ENERGINET

REPORT

SECURITY OF GAS SUPPLY 2018

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.

CONTENTS

SUMMARY

An Early Warning was declared in Denmark in 2018 during a cold March, while Danish gas storage facilities were almost emptied. The situation was handled without raising the crisis level further.

Security of gas supply is increasingly becoming a cross-border issue. Gas systems are extended to diversify sources of supply and secure access to gas. The extension of the European gas system has resulted in market players acting in response to gas prices throughout Europe.

This was also the case when Europe experienced a gas crisis in the spring due to a late cold spell, which resulted in high gas prices in Europe. Initially, gas prices were significantly higher in Germany than in Denmark, and the market players exported gas to Germany. These exports created an imbalance in the Danish system, triggering an Early Warning in Denmark. High withdrawal from Danish gas storage facilities and low stocks in the same period meant that the Early Warning was maintained for three weeks.

The gas supply in the EU is highly depended on countries outside the EU. Russia alone supplies a third of the total consumption. Security of gas supply is therefore an important issue in the EU, which is now taking a further step towards increased solidarity and strengthened cooperation between the member states to ensure that all households always is supplied with gas.

The Danish security of gas supply is increasingly being strengthened by the national biogas production, as the biogas share of the annual Danish gas consumption is expected to constitute 8% in 2018. The summer of 2018 brought along record biogas sales, reaching 26% of the overall gas consumption on one specific day.

Late cold spell in Europe triggers Early Warning in Denmark

Demand for gas was exceptionally high in Europe in early spring as a result of a late cold spell. The high gas demand pushed up prices quickly, making it attractive for market players on the Danish gas market to export gas to Germany. The system was used to such an extent that the market players

Stenlille Gas Storage Facility

exported more gas than they had available in the system. This resulted in a negative imbalance, and Energinet chose to declare an Early Warning on 27 February 2018.

The Early Warning declaration was necessary to remove a price cap on balancing gas. The price cap was lower than the market price of gas, which gave shippers an incentive to transport more gas from Denmark to Germany than what was actually at their disposal. The price cap was removed with the Early Warning declaration, which meant that the incentive disappeared and the system balance was restored.

As a consequence of the increased exports to Germany, there was an increased risk that the Danish gas storage facilities would be emptied. This was reinforced by high gas prices and high storage withdrawal levels in Denmark in the weeks following the Early Warning declaration. Energinet therefore decided to maintain the Early Warning to send a signal to the market that there was a risk of reaching Energinet's emergency storage reserve, which would trigger an Emergency declaration. The Early Warning was called off on 19 March 2018.

In the coming period, the Danish gas market and gas system will develop even further, and Denmark/ Energinet must increasingly pursue cooperation on energy and security of supply across borders.

Assessment of Danish security of gas supply for the coming winter

The security of gas supply has been high in Denmark in 2018 – despite the necessity to declare Early Warning.

In the coming winter 2018/2019, the Danish gas transmission system will remain robust in relation to technical incidents – even with high gas demand, as there will be access to sufficient volumes of gas from the North Sea, Germany and the gas storage facilities.

In addition, the volume of biogas injected into the gas grid will continue to increase. In line with this increase, biogas will begin to make a larger contribution to the security of supply.

Denmark will become dependent on imported gas over the next three years

Denmark is facing a period of approximately three years in which the North Sea gas supplies will be significantly reduced. The reason for this is that the Tyra complex will be redeveloped in the period 2019-2022. Denmark will thus

"The gas supply in the EU is highly depended on countries outside the EU. Russia alone supplies a third of the total consumption. Security of gas supply is therefore an important issue in the EU"

become dependent on gas imports and gas from gas storage facilities for the first time.

The gas transmission system will become less robust and less flexible during this period. This may be critical for the supply, for example in the event of exceptionally high demand or in case of technical incidents in the infrastructure. The market players will be able to supply Danish and Swedish gas customers with gas if they utilise the import capacity from Germany and the gas storage facilities optimally.

Energinet performs regular analyses of the supply situation and the level of stocks in the gas storage facilities to prevent a crisis situation. It is essential that market players act focused during the redevelopment of Tyra to reduce the risk of interrupting supplies to gas consumers. Energinet is monitoring the storage filling and capacity bookings closely. Since the current bookings are relatively low different market initiatives which can increase the market players' utilization of the capacity in the gas system are considered.

Energinet Gas TSO cooperates on energy across borders
In recent years, the Danish gas market has become more oriented towards Europe. For many years, it has been possible to trade gas across borders on virtual hubs and exchanges. This has had an impact on the Danish gas price development, which today follows gas prices in northwestern Europe.

In the coming period, the Danish gas market and gas system will develop even further, and Denmark/Energinet must increasingly pursue cooperation on energy and security of supply across borders.

The EU takes another step towards strengthening solidarity
In 2018, Denmark has commenced various tasks aimed at strengthening solidarity across the EU and complying with the Security of Gas Supply Regulation, which requires close collaboration with other member states. One product is the new regional risk assessments, where Denmark is included in three assessments. For Denmark, the conclusion of the risk assessments is that supply to most of the gas customers can be maintained even in a European supply crisis.

As a result of the formalised solidarity principle, Denmark must enter into agreements with neighboring member states on cross-border supply of gas. The purpose of the agreements is to ensure security of supply to households if European gas supply is significantly reduced. A request for solidarity must be made as a last resort, and the likelihood that the solidarity mechanism is triggered is therefore low. Denmark must enter into agreements with Sweden and Germany.

Regional balance collaboration
Energinet collaborates with the Swedish TSO, Swedegas, to establish a joint balancing zone. One objective of the balancing zone is to facilitate cross-border gas trading and strengthen regional security of supply. The joint balancing zone will be implemented in 2019.

Access to new markets in the EU
Energinet and the Polish TSO, GAZ-SYSTEM, are working together to establish a new gas transport route from Norway through Denmark to Poland, which is expected to be commissioned in 2022. The Baltic Pipe project will benefit the Danish gas customers, as it will result in a significant increase in gas volumes transported in the Danish system. The increase in gas volumes is expected to help stabilise tariffs, even though Danish consumption is expected to fall. The final investment decision is expected to be taken before December 2018.

EARLY WARNING

GAS MARKET TESTED BEFORE TYRA SHUTDOWN

In February and March this year, the Danish gas market experienced an Early Warning. Low temperatures for the season, reductions in North Sea gas production and large withdrawals from Danish gas storage facilities were the reasons why Energinet maintained Early Warning for approximately three weeks. Early Warning was an instructive rehearsal for the gas market and Energinet in light of the coming years without North Sea gas.

From September 2019 until July 2022, the supply of gas from the Tyra field to Denmark will be shut down completely. The security of gas supply will be challenged during this period. Gas will be supplied from Germany and the Danish gas storage facilities. During the shutdown, the security of supply will be more dependent than normally on the market players utilising import capacity and the storage facilities optimally.

For 20 days from February to March this year, the Danish gas market and Energinet were given a foretaste of a possible scenario during the redevelopment of Tyra. The unexpected rehearsal commenced on 27 February at 20:38, when Energinet issued a so-called Early Warning declaration to the gas market. The signal was clear: bring more gas to Denmark or Danish gas customers risk being left without gas. Early Warning is the first crisis level on the common European supply crisis scale. The next steps are Alert and Emergency.

Biting cold from Siberia had settled over Denmark and the rest of northwestern Europe. In the preceding weeks, the cold weather had pushed up gas prices to about triple level. The high demand for gas in Europe meant that more gas players exported gas to Germany.

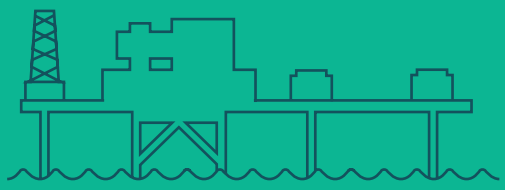
"We were in a situation in which the balance of the Danish system was challenged. Market players could speculate in a negative imbalance and sales of gas to Germany. In a worst-case scenario, this would mean that the security of supply in the Danish and Swedish gas systems would be compromised," explains Christian Allan Rutherford, Chief Economist in Energinet Gas TSO.

The imbalance price in Denmark did not reflect the actual value of the gas in the gas system. European gas prices thus exceeded the Danish imbalance price, which made it financially profitable to export gas to Germany, despite the imbalance in the Danish system.

Facts about Early Warning

The Danish security of supply model destinguish between three crisis levels: Early Warning, Alert and Emergency.

For each crisis level, Energinet has one or more security of supply measures available to increase the probability that the market can continue to supply the customers.



FACTS ABOUT TYRA

The Tyra gas field in the North Sea will be closed temporary to be redeveloped. The Danish gas supply from the North Sea will be significantly reduced in the period September 2019 until July 2022.

The Tyra gas field has since 1987 been the most important supply source to the Danish and Swedish gas customers.

the price cap on imbalance prices, which removes part of the market price signal. This meant that there was no longer a financial incentive to exploit the imbalance in the Danish gas system.

20 days with close monitoring of the gas market
The Early Warning for the Danish gas market was maintained for 20 days, but the market was in balance just one day after the Early Warning declaration. The reason why Energinet maintained the crisis level for another 19 days was that there were huge withdrawals of gas from the Danish gas storage facilities.

"We've never had such low stocks at this time of the season. The curve for gas stocks was pointing straight downwards, so we maintained the crisis level to make the market aware of the risk involved in the large withdrawals of stocks and to make the market players import gas from Germany instead," says Christian Allan Rutherford.

In the first spring months, the market players had withdrawn so much gas from the Danish gas storage facilities in Stenlille and Lille Torup that stocks were nearly limited to the volume of gas reserved for the highest crisis level: Emergency.
Christian Allan Rutherford and his colleagues in Energinet Gas TSO kept a close eye on the Danish gas market. From the Ragnarok meeting room, named after the doomsday prophecy in Norse mythology, they communicated daily with the market on the current stocks in the gas storage facilities and the supply situation.

Senior Engineer Helle Øgaard from Energinet TSO Gas was one of four officers on call who were in close dialogue with Energinet's gas control centre and adjoining systems during the Early Warning:

"The EU's Security of Supply Regulation assigns a significant role to the market players in relation to maintaining security of supply, and as Energinet's principal task is to ensure that gas is readily available, good communication with the market is, in fact, essential."

As transmission system operator (TSO) for gas, Energinet must provide the market with current information if there is a risk of a critical supply situation occurring.

Energinet wants to remove Danish price cap
On 19 February at 13:00, Energinet called off the Early Warning crisis level on the Danish gas market. The gas volumes withdrawn from the Danish gas storage facilities were back to normal levels. More springlike temperatures had come to Denmark, the North Sea gas had begun to flow again, and the price development was stable throughout Europe.

"The Early Warning incident has made us more aware of our monitoring of

"We've never had such low stocks at this time of the season. The curve for gas stocks was pointing straight downwards, so we maintained the crisis level to make the market aware of the risk involved in the large withdrawals of stocks and to make the market players import gas from Germany instead"

Helle Øgaard, Senior Engineer, and Christian Allan Rutherford, Chief Economist in Energinet Gas TSO, worked closely together during Ealy Warning in February-March 2018.

the European gas market. But the most important thing we learned is that we recommend removing the current price cap, which, in situations like this, gives shippers a financial advantage to work against the balance of the system," says Christian Allan Rutherford.

Energinet has sent a method notification to the Danish Utility Regulator in which the TSO recommends the cap system to be discontinued. In addition, Energinet examines the possibility of a significant increase in the price of emergency gas at Energinet's disposal in the Danish gas storage facilities.

Rehearsal for the Tyra shutdown

When Total starts the redevelopment of the Tyra complex in September 2019, the Danish gas system will return to a situation with one single primary source of supply from Germany supplemented by smaller volumes from the North Sea, upgraded biogas and gas from the gas storage facilities. This means that the market players must utilise the capacity in the gas storage facilities optimally if there is to be enough gas to supply the Danish and Swedish gas markets during the cold months.

"The Early Warning incident has made us more aware of our monitoring of the European gas market. But the most important thing we learned is that we recommend removing the current price cap, which, in situations like this, gives shippers a financial advantage to work against the balance of the system"

"In case of extra hard winters, the supply may be challenged. Therefore, the Early Warning this year was a good learning experience for us in Energinet and for the Danish gas market, because it emphasises how important it is that we work together to maintain security of gas supply in Denmark," says Christian Allan Rutherford.

Especially in the period between 26 February and 10 March 2018, only half of the normal volume of gas was supplied to Denmark from the North Sea. This was due to maintenance work on the Tyra platform.

If the market fails to supply consumers, despite all efforts and preparations, Energinet has an obligation to supply all socalled protected gas customers as for minimum 30 days. Ordinary Danish consumers are protected gas customers.

ABOUT 90% OF THE DANISH NATURAL GAS FROM THE NORTH SEA COMES FROM THE TYRA GAS FIELD.

PHOTO: TOTAL

BALTIC PIPE

THE DANISH GAS SYSTEM WILL HAVE NEW NEIGHBOURS AND NEW USERS

In 2022, the Danish gas system will probably be connected to the gas systems in Norway and Poland. This will entail advantages for consumers in Denmark, Poland and the rest of Eastern Europe. But first large-scale onshore and offshore construction work is to be done.

Using the Danish gas system must be as inexpensive as possible. This applies to both households and large workplaces in Denmark. It is an important objective for Energinet and a significant factor in the joint project between Energinet and its Polish counterpart GAZ-SYSTEM aimed at connecting the Norwegian, Danish and Polish gas systems with a new pipeline: Baltic Pipe.

"The costs of using the Danish gas system will increase in the coming years, as some consumer segments are switching to other fuels. Thus, there will be fewer consumers to pay for the joint bill for operating the gas system," explains Jeppe Danø, Director, Gas System Operator.

The challenge of increasing costs of using the gas system is carried by the approximately 400,000 households and business customers using the gas system. In particular Danish food and packaging producers are frequent users of the gas system. This applies to, for example, slaughterhouses.

"Linking the Norwegian, Danish and Polish gas systems more closely to each other mean that volumes 3-4 times larger than now will soon be transported through the system. And this means a wider distribution of the costs so that we avoid increasing prices, which also means that we can use the gas system to transport biogas from rural to urban areas," says Market Director Jeppe Danø.

A European project

The idea for the Baltic Pipe project originated from Poland, which – like a number of other Central and Eastern European countries – is challenged by being dependent on Russian gas to keep the wheels turning and houses heated. They perceive this as a security policy vulnerability, which Baltic Pipe can help them mitigate. In addition, the project is expected to increase competition on the European gas market.

Baltic Pipe is also an opportunity to make inroads into the large coal consumption in Eastern Europe, which has negative impacts on both climate and regional air quality. To the extent that coal is replaced by gas, CO_2 emissions can immediately be halved. At the same time, the gas-fired power plants are so flexible that they can contribute to supporting the increasing volumes of fluctuating wind power from the growing number of wind turbines constructed.

As the Baltic Pipe project has a positive effect on several EU member states, it has been designated as a project of common interest. This means that the EU contributes to fund the project.

Construction work

The establishment of the Danish gas system in the 1980s was one of the largest construction projects in Denmark. With Baltic Pipe, there is a need for a significant upgrade of the existing gas system to enable it to handle the increased gas volumes.

Linking the Norwegian, Danish and Polish gas systems more closely toeach other mean that volumes 3-4times larger than now will soon be transported through the system. And this means a wider distribution of the costs so that we avoid increasing prices, which also means that we can use the gas system to transport biogas from rural to urban areas.

Bolette Ejsing Dahl, Senior Project Manager in Permits and Rights, and Jeppe Danø, Director in Gas System Operator, are working together on the Baltic Pipe project.

In the North Sea, a submarine connection must be established to the existing Norwegian gas system with a new pipeline, brought ashore west of Varde. The new pipeline will continue from the Egtved compressor station and across Funen to Zealand and onwards to a compressor station near Næstved. The pipeline will continue into the Baltic Sea, where it will cross over to Poland and the extensions to the Polish gas system. All in all, this is a distance of about 900 km.

The actual performance of the construction project is essentially no different from when the existing gas system was established. When the pipeline has been covered, the clearest trace of the pipeline will be the compressor station on Zealand. From here, gas will be led through the pipeline and further on beneath the Baltic Sea.

Respect for landowners

A project of this size will inevitably affect a number of landowners along the route where new pipes are to be laid and where the compressor station is to be located. Already from the start of the project, it has been essential to find the routing which creates the least possible inconvenience, and the construction work will therefore take place in relatively sparsely populated areas.

"We've had a group of people engaged in studying detailed maps and plans, and we've been in dialogue with local authorities and landowners to find the routing that will cause the least possible inconvenience," explains Bolette Ejsing Dahl, Senior Project Manager in Permits and Rights. "So, all in all, we have a good solution. But it's clear there will be some landowners who want a different solution."

In connection with the project, a number of studies of the presence of animals and plants will also be conducted so that they are disturbed as little as possible, and it will be examined whether there are archaeological finds and any occurrences of ammunition from previous wars. This creates new knowledge about the local areas which the pipeline crosses.

Project implementation

The project is carried out under a tight schedule as it must be completed in 2022, as the Poles will then be short on gas. The total investment costs are approximately DKK 12 billion, which will be shared equally between Denmark and Poland. The project is based on user fees, which means that the costs will not be incurred by the Danish State.

When the project has been completed, the Danish gas system will thus have Norway and Poland as neighbours, and both Danish and Eastern European consumers will share the cost of using the system.

1. SECURITY OF GAS SUPPLY

Natural 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 natural gas customers are vulnerable to gas supply interruptions, for example private households on cold winter days.

1.1 Security of gas supply in Denmark

As a transmission system operator (TSO), Energinet Gas TSO is responsible for maintaining security of gas supply in Denmark. More specifically, Energinet is responsible for ensuring sufficient available capacity in the gas transmission system: capacity for gas exchange with the European market, gas from the North Sea, to and from the storage facilities and to the distribution systems.

The market players are responsible for ensuring sufficient gas supplies available on the Danish market to supply Danish gas customers, both in normal situations and in crisis situations. Energinet reserves emergency storage volume to ensure that the maximum withdrawal capacity is available. In addition, the emergency storage volume can be used, as a last resort, to supply socalled protected gas customers if the market players themselves are unable to ensure the availability of gas supplies on the market.

1.2 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 supplier. In 2017, the EU imported about one third of the gas consumption from Russia. Security of gas supply in the EU is therefore a high political priority, which means that the framework for security of gas supply is defined in European legislation. The EU Regulation concerning measures to safeguard the security of gas supply (the 'Regulation') sets the framework for member states' cooperation.

The framework for security of gas supply in Europe was further strengthened in November 2017 with revised version of the Regulation. The revised Regulation introduced a formal principle of solidarity: During an extreme supply crisis, the member states must enter into agreements on distribution of the remaining gas between them to ensure that all households are supplied with gas. This may be important to, for example, small and medium-sized enterprises which are not protected under the solidarity mechanism.

The purpose of the Regulation is to safeguard that all necessary measures are taken to ensure uninterrupted supply of gas to the gas customers 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 Regulation is to maintain a well-functioning internal market in the event of gas supply shortage. This means that the market – at national, regional and European levels – helps to strengthen security of supply throughout the EU.

1.2.1 Solidarity

It is a focus in the EU that vulnerable gas customers are ensured gas in situations where the amount of gas

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.
- Maintain security of 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 reporton 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 natural gas supply.

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

The Regulation primarily establishes a legal framework for the following:

- Definition of protected customers and solidarity-protected 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.
- Well-functioning internal market, even in situations of shortage of supply.
- Solidarity in supply crises.

isn't sufficient to cover the total gas demand. This has led to a formalized solidarity mechanism in the revised Regulation. 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 i.a. calculated on the loss incurred by the enterprises as a result of the disruption of their gas supply.

In the course of 2018 and 2019, negotiations will be conducted on agreements between member states for use when requests are made for the supply of gas under the solidarity mechanism. Denmark is obliged to enter into agreements with Germany and Sweden. Under the Regulation, Sweden is exempt from solidarity with Denmark, as Denmark is Sweden's only source of supply.

1.2.2 Crisis levels

When normal operation cannot be maintained and there is a risk of insufficient gas supply to gas customers, this constitutes a crisis situation. The escalation of a crisis situation 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 is able to 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-market-based tools.

In Early Warning and Alert, the market is able to 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 situation develops such 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 not sufficient to meet demand.

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

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

1.2.3 Protected customers

In accordance with the Regulation, 'protected customers', regardless of crisis level, shall be supplied with gas for minimum 30 days in the event of unusually high demand or in the event of disruption of the single largest gas infrastructure. In Denmark, this currently comprises rupture of the Tyra-Nybro submarine pipeline, through which most of the Danish gas production passes. The supply period for protected customers in Denmark has been extended to 60 days, which is the expected repair time for the submarine pipeline. Denmark thus has an increased supply standard in relation to the Regulation. When the Tyra complex is to be redeveloped, the pipeline in Ellund will be the single largest gas infrastructure, and the period in which protected customers are guaranteed supply will be reduced to 30 days.

All private customers (households) are protected, but other customer types may also be included. In Denmark, the Danish Energy Agency decides which gas customers are protected customers. Today, essential social services such as hospitals and educational institutions, small and medium-sized 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.

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. Non-protected customers are typically large enterprises. The need for disconnection of non-protected 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 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 non-protected customers.

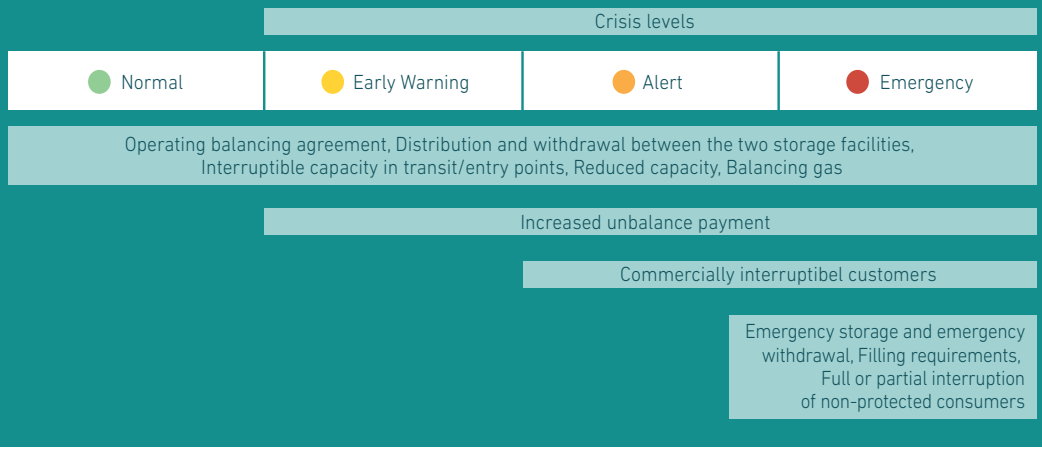
THE DANISH SECURITY OF SUPPLY MODEL

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 based on the framework of the Regulation.

The model contains specific market-based and non-market-based 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 also only be used in certain situations.

The wider circumstances under which the incident occurs are obviously also of great significance to Energinet's assessment of the situation. 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



The protected customers comprise approx. 400,000 private customers, public enterprises, CHP and district heating plants and small enterprises, which together account for around 80% of the consumption. The non-protected customers comprise approx. 47 large industrial enterprises and central power stations, which together account for around 20% of the annual gas consumption in Denmark.

1.2.4 Solidarity-protected customers
Solidarity-protected customers are a new definition in the revised Regulation. It includes the customers that should always be supplied 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. Hence the likelihood that the national supply is reduced down to the solidarity-protected customers' consumption is small. All households are solidarity-protected 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 solidarity-protected customers.

Gas customers who are protected customers, but not solidarity-protected customers, should according to the Regulation 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 medium-sized enterprises as well as individual district heating installations and essential social services. The non-protected customers which have already been disconnected in an Emergency are not entitled to compensation.

1.2.5 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.

If a crisis situation has been declared at EU or regional level, the obligation to safeguard gas supply to Danish protected gas customers is reduced from 60 to 30 days in accordance with the Regulation.

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

"The protected customers comprise approx. 400,000 private customers, public enterprises, CHP and district heating plants and small enterprises, which together account for around 80% of the consumption."

1.3 Documentation of security of supply
The 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 will be updated in 2018 and 2019 and are valid for up to four years, i.e. they cover the period in which the Tyra complex is redeveloped (2019-2022).

1.3.1 Risk assessment
In the risk assessment, it is assessed whether the gas infrastructure is designed to cover total gas demand on a day with unusually high demand and interrution of the largest infrastructure (N-1).

In accordance with the 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

Egtved

to the period 2018-2022, which is the period in which the Tyra complex is redeveloped and Denmark and Sweden are only supplied with gas from Germany. The connection in Ellund is also the single largest infrastructure during the redevelopment.

The updated 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 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 Regulation, the Danish Energy Agency has coordinated the regional risk assessment with the authorities in the neighbouring member states, i.e. especially the German Federal Network Agency and the Swedish Energy Agency but also the Netherlands and Luxembourg. The first joint risk assessment applies from October 2018.

1.3.1.1 National risk assessment
In the risk assessment for Denmark for 2018-2022, covering the period in which the supply from the North Sea has been reduced as a result of the redevelopment of the Tyra complex, the scenarios with the greatest supply impact are summarised as:

- Incidents which affect the supply to Denmark:
  - Technical incidents in the North German gas transmission system
  - European supply crisis.
- Incidents affecting the operation of the Danish gas transmission system:
  - Stenlille gas storage facility
  - Egtved compressor station
  - The pipeline from Egtved to Dragør.

Based on the national risk assessment the following are concluded:

- Supplies from Germany: Supplies from Germany may be interrupted both as a consequence of a European supply crisis (e.g. interruption of supplies from Russia) and in the event of technical interruption in the North German gas transmission system. The German TSO Gasunie Deutschland has assessed that, it will most likely always be possible to maintain at least 65% of the anticipated supplies in Ellund by lowering the supply pressure, which will be acceptable to 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, the probability that it will be necessary to declare an Emergency and thus gain access to non-market-based tools is low.

- 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 supply sources in west and gas consumers in east. In this case, it may be necessary to use the market-based 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-market-based tools.

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

1.3.1.2 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 gas supply via Ellund. In addition, the Swedish gas system is exposed to the same challenges of ensuring gas supplies as Eastern Denmark in situations with unusually high gas consumption as Sweden is located east of the Egtved compressor station.

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

Gasunie Deutschland has informed the risk group that, in the event of outage of the compressor station, it will still be possible to deliver 65% of the firm capacity in Ellund. This will be sufficient to supply both the Danish and Swedish gas markets

1.3.2 Preventive action plan
The preventive action plan 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.

In the future, regional sections must be incorporated in the individual national action plan.

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

1.3.3 Emergency plan

The emergency plan 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.

In the future, regional sections must be incorporated in the individual national emergency plan.

An Emergency will not automatically trigger interruption of gas supplies to Danish non-protected customers. A model may be used according to which non-protected 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.

1.4 Preparedness planning

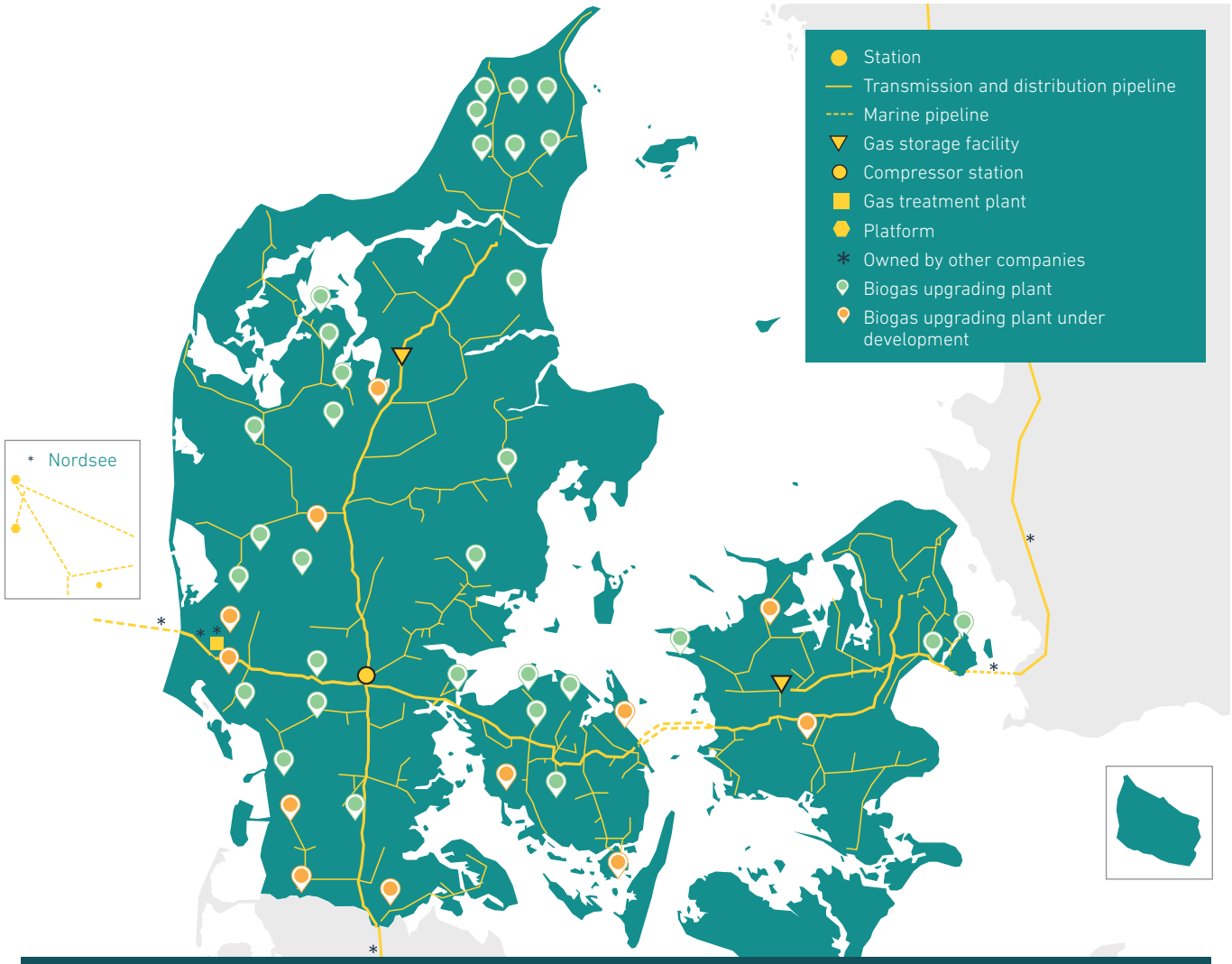
Within the energy sector, the purpose of preparedness planning is to ensure that the most important parts of society's energy supply are maintained and continued in crisis situations. Preparedness planning is different from security of supply in that it primarily concerns potential crisis situations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

In the gas sector, preparedness 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 preparedness arrangements to work preventively and to react quickly to contain accidents.

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

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

THE DANISH GAS SYSTEM



- Transmission grib, length: approx. 900 km.
- Distribution network, length: approx. 17,000 km
- The transmission grib is connected to the distribution network via 43 M/R stations, wich regulate the pressure down to level of the distribution companies' pipeline 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 companies: Dansk Gas Distribution, HMN GasNet.
- Storage company: Gas Storage Denmark.

2. THE PAST 2017/2018 GAS YEAR IN REVIEW

The security of supply has been high in the past year, as there has been sufficient gas to supply gas consumers. However, an Early Warning was declared in February 2018.

2.1 Security of supply incidents

An Early Warning crisis level was declared in the past year. It is only the third time that Energinet has declared a crisis level. Early Warning has previously been declared twice in 2013.

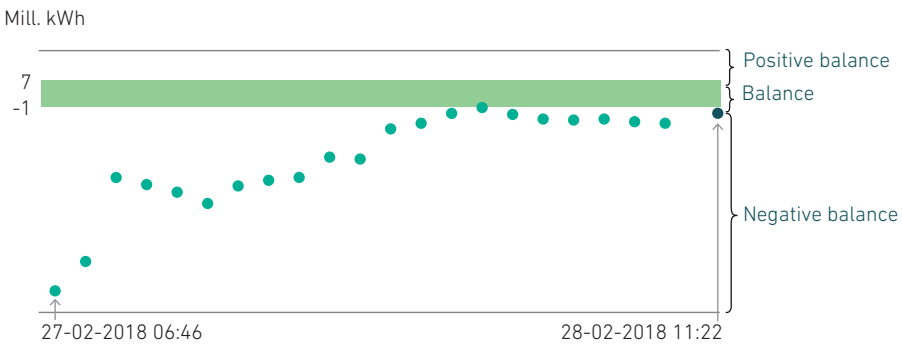
2.1.1 Early Warning in February 2018

Energinet declared Early Warning on Tuesday evening, 27 February 2018. The incident was triggered by cold temperatures and gas exports to Germany, which led to an increasing negative imbalance in the Danish gas system; see Figure 1.

The shippers' gas supplies (entry) and offtake (exit) in the Danish system must balance per gas day. When shippers have a negative imbalance, their offtake exceeds their supply to the system, and Energinet may need to buy gas on the Danish gas exchange, Gaspoint Nordic, to maintain the overall system balance.

Shippers with an imbalance after the gas day pay the marginal price at which Energinet has traded during the gas day. The Early Warning illustrated that the price of having a negative imbalance in Denmark does not always give shippers an incentive to ensure gas balance in Denmark. This is due to a price cap on Energinet's price of balancing gas, also called the imbalance price. The price cap meant that the imbalance price remained lower than the market price of gas in Denmark and the adjacent gas markets. By declaring an Early Warning, it became possible to remove the price cap. The actual market prices were thus reflected in the imbalance price, and the shippers received the right price signals, giving them an incentive to balance their portfolios. The day after the Early Warning was declared, the Danish gas system balance was restored.

FIGURE 1: PROVISIONAL (YELLOW) AND FINAL (BLACK) SYSTEM BALANCE IN THE DANISH GAS SYSTEM ON TUESDAY 27 FEBRUARY 2018



Energinet maintained the Early Warning, despite the system balance having been restored. The declaration was maintained due to the risk that there would not be enough gas to supply the gas customers. The reason for this was that North Sea supplies were reduced and commercial storage volumes were extraordinarily low with continued high withdrawals from storage facilities. In addition, the weather was cold in most of Europe, and the Danish gas system was therefore in competition with the rest of Europe for attracting gas to the system.

At the end of the Early Warning process, temperatures increased, the storage facility withdrawals stabilised, there were no major reductions of North Sea supplies and the system balance was stable. The supply situation was thus improved. Energinet called off the Early Warning on Monday 19 March 2018.

Before the Early Warning was declared, Energinet had a discussion with the market players about whether the price cap should be removed. During the Early Warning, it was clear that this change was necessary. At the beginning of July, Energinet therefore sent a

TABLE 1: CAPACITIES AND UTILISATION OF THE TRANSMISSION SYSTEM, 2015-2017

			Maximum daily flow		
		Capacity Mcm/d	2015 Mcm/d	2016 Mcm/d	2017 Mcm/d
Nybro	Entry	32.4 [2]	14.6	13.2	14.0
Lille Torup Gas Storage Facility	Injection/ Withdrawal	3.6/ 8.0 [3]	3.5/ 7.3	3.7/ 7.5	3.8/ 7.6
Stenlille Gas Storage Facility	Injection/ Withdrawal	4.8/ 8.2 [3]	5.4/ 7.8	4.8/ 6.8	4.8/ 6.3
Exit zone	Exit	25.5	15.6	17.5	16.7
Ellund	Entry/ Exit	10.8 [4]/ 20.0	4.2/ 7.0	4.8/ 9.3	4.9/ 5.2
Dragør Border	Exit	8.6 [1]	6.2	6.0	4.7

Note 1: The Swedish system is not designed to receive these volumes at the assumed minimum pressure at Dragør of 44 bar. The firm capacity is stated at 7.2 million Nm^3/day.

2: Total capacity of the receiving terminals at Nybro. The potential supplies are smaller today as the Tyra-Nybro pipeline is subject to a capacity constraint of approx. 26 million Nm^3/day, and large volumes cannot be supplied from the Syd Arne pipeline.

3: The Danish storage company dimensions the commercial injection capacity conservatively in relation to the pressure in the gas transmission grid. When the pressure 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/Nm^3.

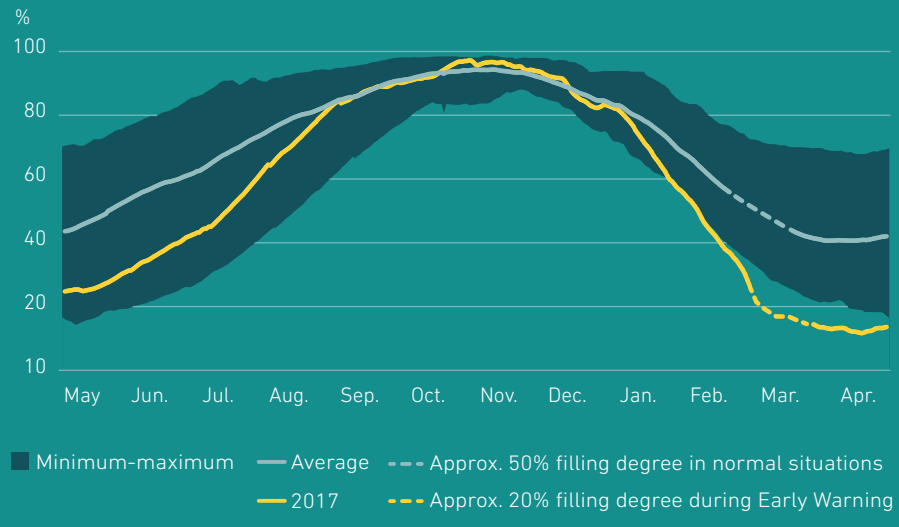
THE LATE COLD WINTER IN 2018 ILLUSTRATES THE MARKET PLAYERS' CHANGED USE OF GAS STORAGE FACILITIES

Energinet Gas TSO declared an Early Warning on 27 February 2018. This occurred in connection with a cold spell, fairly late in the winter. At the time, stock volumes in the gas storage facilities were unusually low for the season in both Denmark and the EU. Combined with the cold weather, which led to a high demand for gas, the consequence was that gas prices increased significantly. The reason for the relatively low stocks in the gas storage facilities for the season is that storage customers increasingly hedge their storage facility position through the European forward market. This is done by purchasing gas for delivery in the summer and selling gas for delivery in the winter on the forward market. Sales of gas in January and February are particularly attractive, as this is when the highest price is achieved on the forward market. This means that there is little gas for delivery in March, as the gas price is usually lower during this month, and the market players do not take into account sudden cold spells or other conditions that may affect the security of supply.

Danish storage customers have historically had more gas in storage in March and April than they had in these months in 2018, as they are part of the winter in Denmark. The forward market, which is based on the conditions in Germany and the Netherlands, does not, however, price March, let alone April, as actual winter months. Danish storage customers thus increasingly act on the development on the forward market to obtain the most favorable price conditions. Danish end customers' needs for security of supply are not a major element in this pricing.

As a result of the 2017/2018 winter season ending with extraordinarily empty gas storage facilities, there was a greater demand for gas in summer 2018, as the gas storage facilities need to be refilled before winter. This has contributed to a higher gas price than usual over the summer. The winter price of gas has not increased correspondingly, which means that the difference between forward prices for summer and winter has narrowed. In line with a narrowing of the price difference, the value of having gas stocks in the gas storage facilities has decreased. This reduces the incentive to replenish stocks completely. This means that such a cold spell results in a decrease in the value of stocks over the filling season, which is a paradox considering that the market players with gas in storage are those best secured in such a situation. But it is a consequence of the market players' new behavior, under which gas stocks are primarily priced on the basis of the development on the northwestern European forward market.

FILLING DEGREES: AVERAGE IN THE PERIOD 2006-2016 AND 2017



method notification to the Danish Utility Regulator containing a proposal to remove the price cap. The same method notification also includes a new formula for calculating the cost of having an imbalance in an Emergency. With the new formula, a greater incentive has also been created for retaining gas storage volumes until later in the season, instead of emptying all gas storage facilities when the price is high.

2.1.2 IT incidents

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

2.2 The transmission grid

None of the peak day volumes came close to the capacity limits in the transmission system entry and exit points in 2017. Only the Lille Torup gas storage facility, with a withdrawal of 7.6 mcm/day, came close to the withdrawal capacity at Lille Torup of 8.0 mcm/day. This was on 5 January 2017, which was also the coldest day of the year with a 24-hour mean temperature of -6°C. During the Early Warning in 2018, the commercial withdrawal capacities of both storage facilities were utilised. On 27 February 2018, Lille Torup exceeded the commercial withdrawal capacity with a withdrawal of 8.3 mcm. On 28 February 2018, the daily withdrawal from Stenlille was 8.2 mcm, i.e. the maximum daily commercial withdrawal capacity.

2.2.1 Gas supplies from the North Sea

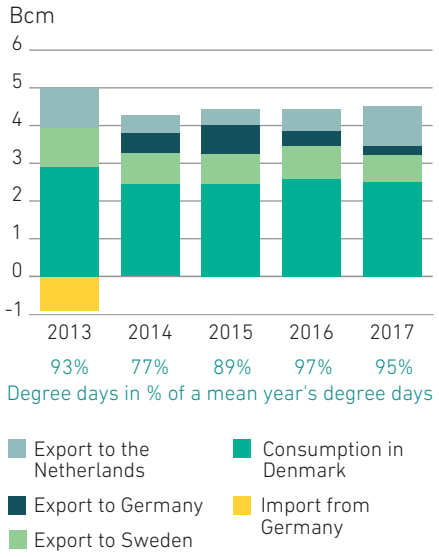
Most of the gas supplied to Denmark comes from Danish gas fields in the North Sea. The gas is taken onshore at Nybro via two submarine pipelines and sold for consumption in Denmark and exported to Sweden and Germany. The gas can also be exported directly from the North Sea to the Netherlands. Denmark continues to be a net exporter of gas, but sometimes over the course of the year, the flow is reversed and natural gas is imported from Germany. Annual production distributed on consumption and exports is shown in Figure 2.

Supplies to Nybro were approx. 3,366 mcm in 2017, exceeding the total Danish and Swedish gas consumption of approx. 3,210 mcm. In the first six months of 2018, the Nybro supplies reached approx. 1,618 mcm, and the supplies are expected to be approx. 3,500 mcm for the whole of 2018.

2.2.2 Ellund

The flow direction between Denmark and Germany (Ellund) was northbound in winter 2017/2018. The flow was only southbound in Ellund during the Early Warning in February/March.

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



2.2.2.1 Capacity orders at Ellund

It is now a common European requirement that the capacity at so-called 'interconnection points' (often border points) is offered for minimum five years ahead. At Energinet, this is only relevant for the Ellund point towards Germany, as the Dragør point towards Sweden will no longer be regarded as an interconnection point when the joint balancing zone is implemented.

Annual orders at Ellund Entry have been of particular interest in 2018. One reason for this is that the capacity has been offered for the next five years and thus covers the whole redevelopment period for the Tyra complex, and another reason is that Gasunie Deutschland invited tenders for 1 million kWh/h new capacity, in addition to the current capacity, from 2019.

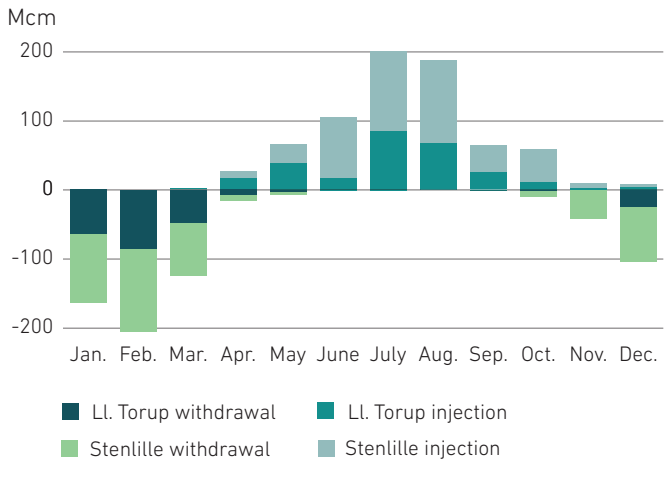
The call for tenders was made at the annual auction on the common European platform PRISMA on Monday 2 July 2018. Table 2 shows the tendered and sold bundled capacity, i.e. the total capacity in the German Ellund Exit and in the Danish Ellund Entry, between Energinet and the two German TSOs Gasunie Deutschland and Open Grid Europe.

TABLE 2: TENDERED AND SOLD BUNDLED CAPACITY FROM GERMANY TO DENMARK 2018-2022

	Mill. kWh/h				
Ellund entry	Gas year 2018	Gas year 2019	Gas year 2020	Gas year 2021	Gas year 2022
Tendered bundled capacity	1.2*	3	3	3	2.1
Sold bundled capacity	0.3	1	0.7	0.4	-

*Only capacity tendered by the German TSO Gasunie Deutschland.

FIGURE 3: STORAGE WITHDRAWAL AND INJECTION PER MONTH, 2017



2.2.3 Use of gas storage facilities

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

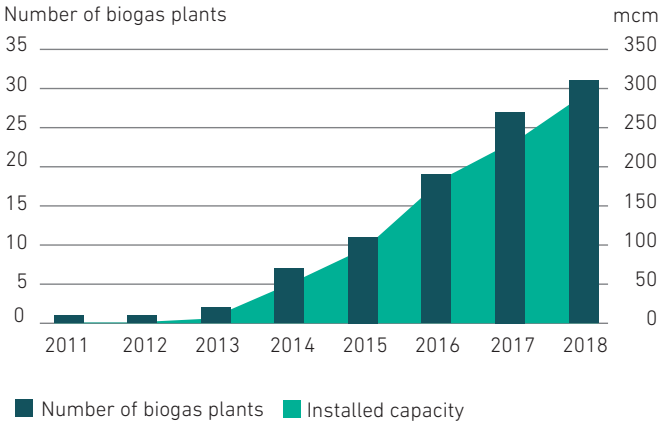
Gas consumption varies over the year and over each 24-hour period. Market players can use the Danish gas storage facilities to store gas to exploit price differences, for example across seasons and markets, and to supply the necessary daily capacity. During the summer, when gas consumption is low, gas is injected into the gas storage facilities. In winter, when supplies from the North Sea can no longer cover Danish consumption or exports to Sweden and Germany, gas is withdrawn from the storage facilities again; see Figure 3.

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

Gas Storage Denmark has decided to increase the withdrawal capacity at Lille Torup gas storage facility from 2019. The withdrawal capacity in Lille Torup will thus increase from 8.0 to 10.3 mcm/day, giving a total storage withdrawal capacity of 18.3 mcm/day. The expansion is one of the initiatives Energinet has analysed prior to the redevelopment of the Tyra complex.

In Sweden, the Swedish TSO, Swedegas, has decided to discontinue the operation of its Skallen gas storage

FIGURE 4: CONNECTED BIOGAS PLANTS AND INSTALLED CAPACITY (ACCUMULATED), 2011-2018



facility, such that it will not be in commercial operation from winter 2018/2019. Thus the gas storage facility, which is the only one in Sweden, cannot be used neither in normal situations nor emergencies. It will take approximately one month to resume operation. The gas storage facility has a total volume of 10 mcm.

2.2.4 Biogas in the grid

Biogas is increasingly upgraded and supplied to the gas grid. The first demonstration plant was connected in 2011, and the first commercial biogas plant was connected by the end of 2013. Today, 31 biogas plants are connected to the gas grid. 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. 300 mcm/year. In 2017, the plants utilised approx. 72% of the connection capacity.

The volume of biogas injected into the gas system has been increasing. Upgraded biogas amounted to 6.6% of Danish gas consumption from the grid at the end of 2017 and is expected

"Gas Storage Denmark has decided to increase the withdrawal capacity at Lille Torup gas storage facility from 2019."

to reach 8% at the end of 2018. In summer, when gas consumption is low, biogas constitutes an even higher share. In July 2018, biogas in the gas grid constituted 18.6% of total Danish consumption. On a single day, 28 June 2018, the share reached 26.4%.

Energinet has information of around 10-15 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 or transmission grid in 2018 and 2019. Overall, these plants will increase the total connection capacity by approx. 150 mcm/year to approx. 450 mcm/year.

2.3 Gas consumption

After having declined for many years, gas consumption has been slightly increasing since 2014; see Figure 2. In 2017, gas consumption was approx. 2,492 mcm, and consumption in 2018 is expected to be approx. 2,600 mcm.

2017 was slightly warmer than average with 5% fewer degree days than in a normal year. Likewise, 2018 seems to be a warm year. In the first six months of 2018, there have been 4% fewer degree days than in a normal year.

2.3.1 Peak day consumption

The temperature has a major impact on peak day consumption. In the first six months of 2018, the peak day consumption in Denmark was 15.6 mcm. This was on 28 February 2018, the day after an Early Warning was declared,

[1] As at 1 October 2018

FIGURE 5: GAS VOLUMES SOLD ON GASPOINT NORDIC, 2016/2017 AND 2017/2018 GAS YEARS

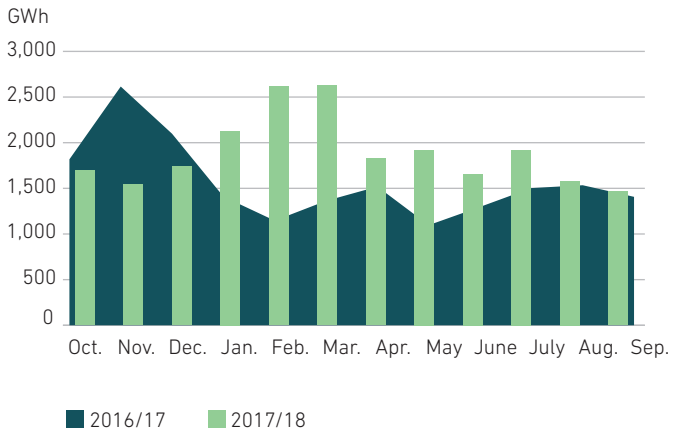
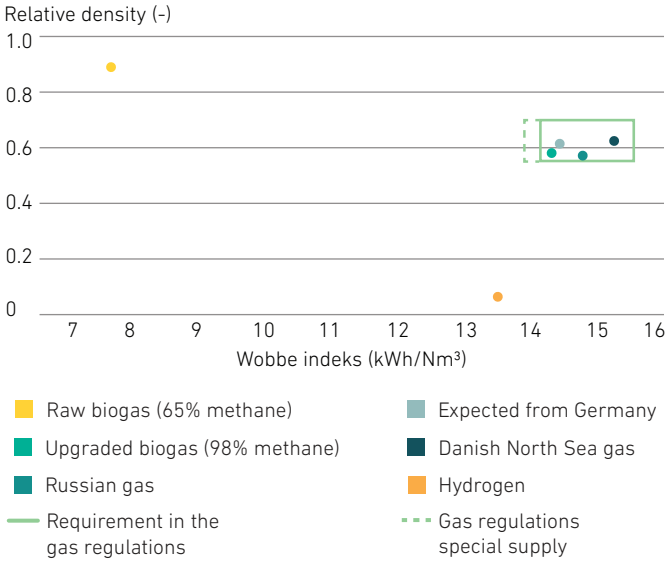


FIGURE 6: ILLUSTRATION OF GAS QUALITY FOR DIFFERENT TYPES OF GAS



Note: In the future, new types of RE 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.

when the daily mean temperature was -7.3°C. In 2017, the peak day consumption was 16.7 mcm.

2.4 The gas market

The Early Warning declaration in February was the largest event on the gas market in 2018. The Early Warning incident is described above under security of supply incidents.

2.4.1 Trading on Gaspoint Nordic

The traded volume on the Gaspoint Nordic gas exchange increased again in winter 2017/2018 after having decreased the previous winter; see Figure 5. On this basis, the traded volume in 2018 is expected to end on a par with 2016, which is the best year to date for Gaspoint Nordic, where more than 60% of the Danish consumption was traded on the stock exchange.

One of the reasons for the increase in traded volume is the cold period from end-February to mid-March in which Energinet had declared an Early Warning. During this period, several records were set for the volume traded on a single day in relation to all previous years. During the Early Warning, a volume was traded corresponding to around 9% of the total volume traded in the 2017/2018 gas year.

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 Gas Regulation. The gas is supplied from different sources of supply (the North Sea, via 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/

Lille Torup Gas Storage Facility.

Nm^3). The relative density of natural gas must not be below 0.555 or above 0.7.

The transported gas complied with the quality requirements in 2017.

2.6 Incidents and drills

Gas system drills are organised so that drills are performed in respect of all significant elements over a five-year period. The following are examples of drills and incidents in 2017-2018. In addition, a number of minor tests and drills, each practising sub-elements, are performed on a regular basis.

- On 26 October 2017, Energinet performed an extensive drill at Stenlille gas storage facility. The drill focused on the involvement of and cooperation with the local emergency services. The drill scenario was a fire in the central plant in the gas storage facility.

"Gas system drills are organised so that drills are performed in respect of all significant elements over a five-year period."

- In November and December 2017, Dansk Gas Distribution conducted minor drills focusing on repair of the distribution grid and reestablishment of operation following a distribution and regulator station breakdown.
- 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 redevelopment of the Tyra complex.
- Energinet Gas TSO and Engineering & Construction conducted a larger drill, Starlight, at Nyborg 18-19 September 2018. The objective of the drill was to test the repair time for a pipeline breach, to verify that it is possible to repair the damage within two days.

In February and March 2018, the supply situation was very strained due to the prolonged cold weather and various incidents in the system. Energinet therefore declared Early Warning. The internal learning in Energinet as a result of the incident was significant, and there will be followed up on the situation in the same way as for drills.

3. THE COMING WINTER 2018/2019

System capacities for supplying Danish gas consumers are expected to be sufficient, even in case of a very cold winter. The overall supply situation in Europe is also looking good for the coming winter, during which the flexibility in the system is expected to be sufficient.

3.1 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 2018/2019 gas year:

- Ellund Exit, exports of gas to Germany: No annual orders have been placed for the 2018/2019 gas year. In the past two years, annual orders have been close to zero, so this was not unexpected.
- Ellund Entry, imports of gas from Germany: For the coming gas year, 0.3 million kWh/h has been sold as bundled annual capacity, i.e. both capacity at the German Ellund Exit and capacity at the Danish Ellund Entry. In addition, approx. 3.1 million kWh/h has been sold from the long Open Season contracts[2]. The total capacity at Ellund Entry is 7.7 million kWh/h.
- Dragør Exit[3], exports of gas to Sweden: Annual capacity of approx. 0.7 million kWh/h has been sold. This means that the annual order has decreased by approx. 0.4 million kWh/h since the 2016/2017 gas year. The total capacity for sale at Dragør Exit is approx. 3.7 million kWh/h.
- Nybro Entry: Approx. 3.6 million kWh/h has been ordered on annual contracts. This is an increase compared with the previous gas year, where annual orders amounted to approx. 3.2 million kWh/h. This may be an indication that more gas will be transported to Denmark than in the previous year, at the expense of transport of gas to the Netherlands.
- Exit zone, supply of gas to Danish end users (distribution areas): Annual capacity can be ordered all year round. However, sales of annual capacity have generally decreased significantly, partly due to the shorter products having become less expensive, relative to the annual capacity, and partly because the price of transporting gas without having the capacity is much lower than previously (overrun fee). At the end of 2016, annual orders thus amounted to approx. 6.3 million kWh/h, but, in September 2018, the level is approx. 2.5 million kWh/h.
- 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 RES Entry can be purchased throughout the year. The point has also undergone the same development as the exit zone in terms of overrun fee. Sales of annual capacity at this point are more or less on a par with last year, over 0.2 kWh/h, despite biomethane production seeing strong growth.

[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.

[3] The Dragør point is connected to the Swedish transmission system. The point is primarily used for exports of gas to Sweden, but capacity may also be ordered commercially in reversed flow, from Sweden towards Denmark.

ENERGINET'S WINTER OUTLOOK

To assess the supply situation, an evaluation of robustness 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, incl. 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 -13°C.

Assessment for the coming winter 2018/2019

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 mcm/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 mcm/day.
Dragør: Dragør has exports of 5.9 mcm/day.
Storage facilities: Total withdrawal of gas from the storage facilities is estimated at 16.2 mcm/day, with 8.2 mcm/day coming from Stenlille and 8.0 mcm/day from Lille Torup. A distribution of withdrawals is used which supports the highest possible grid pressure.
Nybro: Supplies at Nybro are estimated at 8.8 mcm/day.
RES: 0.3 mcm biogas/day is supplied to the gas system.

Assessment for winter 2019/2020 - the first winter without Tyra in production

The assessment indicates that there is sufficient capacity in the gas system to meet demand on a very cold day.
Denmark will temporarily lose an important source of supply during the redevelopment of the Tyra complex, which makes the system less flexible.
Exit zone: Consumption in Denmark is 19.9 mcm/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 mcm/day.
Dragør: Dragør has exports of 5.7 mcm/day.
Storage facilities: Total withdrawal of gas from the storage facilities is estimated at 18.5 mcm/day in normal situations, with 8.2 mcm/day coming from Stenlille and 10.3 mcm/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 mcm/day.
RES: 0.4 mcm biogas/day is supplied to the gas system.

3.2 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.

For the 2018/2019 gas year, the limit for protected customers is 3.2 mcm/year. In practice, this means that industrial enterprises and gas-fired CHP plants will be protected if they have an annual gas consumption of less than 3.2 mcm/year.

3.3 Gas quality during the coming winter

Energinet expects gas quality in the coming winter to be based on a combination of North Sea gas, gas from Germany and biomethane.

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

- The Wobbe index for the Danish North Sea gas is expected to vary from 14.7 kWh/Nm^3 to 15.5 kWh/Nm^3.
- 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/Nm^3, varying from 13.9 kWh/Nm^3 to 15.5 kWh/Nm^3.
- 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 chemically similar to 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 kWh/Nm^3 to 14.8 kWh/Nm^3.

3.4 Distribution

Gas supplies to the individual consumers must be maintained in crisis situations at very low daily mean temperatures, where demand is expected to be unusually high. Therefore, the gas system must be dimensioned to the necessary capacity to supply distribution areas at all times. This is ensured by assessing natural gas offtake from each meter and regulator (M/R) station. The assessments are performed by Energinet based on reporting from the distribution companies.

The gas market is changing and constant or declining gas consumption combined with increased biogas production is generally expected. The change in the use of distribution systems creates a number of new challenges in the gas grid, including a need to handle situations in which local biogas production in the distribution grid exceeds consumption in the same grid. Energinet and the distribution companies continuously work to find solutions, to ensure a wellfunctioning and efficient gas system.

"The gas market is changing and constant or declining gas consumption combined with increased biogas production is generally expected. "

3.4.1 Dansk Gas Distribution A/S

Energinet assesses that the M/R stations and distribution systems in Dansk Gas Distribution's (DGD) area have sufficient capacity to cover the supply requirement for winter 2018/2019.

Before the end of 2018, a total of 12 biogas upgrading plants are expected to be connected to the distribution grid in the DGD area. A total capacity of 16,000 Nm^3/h, corresponding to an annual capacity of 140 mcm, will be connected. (In 2017, approx. 72% of the installed capacity was utilised.)

DGD, which is owned by Energinet, took over NGF Nature Energy Distribution A/S in May 2018. The political objective is that a full consolidation of the distribution grid is implemented.

3.4.2 HMN GasNet P/S

Energinet assesses that the M/R stations and distribution systems in HMN GasNet's area have sufficient capacity to cover the supply requirement for winter 2018/2019.

Before the end of 2018, a total of 18 biogas upgrading plants are expected to be connected to the distribution grid in HMN GasNet's area. A total capacity of 16,850 Nm^3/h, corresponding to an annual capacity of 148 mcm, will then be connected.

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 four 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 2018/2019:

- The European gas system will be able to withstand a cold winter with sufficient flexibility in most countries.
- As of 1 October 2018, the storage filling was at the lowest level since 2011. The low level is due to extraordinary high withdrawal from the storage facilities in February/March 2018 due to the late cold period. The high storage withdrawal meant that the storage filling was historically low in spring 2018. However, it is assessed that there is sufficient flexibility in the European gas system prior to the winter. Increased storage filling towards winter will, however, increase flexibility.

ENTSOG's simulation 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 and is thus based on reduced supplies from the North Sea. On the other hand, the simulation does not take into account that extra firm capacity will be offered in Open Grid Europe's grid at Ellund from 2019 and that consumption is expected to decline. Moreover, ENTSOG's simulation does not include extra measures in Denmark and Sweden. ENTSOG's simulation thus paints a more negative picture than Energinet's own analyses, as they will be described in the preventive action plan and emergency plan in spring 2019.

4. DEVELOPMENT IN THE DANISH GAS TRANSMISSION SYSTEM

The future trend for the supply situation is analysed to assess what might affect long-term security of supply. The analysis helps identify whether further initiatives should be implemented.

4.1 Reconstruction of the Tyra complex 2019-2022

Mærsk, and subsequently TOTAL, has announced on behalf of DUC (Danish Underground Consortium) that the Tyra complex must be redeveloped to secure the gas production for many years to come. The redevelopment will significantly reduce the production and thus the supply of gas to Denmark, as 90% of Danish gas supplies are made via the Tyra complex.

In a communication to the market (REMIT) on 24 November 2017, Mærsk announced that the Tyra complex will close down from 1 November 2019, and that gas supply is expected to recommence from 1 July 2022. The moment for when Tyra will close down has later been updated to September 2019. However, the supply will be reduced gradually from March 2019. In a historical context, it is remarkable that such a large part of the gas supplies to a market are removed for an extended period of time.

During the redevelopment of the Tyra complex, Denmark and Sweden will be dependent on gas imported from Germany and use of the Danish gas storage facilities. In order to safeguard the supply of gas to Danish and Swedish consumers, it is necessary that the market players utilise the import capacity and the gas storage facilities. Energinet is monitoring the storage filling and capacity bookings closely. Since the current bookings are relatively low different market initiatives which can increase the market players' utilization of the capacity in the gas system are considered.

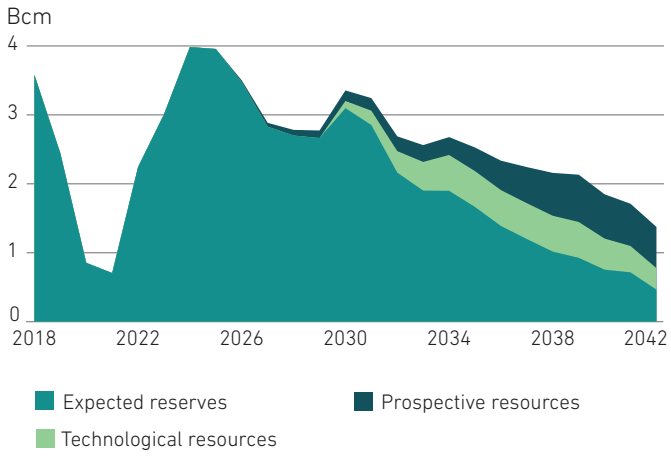
To support the market players, Energinet is continuously monitoring the supply situation and ensures that new information on developments, and market expectations, is passed on to the market players. Energinet thus provides the market players with a common information basis, which allows them to take the necessary precautions to prevent any critical supply situations.

The most recent analysis of the supply situation during the redevelopment of the Tyra complex shows, that 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 redevelopment 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 Gas TSO is expecting more Early Warning declarations during the redevelopment of the Tyra complex.

Since the first announcement from DUC in April 2016, Energinet Gas TSO has worked on preparing the gas market and system operations for handling the situation. Work is still being done on different types of measures aimed at improving the supply situation.

Energinet's compressor station in Egtved will be essential throughout the

FIGUR 7: EXPECTED RESERVES, 2018-2042



Note: The figure is based on data from the Danish Energy Agency. 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.

period, as constant gas imports from Germany are expected. In order to ensure maximum uptime of the compressor station, it has been decided to purchase and stock critical spare parts as well as bringing forward certain maintenance works.

Together with Gas Storage Denmark, it has been decided that the Lille Torup gas storage facility's physical withdrawal capacity is to be increased by approx. 2 mcm/day before the redevelopment of the Tyra complex. Extra withdrawal capacity will thus be available in the event of, for example, disruption of supplies from Germany.

In July 2018, Gasunie Deutschland held an auction on the PRISMA platform, offering possible extra capacity from 1 October 2019 of 1 GWh/h in addition to the current capacity for German Ellund Exit to Denmark. However, no bids were received for this extra capacity. Nevertheless, Gasunie Deutschland has decided to carry out the expansion, but the capacity has been reserved for Schleswig-Holstein.

Other measures will be improved information 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 marketing initiatives. In specific terms, Emergency workshops will be held with the market players to strengthen knowledge about crisis situation mechanisms. Energinet Gas TSO held an Emergency workshop on 25 January 2018 and expects to hold the next workshop in spring 2019. In Ellund, improved commercial products and mechanisms will be introduced. Furthermore, work is being done to adapt and supplement Energinet's emergency supply tools and products.

4.2 Expected use of the gas system

The primary supply sources for the Danish gas market are own production in the North Sea and imports from Germany. In addition, biogas production accounts for a small, but increasing, share of the gas supply in Denmark. The redevelopment of the Tyra complex will be commenced in 2019, and the supply of gas from the North Sea will gradually be reduced from March 2019. Germany will thus become the primary source of supply to Denmark and Sweden in the course of 2019 and until the Tyra complex has been redeveloped. After the redevelopment, gas will again be transported from the North Sea in volumes that will be similar to historical volumes.

4.2.1 North Sea production

The total reserve estimates have been generally increased from 2022, due to changes in risk assessments and several expected expansions. The expected reserves have also been significantly increased, while the

contribution from technological reserves and the exploration contribution have been reduced.[4]

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 distribution is determined by the market players.

4.2.2 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, and as there are ample opportunities for natural gas supplies from the North Sea and Germany. Production of upgraded biogas is expected to increase to 10% in 2019 compared with the previous year's gas consumption, and, with an expected increase to about 15% in 2020, the contribution to security of supply is becoming more significant. In the first year during the redevelopment of the Tyra complex, biogas will contribute with around the same volume as the Syd Arne field on security of supply.

4.2.3 Gas storage capacity

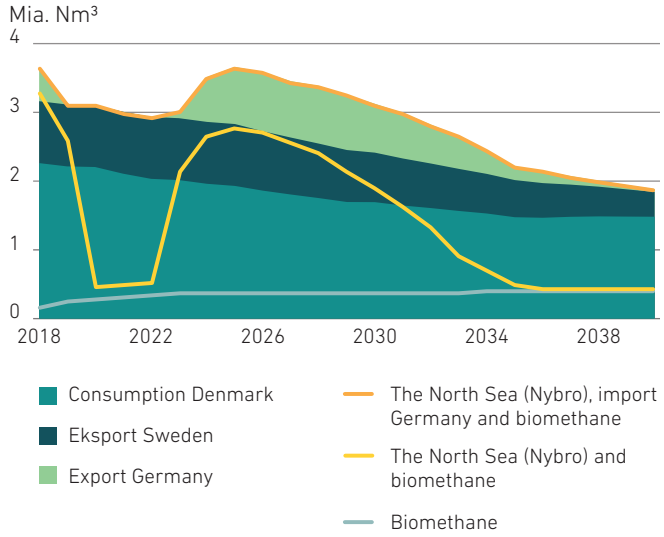
The shippers are responsible for balancing their portfolios and thus safeguarding the supply of their connected Danish consumers (via gas suppliers). Thus, they have the responsibility for ensuring access to sufficient gas in the system to prevent an Emergency declaration. It is therefore important for the security of gas supply that the shippers store sufficient gas volumes to safeguard the supply of their connected Danish 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. Today, this emergency storage is determined by the gas volume needed to ensure the maximum storage withdrawal capacity and a situation in which the Tyra-Nybro pipeline is interrupted for 60 days, but where the supply can be replaced with supplies from Germany. While Tyra is being redeveloped, the emergency storage volume will be determined by a situation in which no gas is supplied from either 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 RES. During the period in which the Tyra complex is out of operation, the procurement of emergency storage volumes is therefore expected to be increased from the current approx. 100 mcm to approx. 170 mcm.

During the redevelopment of Tyra, the 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 Regulation) during the redevelopment of Tyra.

[4] The Danish Energy Agency's report on Oil and Gas Production in Denmark, 2018.

FIGURE 8: SUPPLY SITUATION, 2018-2040



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

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 will correspond to the work volume in the storage facilities decreasing by 10-12%, equal to approx. 100 mcm compared with today.

4.2.4 Supply situation 2018-2040

The supply situation[5] during the redevelopment of the Tyra complex in the period 2019-2022 requires special attention, and Energinet will regularly update the supply situation outlook. The supply situation outlook is Energinet's best estimate of how the supply situation may be. The estimate is subject to uncertainties.

The Danish gas system will become more vulnerable when the redevelopment of the Tyra complex starts. However, it has been expanded with sufficient capacity between Germany and Denmark which, together with the gas storage facilities, provides the requisite flexibility in the system to supply Danish and Swedish gas consumers. However, it is a condition that the market players make optimal use of the capacity of the gas storage facilities and Ellund during the redevelopment period.

Energinet has updated the analysis of the supply situation with the Danish Energy Agency's new forecasts for Danish gas consumption in the period 2018-2040 (Analysis Assumptions 2018). It appears from the Analysis Assumptions 2018 that consumption has been reduced by 200-300 mcm/year in the period in which the Tyra complex is redeveloped compared with Analysis Assumptions 2017. This results in an improvement of the supply situation outlook during the redevelopment period compared with Energinet's analysis of the supply situation from August 2017.

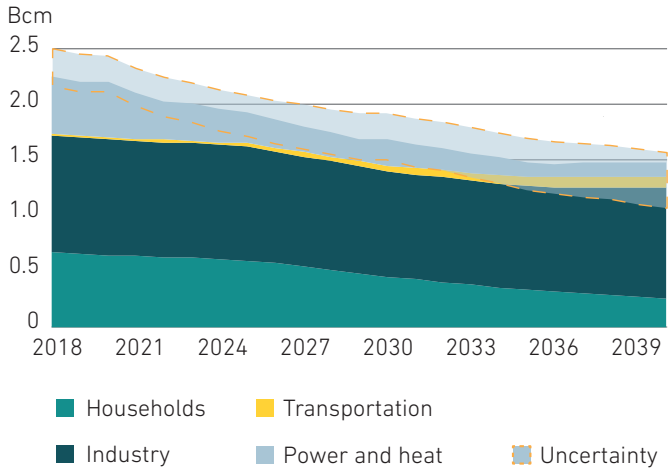
Today, the security of gas supply is very high, and after the redevelopment of the Tyra complex in 2022, the security of supply is expected to be just as high as today.

4.3 Development in consumption in Denmark and Sweden

The total natural gas, biogas and biomethane consumption in Denmark, excluding production consumption in the North Sea, is expected to decrease to approx. 1,700 mcm in 2030. Natural gas consumption in Denmark is expected to decrease to approx. 1,300 mcm in 2030. Consumption of biogas and biomethane is expected to increase from the current level of approx. 300 mcm to approx. 400 mcm in 2030.

[5] The supply situation outlook 2018-2040 is based on the Danish Energy Agency's Analysis Assumptions and North Sea forecasts from 2018.

FIGURE 9: EXPECTED GAS CONSUMPTION DISTRIBUTED ON APPLICATIONS, 2018-2040



Note: Industry includes the service industries and comprise gas for heating and process heating.

4.3.1 Development in consumer segments

Gas consumption for electricity generation and heating is expected to continue to decline. The declining gas consumption is driven primarily by the cancellation of the basic amount paid to local CHP plants by the end of 2018, which is expected to result in the decommissioning or conversion of CHP plants to biomass or heat pumps.[6]

Consumption for individual heating systems is expected to decline by approx. 33% until 2030, due to energy savings and conversion to alternative heating sources, and by a further 66% up until 2040. Gas consumption by industry 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. However, the growth in gas consumption is expected to be smaller at the end of the period as a result of increased electrification. In relation to the security of gas supply report from 2017, the expectations for the growth of gas in the transport sector are more modest. The expected development is, however, subject to considerable uncertainty.

Swedish consumption of natural gas 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, but Denmark is expected to remain Sweden's primary source of natural gas supply.

Natural gas consumption in Sweden is expected to reach a maximum of approx. 800 mcm in 2018. In the period 2017-2025, consumption is expected to be approx. 900 mcm per year. Based on the Danish Energy Agency's Analysis Assumptions 2018, gas consumption in Sweden is expected to decline after 2025 in line with Danish consumption.

4.3.2 Sensitivities in gas consumption

Any assessment of future gas consumption is exposed to uncertainty. The range for gas consumption has been assessed based on a number of sources, including Energinet's System Perspective 2035 scenarios for 2035 and 2050, which describe a number

[6] The projection for the electricity and district heating sector, individual heating, industry and transport comes from the Danish Energy Agency's Analysis Assumptions 2018.

of alternative developments for the whole energy system with different focus on the green transition and the use of electricity and gas in various sectors.

The assessment is that gas consumption in a normal year in 2030 could vary by +/- 250 mcm compared to the key estimate. This means that the range of possible outcomes is about 500 mcm.

Trends which may result in lower gas consumption: A larger share of gasfired CHP plants changing operating patterns or closing down; conversion to biomass and electricity in the process industry; faster reduction of natural gas consumption for heating; recession and outsourcing 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 gas-fired combined heat and power, for example higher CO_2 and electricity prices.

4.4 Gas market development

4.4.1 Joint balancing zone with Sweden in 2019

In 2018, Energinet and the Swedish gas TSO Swedegas decided to merge the Danish and Swedish balancing areas from 1 April 2019. This is based on detailed analyses of the prerequisites for balancing and trade.

The project is in line with EU efforts to harmonise the markets, and will increase regional security of supply in Denmark and Sweden, as increased linepack in the Swedish system is a prerequisite. There will thus be more gas available in the system for supplying Danish and Swedish gas customers.

Shippers have been involved in the process to a great extent, and they support the development. The Danish Utility Regulator must approve the method for the joint balancing zone and will make a decision in the first quarter of 2019.

4.4.2 Market initiatives during the redevelopment of the Tyra complex

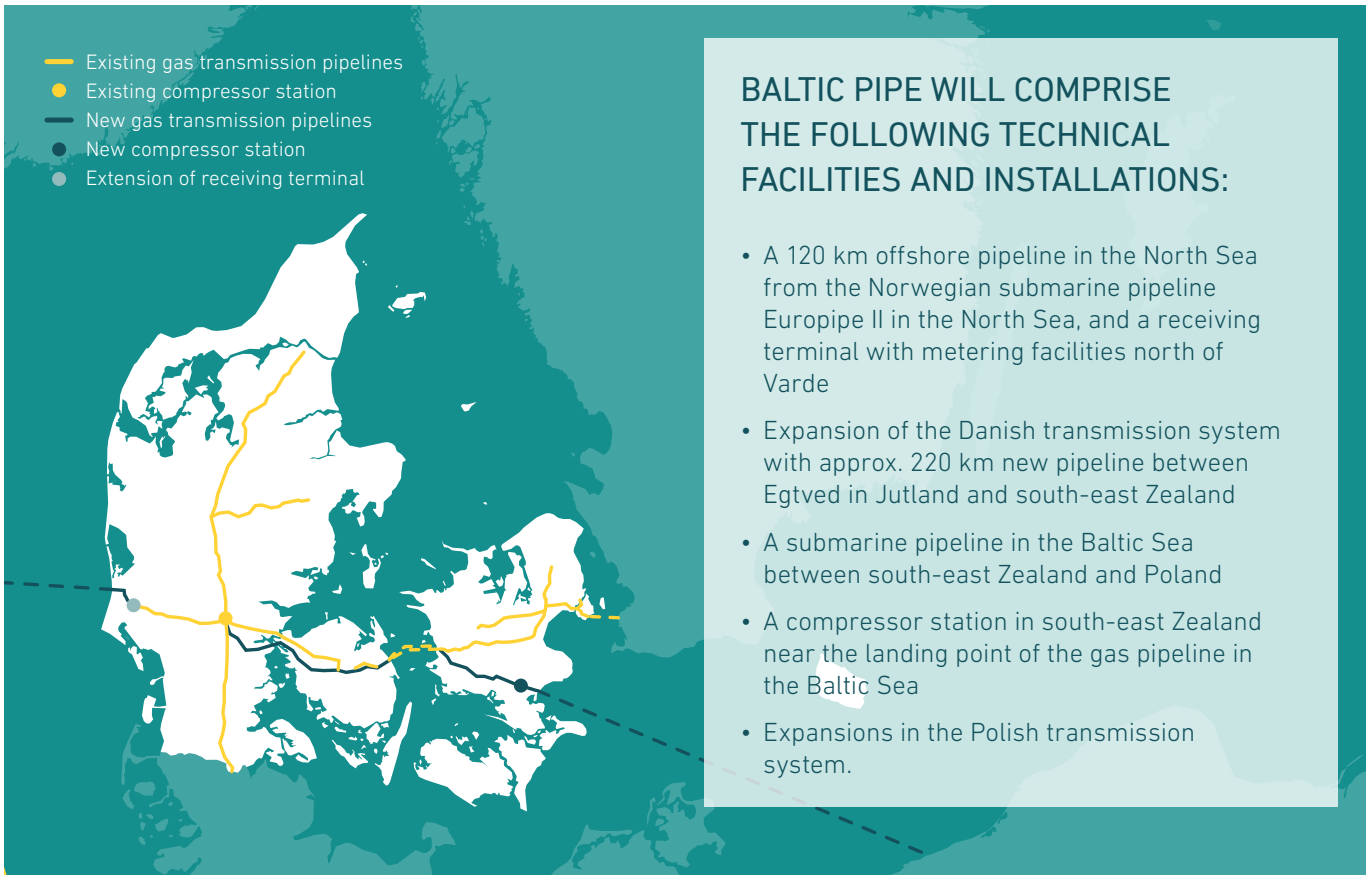
In the course of 2017 and 2018, Energinet has discussed, via a number of User Groups and bilateral meetings, how gas supplies to the market can be safeguarded when gas production from Tyra stops in autumn 2019 and with operations not being expected to be resumed until in mid-2022.

It has been a fundamental view among the market players that the market must be able to act in the same way as today to the greatest possible extent and that measures interfering with the market can only be used in a crisis situation. This fundamental view is greatly reflected in the market measures adopted by Energinet, where most of the measures can be regarded as general improvements.

The market measures can be grouped into three categories:

- Communication
  - -Day-by-day display of the supply situation for the relevant season in a fixed graph online (called Minimal Storage Filling)
  - 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 options for shippers to trade secondary capacity on PRISMA
  - Introduction of an 'overnomination' mechanism, so that shippers can nominate, without booking capacity first
  - 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 the imbalance price if there is an imbalance on the entire market on a given day
  - New mechanism for calculating the imbalance price in the event of an emergency supply incident.

In addition, Energinet is looking at a possible new method for purchasing commercial interruptible consumers as well as a new concept for purchasing



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.

filling requirements, in cooperation with Gas Storage Denmark.

4.5 Long-term development of Danish gas infrastructure

In Energinet Gas TSO, work is done on grid planning aimed at economically efficient development of the transmission system and with focus on solutions that can be used now and in the long run. With this regard, it is important that the solutions create as much value as possible for the gas system. In order to ensure timely and effective development of the transmission system, there is also a need to focus on the overall gas system.

4.5.1 International infrastructure projects

Energinet Gas TSO arbejder på to internationale projekter: Baltic Pipe-projektet og North Sea Wind Power Hub-projektet, som er et udviklingsprojekt.

4.5.1.1 Baltic Pipe

Together with the Polish TSO, GAZ-SYSTEM, Energinet has commenced the work on the so-called Baltic Pipe project. The Baltic Pipe project is a new gas transport route which makes it possible to transport up to 10 bcm 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.

In March 2018, Energinet's Board of Directors approved the business case for the Baltic Pipe project. The Danish Minister for Energy, Utilities and Climate is expected to make the final investment decision regarding the project before 1 December 2018. If approved, the project must be completed before October 2022.

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

Access to Norwegian gas is positive 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 support from the EU, for example for preparatory work. The Baltic Pipe project has already benefited from this.

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

4.5.1.2 North Sea Wind Power Hub

The North Sea Wind Power Hub (NSWPH) 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. A consortium has been set up for the purpose of examining potential new offshore wind power solutions by combining grid connection of offshore wind turbines with interconnections via so-called hubs between the North Sea countries. Energinet Electricity System Operator has participated in the consortium since March 2017 together with the Dutch and German electricity TSO TenneT. At the end of 2017, Energinet Gas TSO, the Dutch gas TSO Gasunie and the Port of Rotterdam also decided to join the consortium. Other players in the North Sea region have expressed an interest in joining the consortium.

Energinet participates in the development project for two principal reasons. 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. Secondly, to assess the prospects for a possible Danish electricity transmission connection to a wind hub in the North Sea and the potential positive effects of coupling the gas transmission grid via Power-to-Gas (PtG), for example in the form of reduced infrastructure costs and the green transition of e.g. heavy industry and transport. The cooperation will, in its present form, continue until June 2019, and is non-binding in relation to any future construction project. A decision on possible continued cooperation and commitment from Energinet after June 2019 will have to be based on the overall analyses and calculations and their prospects.

4.5.2 Green transition

In line with the establishment of more biogas plants 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 low. In some cases, this is handled by connecting distribution grids, while, in other cases, there is a need to be able to return gas to the transmission grid 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) in order to be transported in the transmission system.

Today, biogas injection points have been established at Aalborg and St. Andst M/R stations. It is expected that there will be a need to inject gas back into the transmission grid at another three M/R stations: Midtfyn, Viborg and Terkelsbøl. Each project will be implemented in close cooperation with the distribution companies.

4.5.2.1 Cooperation with distribution companies

Energinet Gas TSO and the distribution companies have established cooperation aimed at cross-sectorial cooperation in the Danish gas system; from connection of gas producers to operation of Energinet's transmission system. There is also a focus on changes in the surroundings which affect the gas system, to ensure that the system can handle the issues and exploit the opportunities that it will face in the future.

One of the central topics in the cooperation is the increased need to return

gas to the transmission grid. The return of gas creates a number of new challenges that need to be addressed. 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 to be able to remove odorant[7] from the gas before it is transported into the transmission grid. 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.

A trend which Energinet Gas TSO must include in the future cooperation is that the development in gas consumption has been declining over the past ten years. The decline in gas consumption, combined with an increase in the volume of biomethane in the distribution system, means that many of Energinet Gas TSO's assets are about to reach a point at which the capacity is too large in relation to the demand that they are to cover. Therefore, it is important to analyse the future gas system demand, to ensure that resources are not used to maintain and operate a grid that is not commensurate with the actual demand.

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 2016, Energinet Gas TSO became certified under the ISO 55001 Asset Management system and must be recertified in 2018. In order to be certified, Energinet 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.

This means that, in addition to meeting the current statutory maintenance requirements, we have a condition-based approach to the maintenance of our assets. The latter entails a riskbased approach because technical faults in plants and facilities may have major consequences for system operations. The condition assessment is based on the condition and age of the plants and facilities and their importance to system operations.

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

4.5.2.2 Oxygen from biogas in the gas grid

Upgraded biogas injected into the gas system contains a higher level of oxygen relative to natural gas. Oxygen is a byproduct of sulphur removal in the biogas upgrading process. The allowed oxygen content in the gas must is regu-

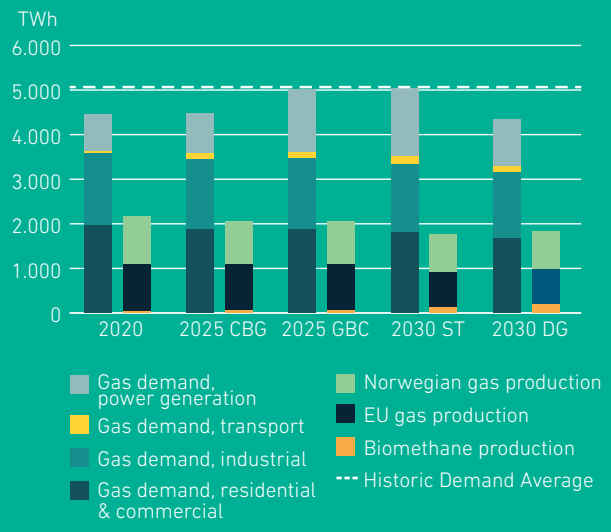
[7] Odorant is an odorous substance which is added to the gas when it is led from Energinet's meter and regulator (M/R) stations out into the distribution system. The odorant is added for safety reasons, so that any gas leaks can quickly be detected by persons in the vicinity.

LONG-TERM CONSUMPTION AND PRODUCTION IN THE EU

Demand
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 2010-2016.

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 2017 that Europe's own natural gas production will come to just under 110,000 mcm in 2018. Own production is expected to decline to just over 40,000 mcm in 2040. This will probably increase the need for imports to the European gas market.

CONSUMPTION AND PRODUCTION IN THE EU



Note: The figure is based on data from the ENTSOs TYNDP 2018 Scenario Report from 2017. The pillars refers to different scenarios: CBG Coal Before Gas, GBC Gas Before Coal, ST Sustainable Transition and DG Distributed Generation.

lated primarily in national rules and standards, and as a consequence may vary between countries.

In Denmark, the oxygen content in biogas injected into the gas grid must not exceed 0.5%. In Germany, the oxygen content depends on the gas pressure and if there is oxygen sensitive installation connected to the gas grid, such as gas storage facilities, where oxygen potentially can increase the risk of corrosion in gas installations with water. Today, where the amount of biogas injected into the gas system is increasing, different requirements to the oxygen content is a challenge for gas exported to Germany, where the storage facilities in Northern Germany do not accept gas with an oxygen content above 0.001% (10 ppm).

Due to the expected injection of biogas into the transmission system, it will be difficult to meet the German requirements for the oxygen content of the exported gas, after commissioning of the Tyra complex in 2022. Therefore, Energinet is working on a flexible European gas quality solution, together with European partners, which ensures the continued expansion of green gases without compromising the well-functioning internal gas markets in the EU. Concurrently, Energinet is looking into various operational solutions in a close dialogue with Danish stakeholders and the North German TSO, Gasunie Deutschland.

4.6 Infrastructure in Europe

Every two years, ENTSOG publishes a Ten Year Network Development Plan (TYNDP). The plan provides an overview of the long-term challenges for the European gas system up until 2035. The TYNDP analyses the security of supply and the development on the European gas market.

The most recent network development plan was published in April 2017 (TYNDP 2017). ENTSOG is already working on the next plan (TYNDP 2018) as the ENTSOs for electricity and gas (ENTSO-E and ENTSOG) are to follow the same schedule for TYNDP in the future.

Prior to the next TYNDP for electricity and gas, respectively, the ENTSOs have worked together to develop common 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.

4.7 Tariffs for use of the transmission system

Energinet's finances are based on a break-even principle.

This means that income and expenses must balance. Differences in income and expenses are called excess revenue and deficit and are generally transferred to the budget for the coming year. Most of the income is collected through tariffs.

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

4.7.1 Transport tariff – current method
In 2016, Energinet obtained approval of an adjustment to the tariff method, which entered into force from gas year 2017/2018. The capital costs for the Ellund-Egtved expansion are distributed as follows on the different points:

- One third of the capital costs for the compressor are allocated to the Ellund entry point.
- One third of the capital costs for the compressor and two thirds of the pipeline looping are allocated to the exit zone and Dragør exit.
- One third of the capital costs for the compressor and pipeline looping are allocated to the emergency supply tariff.

Transport tariffs have risen in recent years. This is due to the inclusion of lower excess revenue and smaller volumes of transported gas compared to previous years. Transport tariffs are expected to continue to rise in the long term if the volumes of transported gas continue to decline. If the Baltic Pipe project is realised, larger volumes of gas in the Danish gas system will contribute to stabilising consumer transport tariffs.

4.7.2 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 non-protected customers – as there are differences in the security of supply for the two customer groups in an Emergency.

The overall cost of measures which can be used in an Emergency will be allocated between protected and non-protected customers in a ratio of 80/20. The emergency supply tariffs will still be different for the two customer types. The weighted emergency supply tariff was 0.00047 DKK /kWh in the 2017/2018 gas year, and is 0.00324 DKK /kWh in 2018/2019.

4.7.3 Transport tariff – coming method
The European tariff network code was published in mid-March 2017. The aim is to strengthen the internal gas market by harmonising tariff methods across national borders, increasing transparency and reducing transaction costs for consumers. The tariff method will still support a competitive Danish gas transmission system.

Energinet will further develop the current tariff method in compliance with the tariff network code in 2018. Energinet Gas TSO expects to submit the tariff method to the Danish Utility

Egtved

Regulator by the end of 2018, in which it is proposed that the tariffs will be uniform, which means that the same tariff will be charged for all points. The new method is expected to be implemented on 1 October 2019.

4.8 Information security

Increased use of IT has created major development opportunities in the energy sector, both in terms of business and technology. The use of IT is one of the most essential preconditions for the ability to operate a cost-efficient 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 supply-critical IT systems and training situations where systems are unavailable. Various system tests, controlled hacker attacks and information campaigns have been regularly conducted internally at Energinet.

ENERGINET

Tonne Kjærsvej 65
DK-7000 Fredericia
Tel. +45 70 10 22 44

info@energinet.dk
www.energinet.dk