longer term, the transport tariffs are expected to increase as a result of decreasing volumes[7]. If the Baltic Pipe project is realised, larger volumes of gas in the Danish gas system will contribute to stabilising consumer transport tariffs.

The tariffs for the 2019/2020 gas year are kept close to constant, if the method change is disregarded[8], despite the falling volumes and increasing costs. This is due to the inclusion of excess revenue of DKK 88 million. The tariffs for the gas year are capacity tariff DKK 23.54 kWh/hour/year and volume tariff DKK 0.00241/kWh, respectively.

4.5.2 Emergency supply tariffs

End customers are charged an emergency supply tariff as payment for the tools that Energinet makes available during a crisis situation. There are two different tariffs – one tariff for protected customers and another lower tariff for nonprotected customers – as there are differences between

[7] As a result of the Tyra reconstruction
[8] Larger share of capacity tariff (70%), smaller share of volume tariff (30 %)

INFRASTRUCTURE DEVELOPMENT IN EUROPE

Infrastructure development in Europe

Every two years, ENTSOG publishes a european Ten Year Network Development Plan (TYNDP). The plan provides an overview of the long-term challenges for the European gas system up until 2040. The TYNDP analyses the security of supply and the development on the European gas market.

The most recent european network development plan (TYNDP2018) is published in 2019 and ENTSOG is already working on the next plan (TYNDP 2020).

The ENTSO's for electricity and gas have worked together to develop joint scenarios (TYNDP 2018 Scenario Report), which are to be used in the analyses in TYNDP 2018.

ENTSOG's TYNDP contains one Danish project, the Baltic Pipe project, which also has PCI status.

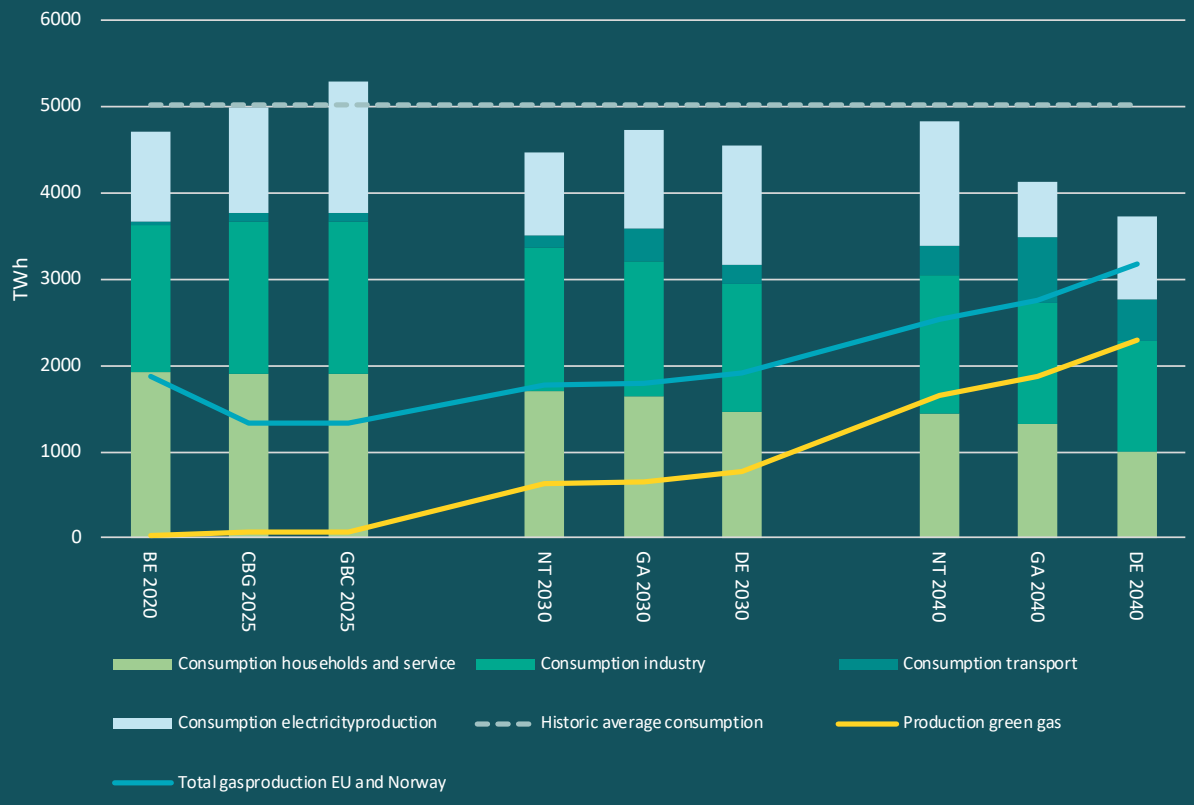
Long-term consumption and production in the EU

Consumption of natural gas in the EU showed a decreasing trend until 2014, but has been increasing slightly since 2015. However, the development in demand varies from country to country. For example, Denmark is one of the countries with the strongest decline in demand. The expected development in total gas consumption in the EU will be around or lower than the average for the period 2010-2017, with a peak around 2025.

Production and imports to Europe

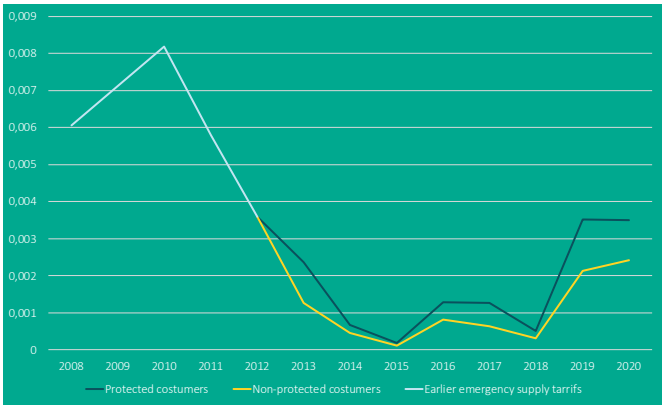
Supply in Europe is safeguarded through the countries' own production, imports from Russia and Norway in particular, LNG imports and gas in the storage facilities. It is assumed in TYNDP 2020 that Europe's own natural gas production will come to approx.. 92,000 million Nm3 in 2020. Own production is expected to decline to just over 33,000 million Nm3 in 2040. The lower amount of own production will be compensated by a lower demand for gas in general and an increased production of green gas: power to gas and biogas. In the long term the need for import of gas is expected to fall.

FIGURE 10: CONSUMPTION AND PRODUCTION IN THE EU



Note: The figure is based on data from the ENTSOs' TYNDP 2020 Scenario Report from 2019. The columns refer to different scenarios: BE Best Estimate, CBG Coal Before Gas, GBC Gas Before Coal, NT National Trends, GA Global Ambition, and DE Distributed Energy.

FIGURE 11: EMERGENCY SUPPLY TARRIFS



the security of supply for the two customer groups in an Emergency.

The overall cost of tools which can be used in an Emergency will be allocated between protected and nonprotected customers in a ratio of 85/15. The emergency supply tariffs will still be different for the two customer types. The weighted emergency supply tariff was DKK 0.00320/kWh in the 2018/2019 gas year, and it is DKK 0.00329/kWh in 2019/2020.

4.6 Information security

Increased use of IT has created major development opportunities in the energy sector, in terms of both business and technology. The use of IT is one of the most essential preconditions for the ability to operate a costefficient and reliable energy system. The stronger dependence on IT also means that the gas system becomes more vulnerable if IT disruptions or faults occur in the systems and to cyberattacks.

Information security is defined as all security measures aimed at protecting information assets, whether these are physical, electronic or oral information.

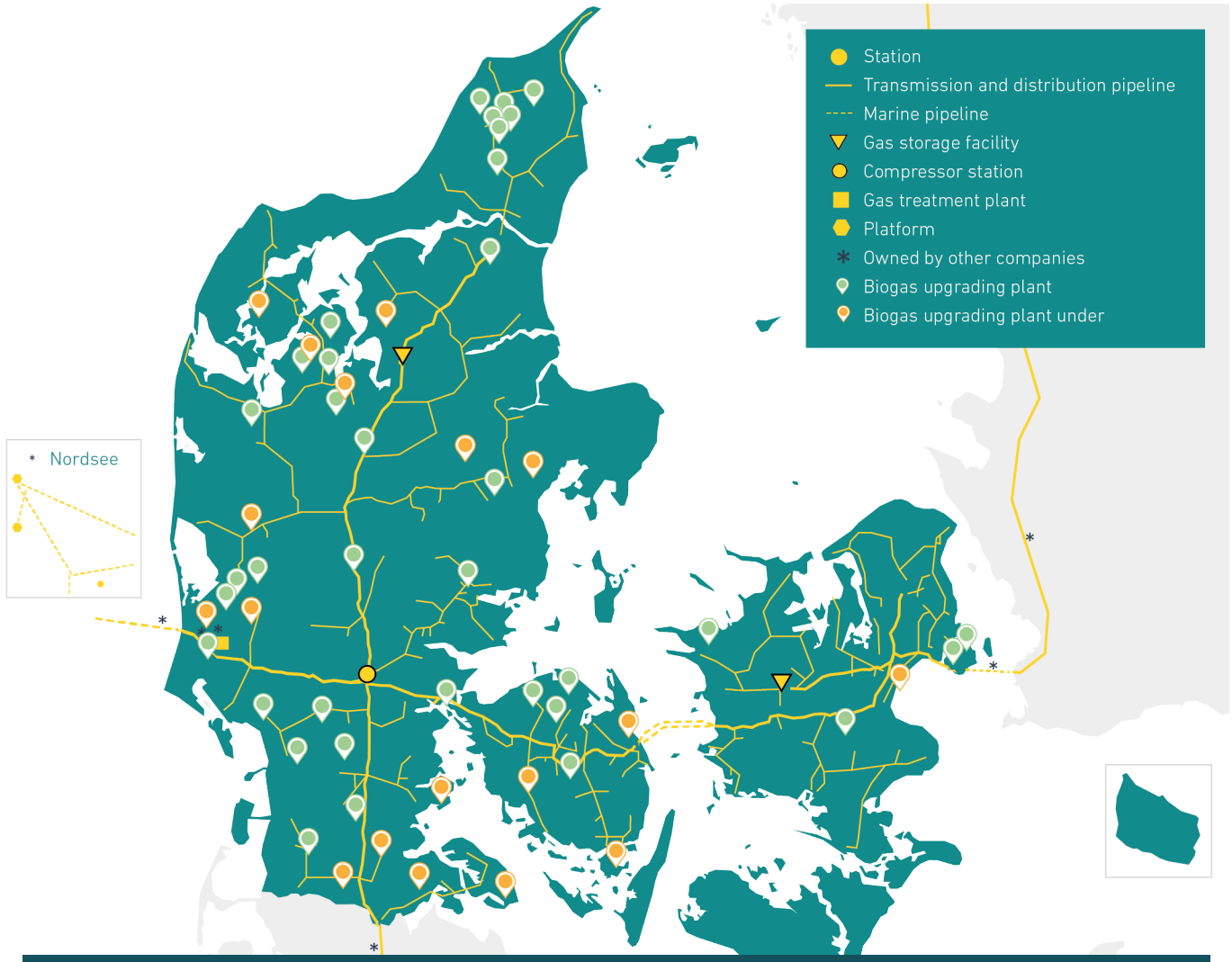
Energinet has three information security objectives:

- Availability: Systems, data and information are available when needed.
- Integrity: Data and information are complete and reliable and have not been distorted by unintended changes.
- Confidentiality: Data and information may be confidential and require protection from unauthorised access.

All three information security objectives are important. Data integrity and the availability of critical control systems, in particular, are crucial to security of supply.

Historically, information security breaches or IT uptime has not had serious impacts on Danish gas supply. Information security is a strategic focus area, and, for several years, Energinet has had a special focus on safeguarding supplycritical IT systems and training in contingency situations where systems are unavailable. Various system tests, controlled hacker attacks and information campaigns have been regularly conducted internally at Energinet.

THE DANISH GAS SYSTEM



- Transmission grid, lenght: approx. 900 km.
- Distribution network, lenght: approx. 17.000 km
- The transmission grid is connected to the distribution network via 43 M/R stations, which regulate the pressure down to the level of the distribution companies' pipiline systems.
- Number of gas consumers: approx. 400.000 private households and companies
- City gas networks: Copenhagen, Frederiksberg and parts of Aalborg
- Gas transmission company: Energinet
- Gas distribution company: Evida
- Storage company: Gas Storage Denmark

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