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History of development and gas industry features in Norway and the Kingdom of the Netherlands

Abstract. The article presents an overview and analysis of data from two leaders on natural gas fields in Europe: Norway and the Netherlands. Particular attention is paid to the history of the development of the Kingdom's gas markets and its influence on the formation of this industry in the European Community and in the world. The largest fields are Troll and Groningen, they are considered, as well as the little-known small fields that are currently open. The development of oil and gas resources on the Norwegian Continental Shelf has gone in different ways since the start of the first commercial production of hydrocarbons in 1971. Some results on the development of the industry in countries have been summed up.

Keywords: European gas market, natural gas, Netherlands gas, Norway gas, gas export, Groningen field.

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The study is addressed to the topic of the gas sector of two leading gas producing countries in Europe. These are Norway and the Kingdom of the Netherlands. These countries are the largest producers and exporters of natural gas in Europe.

Table 1

Statistical survey of the world leaders in gas production in the world for 2017

Country	Production volume rating, billion m2.	Percentage of production among leading countries	The largest gas fields	Geographic location
USA	762	29,82	Gulf-Coast	Texas
Russia	649	25,40	Urengoiskeye, Bovanenskoye	West and East Siberia
Iran	238	9,32	SouthPars	Persian Gulf
Canada	184	7,20	Rainbo-Lake	Newfoundland island
Qatar	163	6,38	NorthPars	PersianGulf
PRC	143	5,60	Dazhou	South-West China
Norway	127	4,97	Troll-West	NorthSea
Saudi Arabia	115	4,50	Ghawar	PersianGulf
Algeria	94	3,68	Hassi-R`Mel	NorthofAfrica
Turkmenia	80	3,13	Galkynysh	South-EastofTurkmenia

Note: compiled by the author, based on statistics <https://www.ceicdata.com/en/indicator/natural-gas-consumption> (reference date 20.10.2019)

As it can be seen, from the table 1 below, Norway is in the top ten countries. At the current stage, the Kingdom of the Netherlands is not in this list, but back in 2013 and earlier this indicator was at around 85 billion cubic meters gas production per year [5].

In 2017, Norway reached a record level of gas production for its country, thereby standing on the 7th line of the lead countries on gas production. [11] According to the forecasts of the Norwegian

Petroleum Administration (NPD), in this volume production will be stable until 2025 and then decrease to 90 billion cubic meters in year. It is concluded that the latest changes in forecasts reflect a confident assessment of the resource base and numerous options for the development of new gas fields in existing fields. The risk of non-compliance with updated forecasts until 2027 seems to be low. After 2027, forecasts carry an increasing degree of geological, economic, and political risk, especially in a frame of the recent lack of success in exploration.

The development of oil and gas resources on the Norwegian Continental Shelf (NCS) has gone in different ways since the start of the first commercial production of hydrocarbons in 1971. In the early years of offshore operations, the development of gas resources was constrained by market and political considerations [2].

In May 1963 The Norwegian government proclaimed the sovereignty of the Norwegian Continental Shelf (NKS), according to this, all the natural resources of the NCS are owned by the state and only the government can issue exploration and production licenses.

In 1971, the Frigg gas field was discovered on the border between Norway and the United Kingdom. And already in 1972, the Norwegian government took a number of measures to regulate the oil and gas sector.

The Norwegian Petroleum Directorate is set up to manage the oil business and the state-owned company Statoil. The state share is 62%. Statoil was assigned the right to have 50% of all future licenses. The maximum annual oil and natural gas production was also established.

Gas production began in 1977 at the Ecofisk and Frigg fields, but these fields are rapidly draining, so there were no long-term contracts with buyers from continental Europe and the UK [3]. The search for new fields was also due to a government ban on offshore gas burning. A decision was made - the search for European buyers willing to make long-term commitments, if necessary, build and finance a new export pipeline infrastructure.

Difficulties in developing gas resources were finally overcome by the discovery and appraisal of the giant Troll field in 1979–83 and the conclusion of new gas sales agreements on the continent between 1986 and 1990[4].

However, since January 1985, government participation in the oil and gas sector has undergone changes. Now the state's share varies depending on field.

Since the 70s, oil and gas have been produced at 106 fields. At the end of 2018, production was carried out at 83 fields, of which 63 in the North Sea, 18 in the Norwegian and 2 in the Barents Sea of gas in Norway: Troll Complex, Ecofix, Snorr, Drogen, Ozberg, Ormen Lange, Osgard, Kvitebjorn and Aasta Hansteen. At the end of 2019, it is planned to begin production at the new Johann Sverdrup field.

For the first 25 years, oil dominated the development of new fields and oil production at the oil and gas complex. However, since 2000, when oil production peaked, gas production increased dramatically [10].

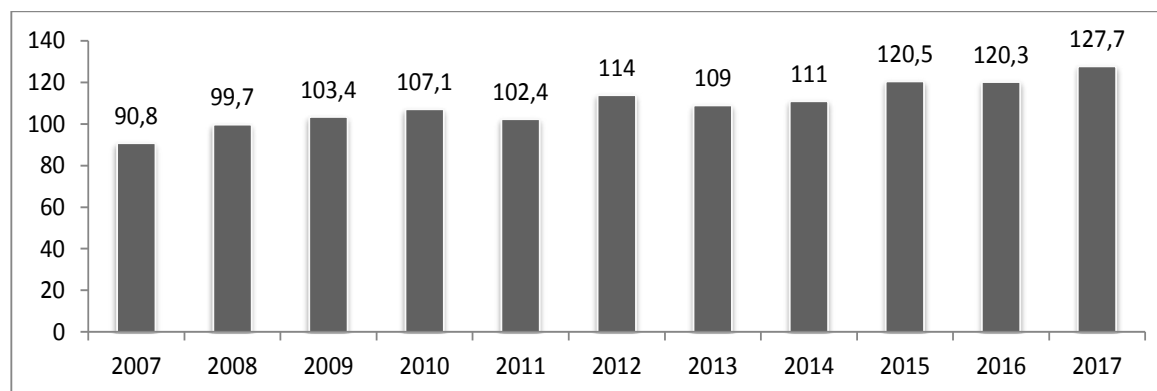
The Troll produced its first gas in 1996 and provided a solid foundation for the further development of offshore gas resources.

Between 1995 and 2005, dry gas production tripled from 29 billion to 86 billion cubic meters, as large fields such as Troll, Sleipner and Åsgard were commissioned to serve long-term volume contracts and meet the growing demand for natural gas. These fields are the main ones, with the addition of small volumes of associated gas from fields in the North and Norwegian Seas.

In 2007, Equinor ASA was formed as a result of the merger of Statoil with the NorskHydro oil and gas division. Equinor ASA is currently a multinational energy company with headquarters in Stavanger and a 67% state share. Major international concerns such as ExxonMobil, ConocoPhillips, Total, Shell, Eni and others in partnership with Equinor ASA are participating in the development of Norwegian fields.

Norway sells 95% of its natural gas through pipelines and only 5% is sold as liquefied

natural gas. Although already in 2007 the first natural gas liquefaction plant has already built on the island of Melkoya, which today is one of the largest LNG export terminals in Europe.



Picture 1 - Natural gas production in Norway 2007-2017 (billion cubic meters)

Note: compiled by the author according to <https://www.ceicdata.com/en/indicator/norway/natural-gas-production-opec-marketed-production>

As it can be seen from the diagram above, in 2007, natural gas production amounted to only 90 billion cubic meters. Since 2012, net gas production has accounted for about 50% of total offshore oil production. But it was precisely during the period of lowering oil prices, in 2015-17, that the government drew attention to the developing market for gas, emphasizing the importance of gas export. While the government does not divide net cash flows between oil and gas.

Since the peak of oil production, the share of export revenues from gas has been steadily increasing from 20% to almost 50% in 2015-17. It is justified to conclude that lower volatility of gas-related revenues may provide some advantages when it comes to forecasting the state budget.

The realization of set prices in energy equivalent is 50-70% of the cost of crude oil, but the cost of production, including the cost of transportation through the pipeline, is also usually lower.

Therefore, companies began offshore production from oil. And they produced gas for later sale. To conserve gas resources to enhance oil recovery and produce gas for sale at later stages of the field's operation.

Thus, the goal of maximizing the economic value of the combined oil and gas resource base is more likely to be achieved in the long term.

All licensees on the Norwegian continental shelf are responsible for the sale of their own gas. In the NCS, there are about 40 shared gas producers, each of which has the right, at its discretion, to determine how, where and to whom it sells its products.

About thirty of these manufacturers are registered shippers in the gas processing and pipeline transportation system, which gives direct access to the traded central markets.

However, in volume terms, gas marketing is largely concentrated in Statoil, which from 2010 to 2017 accounted for 70-85 billion cubic meters per year, or 70-80% of the total pipeline gas sales from the shelf.

Statoil is the operator of the Troll and Asgardfields; Ormen Lange is managed by Shell company.

Petro is not a licensing operator, and all of its oil and gas is sold to Statoil in accordance with the "marketing instruction" adopted by the government in 2001, which gives Statoil a high degree of marketing discretion, but also controls it by Petro.

Statoil did not disclose the details of its derivative contracts for sale, but since 2011 the company has provided a limited summary of its annual supply obligations for the next four years arising from existing long-term contracts. These obligations are met through the supply of gas

from a joint portfolio of gas resources owned by Statoil and SDFI.

In 2017, Statoil also reported that more than half of gas sales (> 35-40 billion cubic meters) were carried out under long-term contracts with “take or pay” exception. Most likely, a significant part of Statoil’s sales (possibly 10-15 billion cubic meters per year) is currently carried out under short-term bilateral contracts for a period of one or two years, signed closer to the beginning of the delivery period.

Table 3

The growth rate of natural gas exports in Norway, for 2008-2017, as a percentage terms

Year	Export cubic meters	%
2008	85 135.000	100,00%
2009	93 052.000	109,30%
2010	99 136 .000	116,45%
2011	100 544.000	118,10%
2012	111 867.000	131,40%
2013	106 596.000	125,21%
2014	106 759.000	125,40%
2015	114 200.000	134,14%
2016	114 373.000	134,34%
2017	122 485.000	143,87%

Source: compiled by the authors according to the statistics <https://www.ceicdata.com/en/indicator/norway/natural-gas-exports>

According to the table 3, it can be seen that over the study period, there is an increase in the volume of natural gas exports by 43% in 2017 compared with 2008.

It is important to note that some of the income is deferred. These are state contributions to the state pension fund or the Oil Fund, the world’s largest sovereign wealth fund, currently amounting to \$ 1 trillion.

The recovery in rising gas demand, the loss of fluctuations and flexibility in Northwest Europe since 2016, and the new investments in NCS gas projects have given Norwegian industry much confidence that recent production will be sustainable until at least 2023.

However, in recent years, the Norwegian oil and gas industry has faced an acute domestic political problem from proponents of tightening restrictions on offshore hydrocarbon activities for local environmental reasons and from proponents of climate change seeking to curb further offshore development.

The new coalition agreement reached in January 2018 includes provisions that illustrate the current, more controversial political issue for offshore operations. Major parties continue to support further offshore exploration and the oil and gas industry, but the leading parliamentary party does not allow further expansion of open sites.

The environmental problem is acute for European gas exporters, an example is the situation in the Netherlands.

At the end of 2017, the share of production in the Netherlands was more than 43 billion cubic meters. However, back in 2013 and earlier, this indicator was at around 85 bcm. in a year. The country was a major producer and exporter of natural gas in Europe. When in the post-war years and in a later period, exploration works of natural resources began, then in the course of geological studies it was found that carbonaceous coal fieldswere the main rocks of the Netherlands.

For the first time in 1948, gas was discovered in eastern Holland near the Coevorden village. The developer of the field was the Dutch company NederlandseAardolieMaatschappij BV (NAM), and in 1951 gas production began from this field.

A few years later, namely in 1959, the Groningen gas field was discovered in the country, the developer of which is also NAM. This is one of the largest gas fields in the world.

Initial reserves were 1960 bn.m³. The first production from this field was made in 1963. Since the discovery of this field, natural gas production has become one of the most important sectors in the country's economy [9]. Natural gas has become the main used energy resource not only in the Netherlands, but also for the neighboring countries of Germany, Belgium and France.

In the following years, gas fields were explored and discovered not only on land, but also on the sea shelf.

In the Table 4 below shows natural gas fields located in the Kingdom of the Netherlands. They are arranged in chronological order and with an indication of the developer.

Table 4

Natural Gas List of the Kingdom of Netherlands

№	Name	Production start	Developer	Type	Notes
1	Groningen Gas Field	1963	NAM	Gas	Discovered in 1959. Maximum production per day – 350 bn cub m.
2	F4,FA gas Fields	2009	Centrica	Gas	Discovered in 1971.
3	F4B,K5A Gas Fields	1994	Total	Gas	Discovered in 1974.
4	Netherlands Joint Development Area Gas Fields	1975	NAM	Gas	Discovered in 1975. Includes more than 50 fields, 28 of them are involved.
5	L04A Gas Fields	1981	Total	Gas	
6	De Ruyter Oil Field	2006	Dana Petr.	Oil/gas	Discovered in 1996.
7	A and B Blocks Gas Fields Development	2008	Chevron	Oil/gas	There are 2 licenses for geological exploration; 5 production licenses
8	Medway Oil&Gas Fields Development	2012	Dana Petr.	Oil/gas	It was received the permission in 2010to conduct development.
Note: compiled by the author					

As it can be seen from the table 4, in addition to the largest Groningen field, there are more than 80 small open fields, some of them mixed, oil and gas fields.

Natural gas produced at the Groningen gas field qualifies as L-gas, which refers to low-

calorie gas. The qualification of natural gas, both low-calorie and high-calorie, depends on the Wobbe index of the gas. The Wobbe index indicates the thermal value of gas (Klimstra, 1986). A gas with a low calorific value contains a higher percentage of nitrogen and a lower percentage of methane than high-calorie gas, resulting in a lower Wobbe index. Therefore, the amount of thermal energy stored in a unit of low-calorie gas is lower than in the same unit of high-calorie gas.

The Groningenstal field has a higher nitrogen content (14.2%) compared to other European gas sources such as Russian or Norwegian gas (about 2%) [6]. Thus, L-gas must be further processed before being delivered to the final consumer.

The complexity of gas production is reflected in the so-called marginal production costs. If the price to be received for natural gas is lower than these marginal-extraction costs, production will be unprofitable (or the producer will not produce at all). The marginal cost of the Groningen field is among the lowest in Europe. In addition, the level of production in Groningen is not regulated by time. This makes it possible to change the output signal level in accordance with market conditions. In other words, it is possible to increase production when demand/price is high, and to reduce production if demand/price falls.

The Groningenstalfield is mainly used in time of high demand. Thus, gas from this field was supplied to North-Western Europe, which ensured maximum income. Revenues from this huge reservoir of natural resources contributed greatly to the economic welfare of the Netherlands in the second half of the 20th century. In the 1980s, the share of gas revenues in total government revenue peaked at 15%, but currently this contribution is gradually decreasing to about 2%.

To develop the Groningen field, very large investments were required, which required state support in the construction of infrastructure for gas production and transportation. The state needed to return the invested funds, in connection with this, a new type of “take-or-pay” contract was invented, and the price of gas was linked to the price of oil. These were long-term multi-year contracts for the purchase of a certain amount of gas. The gas price in these contracts was reviewed quarterly, and if the buyer did not buy all the gas, then penalties were applied to him. Thus, the state ensured the stability of gas sales and the return on invested money.

Thanks to discovery of the Groningen field and its development, the natural gas market of Netherlands began to develop rapidly. However, during the years of the discovery of the Groningen gas field, the Netherlands government’s policy was aimed at ensuring gas supply for 25 years and at the quickest depletion of the Groningen field, since it was believed that nuclear energy would be the thing of the future [7].

However, over time, the state’s energy policy has changed, the oil crisis has shown the strategic importance of natural resources. This caused the changes in energy policy. The Groningen field has become a strategic reserve that must be preserved. Therefore, in 1974, the concept of *Kleineveldenbeleid* was introduced, which is the technology of production in small fields. Thus, the current developer (operator) of the Dutch state-owned company Gasunie committed to buy gas from small fields instead of Groningen. (Gasunie was transformed into GasTerra in 2017).

Such a policy has led to an increase in profitability from small fields. This made it possible to reduce production growth at the Groningen field and reduce the rate of depletion of this field. Until the beginning of 2000, the maximum allowable natural gas production of all gas fields in the Netherlands should not exceed 80 billion cubic meters. At the Groningen field, the maximum allowable production was defined as the difference between the total volume of 80 billion cubic meters and the actual production of smaller fields.

However, as practice has shown, the depletion of smaller fields occurs rather quickly, so since 2006 a long-term marginal production volume from the Groningen field has been set. So the maximum volume of natural gas produced was set at 425 billion cubic meters, with no annual limit. This means that in the period from 2006 to 2015, the total gas production should not exceed

the limit of 425 billion cubic meters, and the size of the annual production remains at the discretion of the developer (operator) of the field.

Despite the measures taken, the situation with the Groningen field has worsened due to seismic activity that is not typical for this region. After careful research, the relationship between gas production and earthquakes was established. And after the 2012 earthquake near Haisinge, the Dutch government revised production restrictions. A new restriction was introduced - natural gas production should not exceed a certain annual limit. In 2015, an annual limit of 27 billion cubic meters was introduced. In 2016, the permitted volume was 24 billion cubic meters, in 2017 - 21.6 billion cubic meters, in 2018 the permitted production volume was 21 billion cubic meters, in 2019 the limit was set in the amount of 19 billion cubic meters. Thus, by 2022, production should be reduced to 12 billion cubic meters.

Earlier, the government planned to shut down completely and stop production from the Groningen field by 2030. However, a strong earthquake in January 2018 forced the government to reconsider plans to close the Groningen field and set a new date for the cessation of natural gas production by mid-2022.

The country's economy has become very dependent on gas production. This effect is called the "Dutch disease" [8]. As a result, the Netherlands, once three largest natural gas producer in the European Community and the main center for gas trade and transportation in Europe, became a net importer of gas in 2018.

Table 5

The growth rate of natural gas exports in Netherlands, for 2008-2017, as a percentage terms

Year	Export cubic meters	%
2008	60088000	100,00%
2009	55593000	92,52%
2010	57751000	96,11%
2011	55851000	92,95%
2012	60411000	100,54%
2013	66668000	110,95%
2014	58661000	97,63%
2015	50962000	84,81%
2016	56597000	94,19%
2017	48017000	79,91%

Source: compiled by the authors based on statistical data.
<https://www.ceicdata.com/en/indicator/netherlands/natural-gas-exports>

According to the table 5 it can be seen that during the study period there is a decrease in the volume of natural gas exports.

Until 2002, various legal regimes were applied to regulate relations in the natural gas market in the Netherlands, depending on the location of the field. One regime for onshore is territories, including territorial waters up to the border of 3 miles; and for offshore (offshore) - the Dutch part of the continental shelf [1].

Ground mode was regulated by:

- Napoleonic Mineral Extraction Act of 1810 (Mijnwet 1810) in its original French text, the authorized translation of which is not available (vestiges of the French occupation);

The Mining Act of 1903 (Mijnwet 1903), with amendments which were added in 1988, on

which the mining regulations of 1964 are based (Mijnreglement 1964);

- The Mineral Exploration Act of 1967 (Wetopsporingdelfstoffen 1967) with amendments which were added in 1988.

The offshore mode was regulated by:

- Act on Mineral Extraction on continental shelf of Netherlands of 1965 (Mijnwetcontinentaalplaat)

- Regulation on mining 1967 (Mijnreglement 1967).

In the 1990s, European energy markets were liberalized. The goal was to stimulate competition, which was supposed to lead to lower energy prices[12].

In 2002, the Mining Act was adopted (Mijnbouwwet 2002). This law included the regulation of mining in both offshore and onshore.

According to this legislation, the Dutch state is the owner of all natural resources and minerals located at a depth of 100 meters. According to Mijnbouwwet 2002, the Dutch government can transfer production under agreement on the cession of rights. On the basis of this agreement, the concessionaire (to whom the rights were assigned) has a monopoly on resources and minerals and their income (Article 143.2 of Mijnbouwwet). Under normal circumstances, the concession owner can choose his production plan on his own.

The Dutch state is only allowed to intervene in special cases. These conditions relate to changes in insights for the planned use or management of minerals; security measures and property damage prevention. The concessionaire is also required to take and observe precautions so that development work does not cause accidents.

However, frequent earthquakes entailed political intervention, in the form of measures to reduce and, ultimately, stop gas production from Groningen. Thus, the implementation of an energy transition in which fossil energy is replaced by renewable energy. Additionally, the Dutch government is taking the necessary measures to reduce gas consumption by decrease of gas use in the residential sector and expanding central heat supply systems.

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Норвегия және Нидерландыдағы газ саласының даму тарихы мен ерекшеліктері

Андатпа. Мақалада екі көшбасшының Еуропадағы табиғи газ кен орындары туралы мәліметтеріне шолу және талдау берілген: Норвегия және Нидерланды. Патшалықтың газ нарықтарының даму тарихына және оның осы саланың Еуропалық қоғамдастықта және әлемде қалыптасуына әсеріне ерекше назар аударылады. Ірі Тролль және Гронинген кен орындары, сондай-ақ қазіргі уақытта ашылған танымал емес ұсақ кен орындары қарастырылады. Норвегиялық континенттік қайраңдағы мұнай-газ ресурстарын игеру 1971 жылы алғашқы коммерциялық көмірсутегі өндірісі басталғаннан бері әртүрлі жолдармен жүрді. Елдердегі саланы дамытудың кейбір нәтижелері шығарылды.

Түйін сөздер: Еуропалық газ нарығы, табиғи газ, Нидерланды газы, Норвегия газы, газ экспорты, Гронинген кен орны.

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История развития и особенности газовой отрасли в Норвегии и Нидерландах

Аннотация. Статья представляет обзор и анализ данных по двум лидерам по залежам природного газа в Европе: Норвегии и Нидерландов. Особое внимание уделено истории развития газового рынка королевств и его влиянию на становление данной отрасли в Европейском сообществе и в мире. Рассматриваются как наиболее крупные месторождения Тролль и Гронинген, так и малоизвестные небольшие месторождения, открытые на данный момент. Разработка нефтяных ресурсов и газовых ресурсов на Норвежском континентальном шельфе шла разными путями с момента начала первой промышленной добычи углеводородов в 1971 году. Подведены некоторые итоги по развитию отрасли в странах.

Ключевые слова: европейский рынок газа, природный газ, газ Нидерланды, газ Норвегии, экспорт газа, Гронинское месторождение.

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