



ENERGINET



REPORT

SECURITY OF GAS SUPPLY 2019

GLOSSARY

Degree days:

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

Gas year:

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

Nm³:

One Nm³ (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.

SUMMARY

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

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

Security of supply during the renovation of the Tyra complex

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

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

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

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

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



Lille Torup Gas Storage Facility

Operations and infrastructural adaptations

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

storage facility, which means that the withdrawal capacity is increased by 15 % for use in extreme situations.

Capacity bookings to Germany

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

Assessment of the Danish security of gas supply for the coming winter

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

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

Closer connection to the European gas market

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

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

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

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

Access to new markets in the EU – Baltic Pipe

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

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

Green transition of gas system

The share of green gasses in the grid has grown rapidly in both 2018 and 2019. This is a continuation of the development where the biogas capacity that has been established over the past five years is equivalent to the accumulated capacity of the past 30 years. The gas system is thus

increasingly becoming a part of the green transition, and biogas is now also contributing to the general security of supply.

One day in the summer of 2019 biogas injected in the gas grid constituted 35 % of the total gas consumption in Denmark. This measurement was registered on July 13th and is thus the record of the year, when you look at the added biogas to the grid in relation to the Danish gas consumption. The amount of biogas injected into the gas network will in the future constitute a growing proportion of the Danish gas consumption. Energinet has several projects concerning balancing the grid between distribution and transmission as a result of the increased number of biogas plants which adds gas to the grid.

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

THE TIME AFTER TYRA IS PROCEEDING AS EXPECTED

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

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

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

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

Good preparation and few faults

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

- This is the first time the station really is in operation as we have not had many hours of operation until Tyra closed. In fact, it is going better than we had expected. We have delivered what

is required, says Per Stangholm Jakobsen, head of department in Operation and Maintenance of the compressor station.

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

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

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

High-price area with import

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

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

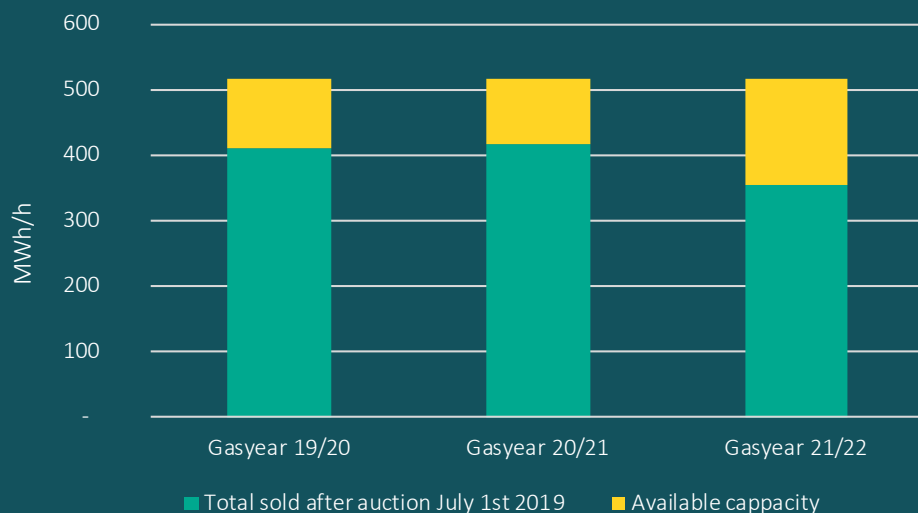
The biting cold, which extended the winter of 2018 well into March, resulted in an unexpected rehearsal of the uncertainty about the supply, as Energinet had to issue an Early-warning message to the gas market: a direct message to market players to retrieve more gas to Denmark.

Hope for a milder winter

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

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

Capacity from Germany to Denmark



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



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BIOGAS IS NO LONGER A PARENTHESIS IN THE GAS SUPPLY

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

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

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

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

At the end of 2019, biogas injected in the gas grid amounts to more than 11 % of the gas consumption in

Denmark. It is particularly in northern, central and western Jutland that the existing 35 biogas plants are located. Plants that are currently the backbone of the green gas paradigm shift and distributes the CO₂-neutral gas to the local grids.

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

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

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

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



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

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

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

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

- Together with the distribution company Evida, we are looking at several possibilities, e.g. connecting some of the distribution grids, so that a slightly larger local area can be used to

purchase the gas before it is elevated in central locations and moved away. We need to think it through and find the most socio-economically sound solution for the future infrastructure.

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

Variations in oxygen limits challenge the gas flow

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

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

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

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

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

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

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