



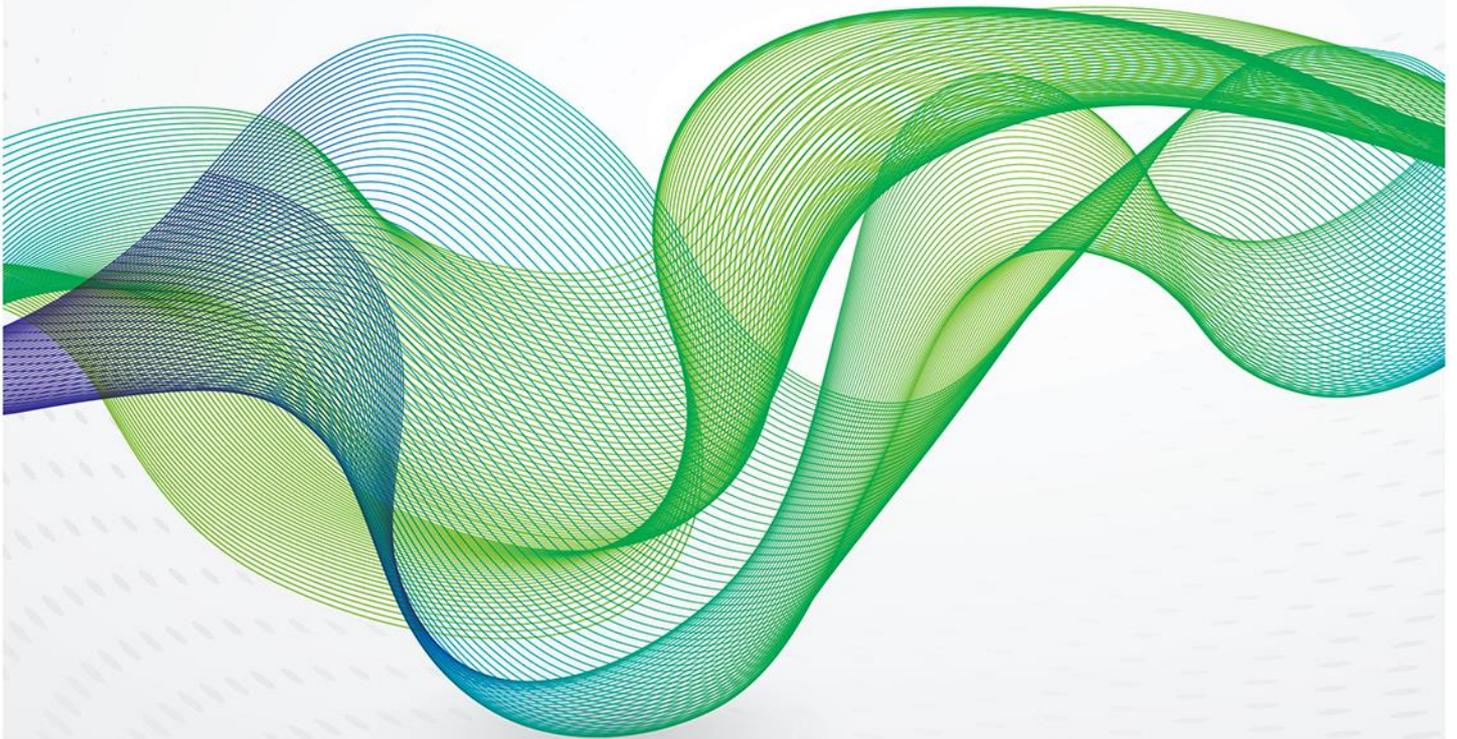
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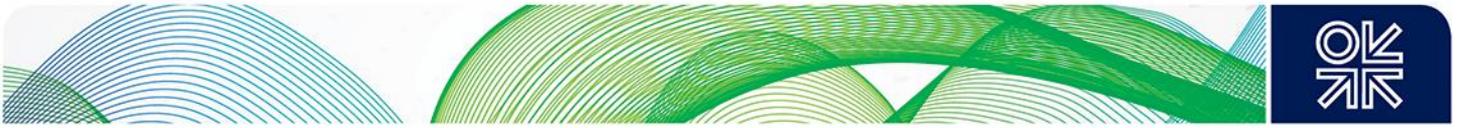
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May 2017

The Dutch Gas Market: trials, tribulations and trends



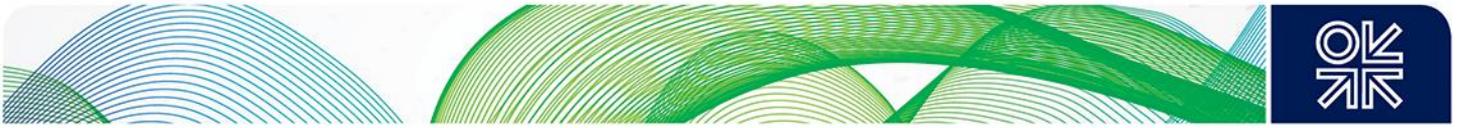


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ISBN 978-1-78467-083-2



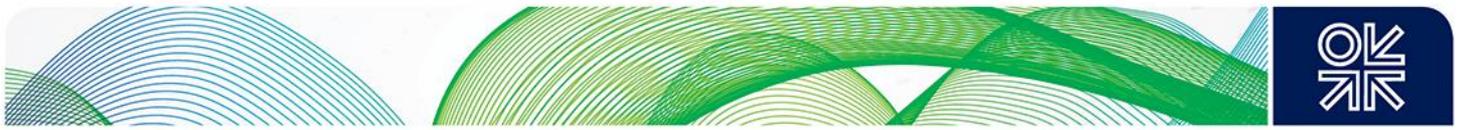
Acknowledgements

My grateful thanks go to my colleagues at the *Oxford Institute for Energy Studies (OIES)* for their support, and in particular Howard Rogers and Jonathan Stern for their helpful comments. A really big thank-you to Sybren De Jong and his colleagues for reviewing the paper, answering my questions and giving me constructive observations. I would also like to thank all the sponsors of the *Natural Gas Research Programme (OIES)* for their useful remarks during our meetings. A special thank you to Liz Henderson for her careful reading and final editing of the paper. Last but certainly not least, many thanks to Kate Teasdale who made all the arrangements for the production of this paper.

The contents of this paper do not necessarily represent the views of the *OIES*, of the sponsors of the *Natural Gas Research Programme* or of the people I have thanked in these acknowledgments.

All the opinions expressed and any remaining errors are my sole responsibility.

Anouk Honoré
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Oxford, May 2017



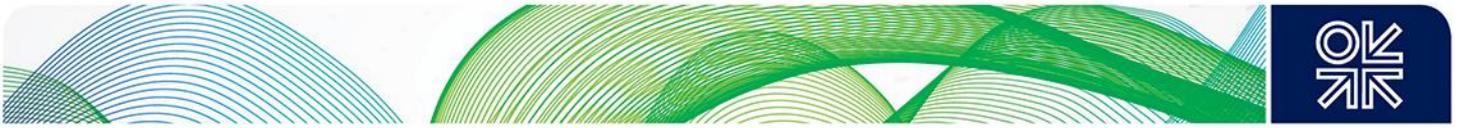
Preface

The Dutch gas market, which has for so long been one of Europe's largest as well as being a key exporter, is at a significant turning point. The problems at the giant Groningen field have been well documented, but the implications of the sharp decline in production that has been mandated as a result of seismic activity have perhaps been less well understood. Not only is the field producing half as much gas as it did only three years ago, but also its flexibility has been dramatically reduced, with the requirement to produce as evenly as possible throughout the year. As a result, customers are being forced to look for alternative sources of imports, with important security of supply implications, and are also having to find new ways to cope with swings in seasonal demand. This issue is analysed in detail by Anouk Honoré in this paper, where she addresses not only the problems at the Groningen field but also the broader range of indigenous gas supply options in the Netherlands.

However, although the Groningen problem is the most obvious issue in the Dutch gas market, the paper also highlights the very significant transition that is taking place across the entire energy economy within the country. While 98 per cent of consumers in the Netherlands are connected to the gas grid, a major shift in public opinion is now taking place and gas is increasingly being viewed as a less desirable fuel in a decarbonising economy. The use of renewables in power generation and an increased focus on energy efficiency have become the key policy drivers, with this shift also being encouraged by the fact that the decline in indigenous gas production is likely to see the county becoming a gas importer by the 2030s. As a result, the changes in the Netherlands reflect a wider trend towards energy transition in Europe as a whole, with the reduction in Dutch gas availability being a key catalyst to action.

With her usual thoroughness and eye for detail, Anouk Honoré covers these two important aspects of the changing Dutch gas market, and also draws some initial conclusions for Europe as a whole, particularly for those countries in the North-West of the region whose imports of Dutch L-gas and H-gas have historically been crucial elements of their supply. Although there are clear alternatives, the implications for increasing reliance on fewer suppliers of pipeline gas highlights one of the significant problems for gas in Europe, namely a reluctance to increase import dependency. As Dutch gas supply, once a key element of the continent's indigenous resource, goes into decline and as Dutch gas consumers, once the most gas-friendly in Europe, increasingly seek alternative energy sources, it is clear that concerns over the future of gas in Europe can to an extent be encapsulated in a study of this one country. Anouk Honoré has provided just such an analysis, which we believe makes an important contribution to our continuing research on the future of gas in the global energy economy.

James Henderson
Director, Natural Gas Programme
Oxford Institute for Energy Studies
Oxford, May 2017

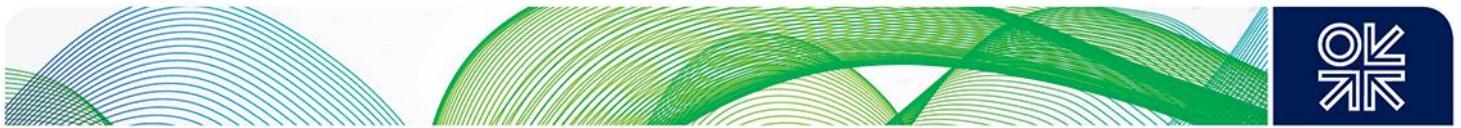


Abstract

This paper forms part of an OIES Gas Programme research theme focusing on the most important national gas markets in Europe (and elsewhere). The rationale behind these papers is that individual markets have specific characteristics and complexities which are essential to understand in order to look at future trends. This paper follows the previous publications on the UK, Spain, Italy, Germany, Brazil and Iran.¹

The Dutch gas market, one of Europe's key exporters, is at a significant turning point. A much stronger than usual earth tremor in 2012 caused by the extraction of gas from Groningen prompted the government to take action and restrain production from the field to help minimize the seismicity. In 2016, gas production from the giant field was less than half the volumes produced just three years previously, with almost no flexibility to cope with seasonality of demand. Nobody seems to be paying much attention to it maybe because there have been no signs of any major threat to security of gas supply nationally and in North West Europe. However, the complete change in the Dutch gas outlook means a major fall in regional production from a European perspective and a big increase in imports from elsewhere with potential security of supply implications (volumes, capacity, prices, and/or dependence). Consideration on the safety and health of the people of Groningen has also changed public opinion about gas dramatically. The use of renewables in power generation and an increased focus on energy efficiency have become the key policy drivers but the transition towards a sustainable economy is also overwhelmed by an anti-gas sentiment. This dramatic evolution casts an important doubt over the future of gas in the country but equally importantly in Europe as a whole, particularly for those countries in the North-West of the region whose imports of Dutch L-gas and H-gas have historically been crucial elements of their supply. It is no longer 'business as usual' and this paper offers some food for thought on the challenges but also the prospects and expectations for the Dutch gas industry looking ahead to a 2030 horizon.

¹ See the full list of publications on <https://www.oxfordenergy.org/gas-programme/>



Executive summary

The Netherlands is the fifth largest market in Europe² (behind Germany, the United Kingdom (UK), Italy and Turkey). It is also the second largest regional producer and exporter of gas after Norway. Natural gas has been at the centre of the Dutch economy, energy supply and power generation for about half a century, but its prominent role has been put into question by climate change policies and the need to decarbonize the economy. A very significant transition is taking place across the entire energy economy and Dutch gas consumers, once the most gas-friendly in Europe, increasingly seek alternative energy sources such as renewables and energy efficiency, which have taken central stage in energy policies while gas is at best the fuel of default. In a country where 98 per cent of households are connected to the gas network, the progressive disconnection of residential customers from the gas grid by 2050 is a dramatic evolution, which casts an important doubt over the future of gas in the country.

The transition towards a sustainable economy is also overwhelmed by an anti-gas sentiment. After a much stronger than usual earth tremor in 2012 caused by the extraction of gas from the Groningen field, the public opinion about gas changed dramatically while consideration on the safety and health of the people of Groningen took centre stage. This event prompted the government to take action and restrain production from the field to help minimize the seismicity: annual volumes were limited to 24 billion cubic metres per annum (bcma) for the 2016-17 gas year, which was to last for five years. In April 2017, the government announced a plan to lower the Groningen cap by 10 per cent to 21.6 bcma for the 2017-18 gas year³ following an increase in seismic activity in the Groningen area.⁴ As a result, gas production from Groningen in 2016 was less than half the volumes produced just three years previously, with almost no flexibility to cope with seasonality of demand as output is to be produced at a consistent rate throughout the year to minimize the risk of large tremors. This is an important change as Groningen production would typically increase during the winter months and fall in summer to follow seasonal variations of gas demand in the heating sector.⁵

The problems at the giant Groningen field have been well documented, but the implications of the sharp decline in production that has been mandated as a result of seismic activity have perhaps been less well understood. The complete change in the Dutch gas outlook means a major fall in regional production from a European perspective, but nobody seems to be paying much attention to it despite the fact that gas extraction in the Netherlands has fallen from 81.5 bcm in 2013 to 68.6 bcm in 2014, 51.2 bcm in 2015, and 47.4 bcm in 2016.⁶ This is maybe because parties have been prepared for a natural decline of the Groningen field and security of supply has not been an issue as measures and regulations regarding volumes and flexibility were based on the minimum volume required by GTS. Contractual obligations have been respected and gas volumes committed on the domestic market and abroad have been delivered without any shortfall.⁷ A combination of carefully managed Groningen gas supply (including volumes in storage), production from smaller fields, higher imports, conversion to low-calorific gas and lower exports whenever possible have cushioned the effects on gas markets, and smoothed out gas price fluctuations.

² OECD Europe

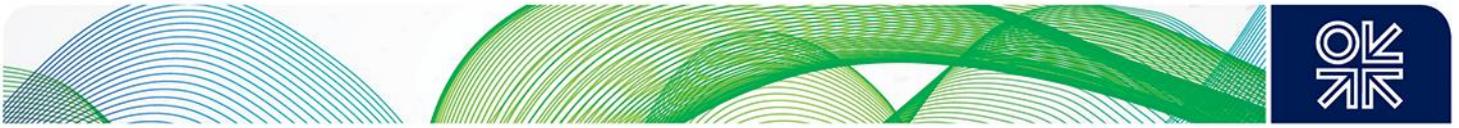
³ At the time of writing, a new production plan was expected to be published in mid-to-late May 2017.

⁴ Dutch producer Nam said that there had been a higher frequency of seismic activity around some of the Groningen field's Loppersum well clusters since late October 2016 (and remained high at the start of 2017), though the seismic activity in the region did not exceed the limits set in the government's production plan for the Groningen field. Source: Argus, 18 April 2017, Dutch Groningen output cap cut 10 per cent for 2017-18

⁵ Groningen gas has a lower calorific value than other European supplies. Millions of households in the Netherlands, Germany, France and Belgium are dependent on natural gas from this giant field and need to be able to continue to rely on this source of low calorific gas to heat their homes. Groningen gas is termed 'G-gas' or sometimes even 'L-gas' as opposed to other source – 'H-gas'. See p.13 for more details.

⁶ <https://www.cbs.nl/en-gb/news/2017/09/gas-exports-halved-in-the-past-three-years>

⁷ At the time of writing: early 2017



In the longer term, however, changes will need to happen and the reduction in Dutch gas availability will be the key catalyst to action. The national market will need to change, but these evolutions will also have consequences for the whole of Europe, especially for those countries in the North-West whose imports of Dutch L-gas and H-gas have historically been crucial elements of their supply. H-gas is available from other sources, essentially from Norway, Russia, North Africa in southern European markets, LNG imports from an even larger range of suppliers, and finally from the spot markets. Whether these countries/markets have enough reserves, production capacity and/or can be commercially attractive to replace 40 bcm of Dutch gas surplus is beyond the scope of this paper, but the question needs to be considered as there can be implications for increasing reliance on fewer suppliers of pipeline gas and rising import dependency.

Regarding L-gas markets, large investments to convert L-gas networks, equipment and appliances to be able to use H-gas are needed and anticipated. The Netherlands is taking steps to transition to an H-gas system while importing countries have already started the process, earlier than anticipated: it is well under way in Germany and is gaining momentum in Belgium and France as all three countries will cease to import Dutch L-gas by 2030. It will then be replaced by imported H-gas, although the exact quantity of additional imports required is uncertain as the energy transition to a low carbon economy will drive the decarbonization of the heating sector (the major consumer of L-gas) in most countries in Europe post-2030.

As of early 2017, there were no signs that there would be any major threat to security of gas supply in North West Europe as a consequence of the restrictions taken on Groningen gas production, but the rapid change means a big increase in imports from elsewhere with potential security of supply implications (volumes, capacity, prices, and/or dependence). Dutch production surplus (production minus demand) fell from about 40 bcm in 2013 to only about 10 bcm three years later, and by 2030, it will likely have disappeared altogether. In other words, within a five year period, Dutch H-gas exports fall and disappear (by early 2020s) and L-gas exports will be halved by 2025 and will disappear by 2030. These are important trends not just for the Netherlands but for the whole European gas market. This is a dramatic evolution for the European supply as a whole that is probably well under-appreciated. Regional production peaked in 2004 at 341 bcm and was down to 257 bcm in 2016 (-84 bcm).⁸ This author expects regional production to decline further rapidly: to 212 bcm in 2020⁹ and to 146 bcm in 2030.¹⁰ This scenario accounts for 111 bcm decline between 2016 and 2030, of which 30 bcm come from the Netherlands alone. This scenario was calculated in May 2017, but there is a risk that Groningen production could be reduced even further before 2021. Court actions to completely shut the field's production down have so far been unsuccessful, but this may not be the case in the future.¹¹ Additional revisions from the Government are also to be expected, probably on an annual basis, especially if there is further serious seismic activity in the Groningen area.

It is no longer 'business as usual' for natural gas in the Netherlands. This paper offers some food for thought on the challenges but also the prospects and expectations for the Dutch gas industry looking ahead to a 2030 horizon.

⁸ Sources data: IEA and JODI. Data for Europe = European Union + Albania + Norway + Turkey + Switzerland

⁹ The decline would be 45 bcm, but the range of possible decline goes from 29 bcm to 62 bcm between 2016 and 2020. Source: Author's estimates for Europe = European Union + Albania + Norway + Turkey + Switzerland

¹⁰ The decline would be 111 bcm, but the range of possible decline goes from 91 bcm to 134 bcm between 2016 and 2030. Source: Author's estimates for Europe = European Union + Albania + Norway + Turkey + Switzerland

¹¹ The frequency of earth tremors has increased since October 2016 and the Dutch state supervision of mines requested that NAM carry out further research into the possible causes. Argus, 31 March 2017, NAM sees no "obvious cause" for Loppersum tremors

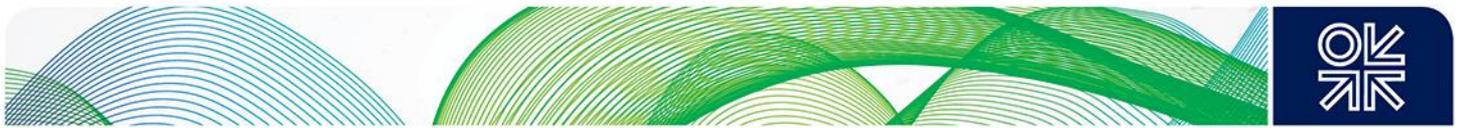
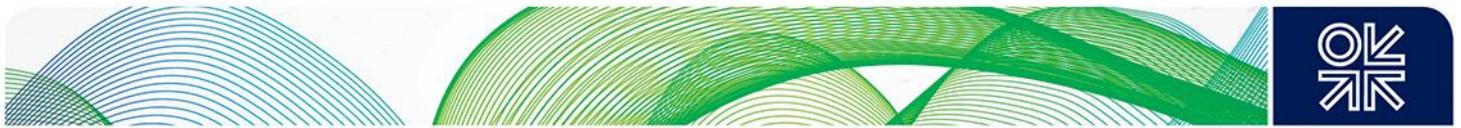


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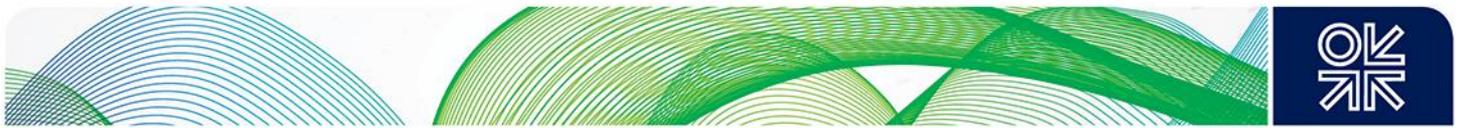
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Glossary

€	Euros
€ct	Cents
Bcm	billion cubic metres
Bcm Geq	billion cubic metres – Groningen equivalent
Bcma	billion cubic metres per annum
Bn	Billion
Cm	Cubic metre
CO ₂	Carbon dioxide
DSO	Distribution Service Operator
ENTSO-E	European Network of Transmission System Operators - Electricity
EU	European Union
G-gas	Gas with low-range calorific value - Groningen quality (lower range)
GHG	Greenhouse gas
GTS	Gasunie Transport Services (the Dutch system operator)
GW	Giga Watt
H-gas	High calorific value (10.5 to 12.8 kWh/cm)
IED	Industrial Emissions Directive
km ²	Square kilometres
KNMI	Royal Netherlands Meteorological Institute
L-gas	Gas with low-range calorific value (below 10.5 kWh/cm)
LNG	Liquefied Natural Gas
mcm	Million cubic metres
mcm/d	Million cubic metres per day
MJ/Ncm	Mega joules per normal cubic metres
MW	Mega watt
MWh	Megawatt hour
NBP	National Balancing Point (British gas hub)
NCG	NetConnect Germany (German gas hub)
NDP	Network Development Plan
NEV	National Energy Outlook
OECD	Organisation for Economic Cooperation and Development
OTC	Over the counter
p/th	pence per therm
PEG Nord	French gas hub
Prisma	European transport capacity platform
PvdA	Labour Party
PJ	Peta joules
Tcm	trillion cubic metres
TNP	Transitional National Plan
TPES	total primary energy supply
TSO	Transportation Service Operator
TTF	Title Transfer Facility (Dutch gas hub)
TWh	Tera Watt hour
TWh/y	Tera Watt hour per year
VVD	People's Party for Freedom and Democracy



Introduction

Context and purpose of the paper

The Netherlands is the fifth largest market in Europe¹² (behind Germany, the United Kingdom (UK), Italy and Turkey). It is also the second largest regional producer and exporter of gas after Norway. However, the Dutch gas market is at a turning point. After unusually severe earth tremors in 2012 due to gas extraction in its giant field Groningen, the government decided to curtail the field's production. After several revisions, the maximum was set at 24 bcma on a normal year (mild winter) in June 2016. It was to be applied for the gas year 2016-17 and last until 2021. This was about 30 bcma less than the volume produced in 2013. Following an increase in seismic activity in the Groningen area and advice by the Dutch state supervision of mines to further reduce the cap,¹³ the government announced a plan to lower the Groningen cap by 10 per cent to 21.6 bcma for the 2017-18 gas year in April 2017.¹⁴ To minimise the risk of large tremors, output had also to be produced at a consistent rate throughout the year while Groningen production would typically increase during the winter months and fall in summer to follow seasonal variations of gas demand in the heating sector.¹⁵ As a result, one of the main sources of flexibility for North West European gas markets is disappearing faster than anticipated. A combination of carefully managed Groningen gas supply (including volumes in storage), production from smaller fields, higher imports, conversion to low-calorific gas and lower exports whenever possible have cushioned the effects on gas markets, and smoothed out gas price fluctuations. Nobody seems to be paying much attention to these changes because despite the drastic reduction of Groningen production, gas volumes committed on the domestic market and abroad have been delivered without any shortfall.¹⁶

In the longer term, however, changes will need to be made and the reduction in Dutch gas availability will be the key catalyst to action. Security of supply and the country's future role as a major gas supplier to Europe were already high on the government's agenda as the gas fields are mature and production has been in natural decline, but additional questions over the future of gas in the country have arisen since a maximum limit has been imposed on Groningen production. Should the country continue to use low calorific value (L-gas) and build new quality conversion facilities? Should the markets convert equipment to use high calorific value (H-gas), which is the quality of imported gas? Maybe even more importantly: should the gas share in the mix, especially for heating, be replaced by other sources of energy such as renewables, which are more in line with the decarbonisation of the economy? Natural gas has been at the centre of the Dutch economy but its prominent role has already been put into question by climate change policies and the need to decarbonize the economy. The use of renewables in power generation and an increased focus on energy efficiency have become the key energy policy drivers. In addition, consideration on the safety and health of the people of Groningen has also changed public opinion about gas dramatically and the transition towards a sustainable economy is also overwhelmed by an anti-gas sentiment. This is a dramatic evolution, which casts an important doubt over the future of gas in the country.

It is no longer 'business as usual' for the gas industry in the Netherlands but these evolutions also have consequences for the whole of Europe, especially for those countries in the North-West whose imports of Dutch L-gas and H-gas have historically been crucial elements of their supply. The future impact in terms of Dutch gas production and of the progressive reduction over the next 5-10 years of

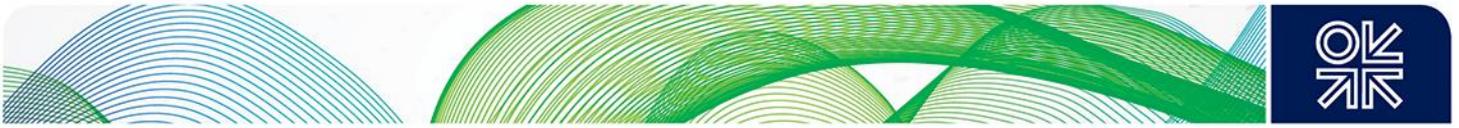
¹² OECD Europe

¹³ Dutch producer Nam said that there had been a higher frequency of seismic activity around some of the Groningen field's Loppersum well clusters since late October 2016 (and remained high at the start of 2017). The seismic activity in the region does not exceed the limits set in the government's production plan for the Groningen field.

¹⁴ A new production plan could be published in mid-to-late May.

¹⁵ Groningen gas has a lower calorific value than other European supplies. Millions of households in the Netherlands, Germany, France and Belgium are dependent on natural gas from this giant field and need to be able to continue to rely on this source of low calorific gas to heat their homes. Groningen gas is termed 'G-gas' or sometimes even 'L-gas' as opposed to other source – 'H-gas'. See p.18 for more details.

¹⁶ At the time of writing: early 2017



Dutch exports and their rapid disappearance post-2020 on the rest of Europe is dramatic and has not been properly appreciated. This paper offers some food for thoughts on the challenges but also the prospects and expectations for the Dutch gas industry looking ahead to a 2030 horizon.

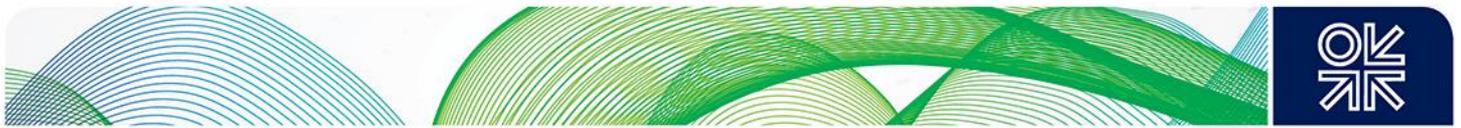
Structure of the paper

The paper comprises three chapters. Following this introduction, the first chapter provides an overview of the Dutch gas market as it stands in 2017, including the role of gas in the energy and power generation mix, the organisation of gas demand, and the likely scenarios over the next ten to fifteen years as far as existing and planned energy policies are concerned. The Netherlands' energy sector is heavily focused on fossil fuels, but the impact of the earth tremors on politics and the public debate has been important. Public opinion about gas has changed dramatically, which in addition to the political commitment toward a decarbonized economy, brings into question the future role for natural gas.

The second chapter takes a closer look at the state of indigenous production, especially the consequences triggered by the decision to specify a maximum output for Groningen gas. There seems to be no chance for a future upward revision of the authorised level of production, and as a result, other sources of gas will be required to replace the lost volumes. It seems that other indigenous production, storage, imports, and quality conversion of gas have made up for the difference since 2013. Over the longer term, other alternatives will need to be considered such as replacing old appliances with new equipment that can use high calorific gas and/or replacing gas with renewables (including green gas).

The third chapter expands on this topic of necessary transition but considers the Dutch gas market in a European context. The Netherlands has been at the forefront of natural gas industry development in Europe since the 1960s, and as such it is a well interconnected market with an extensive infrastructure and a deep expertise in all aspects of the gas chain. The country has been anticipating the natural decline of its resources by starting to establish itself as the gas roundabout for North West Europe. This concept would not only help secure gas supply but would also bring new business opportunities and continued revenues from natural gas to the State. But the changes will not only have an impact on the Dutch market itself; importing countries will also need to adapt, and the final section of this paper consider the challenges facing Germany, Belgium and France as Groningen gas exports decline in the 2020s.

The final chapter brings together the paper's conclusions.



I. A mature gas market in transition

1.1. Overview of a success story

The Dutch gas market started its development after the discovery of the Groningen gas field in 1959. Thanks to this low-cost, onshore giant field, the country became a major producer of natural gas in 1963. By 2016, it was still the largest producer and exporter of natural gas in the European Union, and the second in OECD Europe after Norway.

Nationally, natural gas was placed at the centre of energy policy and consequently gas plays an important role in the primary energy mix and in power generation. However, this mature gas market is facing major transformations.

This first chapter introduces the national gas market: its early developments, L-gas and H-gas specificities, and highlights of the future of natural gas demand in a context of climate change and decarbonization of the economy.

1.1.1. Natural gas at the centre of the energy mix

Discovery of Groningen and rise of natural gas production

The first Dutch gas field was discovered in the Coevorden area in the late 1940s, but it was the discovery of the Slochteren field in the northern province of Groningen in 1959 that kicked off the success story of natural gas in the Netherlands. The giant Groningen gas field covers an area of around 900 km² and was estimated to hold 2.8 trillion cubic metres (Tcm) of gas.¹⁷ Production by Nederlandse Aardolie Maatschappij (NAM)¹⁸ began in 1963. Initially, gas production grew rapidly and peaked at almost 88 billion cubic metres – Groningen equivalent (bcm Geq) in 1976.¹⁹ However, after the 1973 oil crisis,²⁰ the government decided to scale back production to conserve Groningen reserves and prolong the life of the field for as long as possible in order to preserve the Groningen gas field as a strategic reserve. Exploration and production from smaller gas fields both onshore and offshore in the North Sea was encouraged to enable this objective, as well as to capitalize on gas reserves as much as possible.²¹ Since then, more than 470 gas fields have been discovered, of which about 250 fields have been developed.

In 2015, onshore production represented 72 per cent of total gas production (57 per cent from Groningen with 22 processing plants and 258 wells)²² and 15 per cent from other onshore fields), while offshore production from the 150 fields located in the North Sea amounted to about 28 per cent [see Appendix 1 for a map].²³ Remaining gas reserves were estimated at 841 bcm Geq at 1 January

¹⁷ <http://www.nam.nl/english-information.html>

¹⁸ Nederlandse Aardolie Maatschappij: the joint venture between Royal Dutch Shell and Exxon Mobil Corp which operates the Groningen gas field

¹⁹ Groningen gas has a lower calorific value than other European supplies, and this data is in billions of cubic metres of Groningen Gas Equivalent (heating value of 35.17 MJ/Ncm).

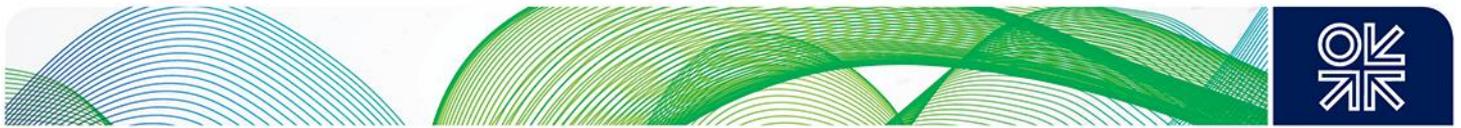
<http://www.nam.nl/feiten-en-cijfers/gaswinning.html#iframe=L2VtYmVkL2NvbXBvbmVudC8/aWQ9Z2Fzd2lubmluZyN0YWltdGFiLWRvd25sb2Fkcy01MjM1MDYzNDc3OTg0M2MyOGI0YThjYTc2OTBIZjhiNQ==>

²⁰ During the first oil crisis in 1973, some Middle Eastern oil-producing countries imposed an oil boycott against several countries including the Netherlands. This risk on security of energy supply prompted the government to promote indigenous natural gas production and to conserve gas in the Groningen field for as long as possible.

²¹ For additional information about early discoveries and production, see <http://www.nam.nl/gas-en-oliewinning/aardgaswinning-op-zee.html> ; <https://www.government.nl/topics/energy-policy/contents/natural-gas>

²² Data for spring 2016. <http://www.nam.nl/gas-en-oliewinning/groningen-gasveld/belang-van-groningen-gasveld.html#iframe=L2VtYmVkL2NvbXBvbmVudC8/aWQ9Q2hhcnRzL2dhc3dpbm5pbmVudG90YWFlLWJhc2li>

²³ <http://www.nam.nl/gas-en-oliewinning/aardgaswinning-op-zee.html>



2016, of these, the Groningen field accounted for 656 bcm, smaller onshore fields for 83 bcm and offshore formations for 102 bcm (excluding contingent resources) [see Table 1 below].²⁴

Table 1: Gas resources in the Netherlands as at 1 January 2016 (bcm Geq)

Accumulations	Reserves	Contingent resources*	Total
Groningen	656	7	663
Others Onshore	83	37	120
Offshore	102	25	127
Total	841	69	910

* Discovered volumes of gas which are currently not considered to be commercially recoverable

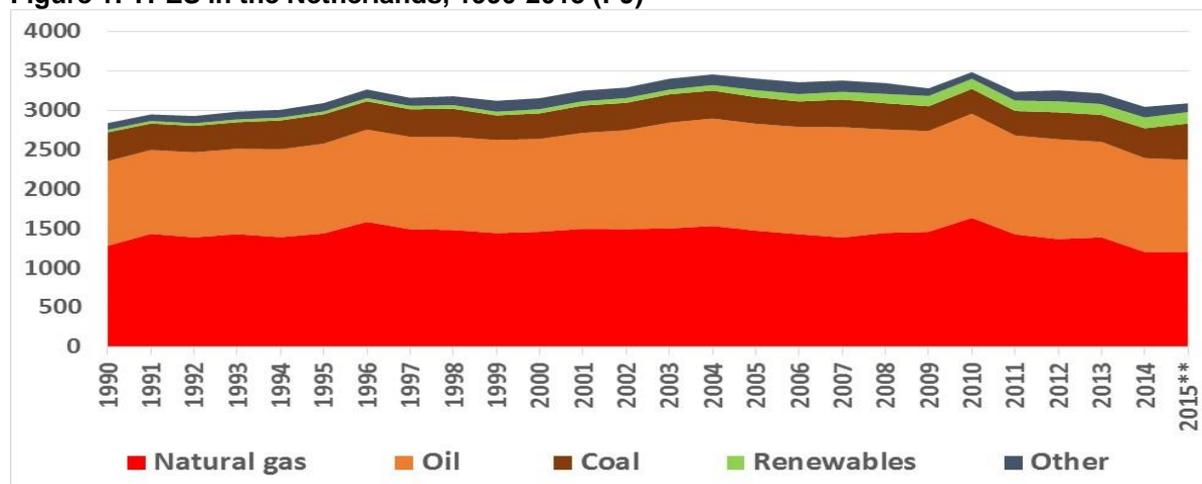
Source: <http://nlog.nl/en/oil-and-gas-fields-overview>

Sales and exports of natural gas provide an important source of income to the State, but as in other parts of Europe, indigenous production is declining following the depletion of the reserves. The Groningen field has declined even faster than anticipated since 2013 with maximum production caps imposed by the authorities after a stronger than usual seismic event in 2012 (see Chapter 2 for more details).

Fossil fuels at the centre of the primary energy mix

Development of end uses and a rapidly expanding network placed natural gas at the centre of energy consumption in the Netherlands [Figure 1]. In 2015, the total primary energy supply (TPES) was still heavily dominated by fossil fuels (92.4 per cent), which were mainly used in the oil-refining, petrochemical and iron and steel industries, agriculture, power generation and transport; while renewable energies (geothermal, solar, wind, wave, tide, heat, biofuels and waste) accounted for 6.2 per cent in total and nuclear for 1.4 per cent. Of the fossil fuels, natural gas represented 39.6 per cent of the TPES, followed closely by oil (37.3 per cent) and finally coal (15.5 per cent).²⁵ The share of natural gas fluctuates year on year, and peaks during cold years as gas is the main source of energy in the heating sector. Oil is mainly used in transport, and coal and lignite are directed to power generation, in addition to nuclear and renewables.

Figure 1: TPES in the Netherlands, 1990-2015 (PJ)



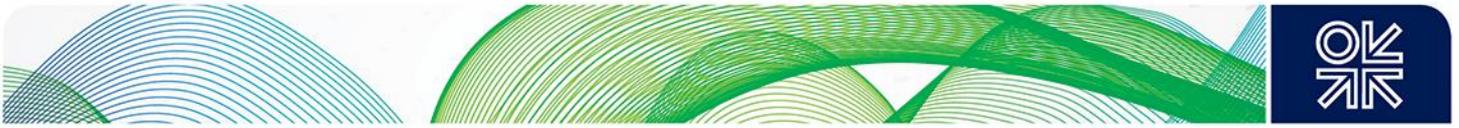
Notes: data exclude electricity; ** estimates

Source: Central Bureau of Statistics, retrieved February 2017²⁶

²⁴ <http://nlog.nl/en/oil-and-gas-fields-overview>

²⁵ IEA (2016), Natural gas information, p.III.126

²⁶ <http://statline.cbs.nl/Statweb/?LA=en>

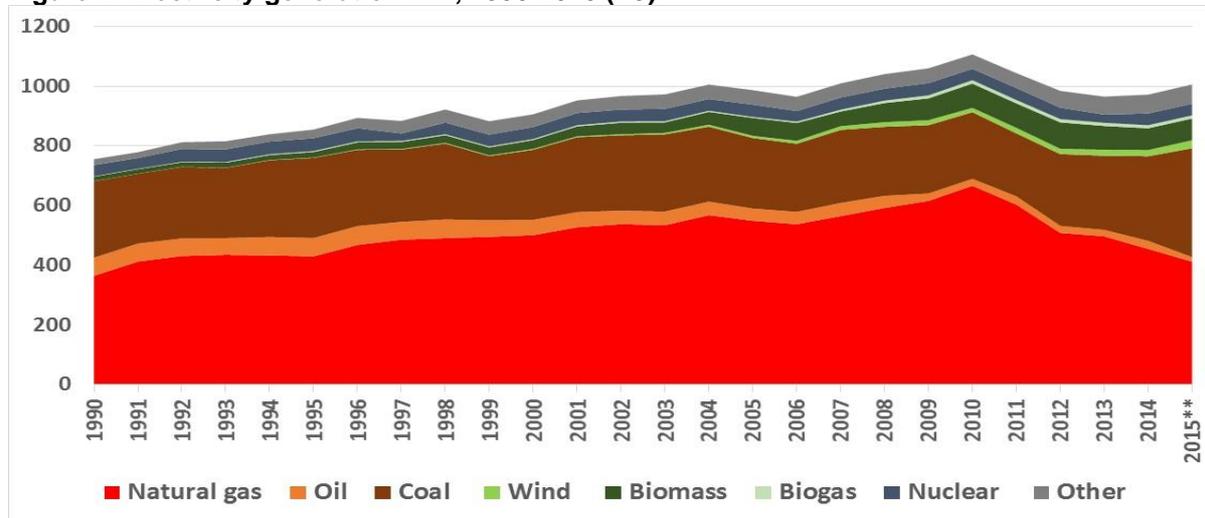


The TPES seems to have begun a gradual decline post-2010, an effect of the prevailing economic situation and efficiency gains. The role of natural gas has dropped from 47 per cent in 2010 to 40 per cent in 2015, losing market share to other fuels, especially coal which has jumped from 9 per cent to 15 per cent over the same time period as a result of the uncompetitiveness of gas prices relative to coal prices, therefore shifting merit orders in the power sector.

Predominant role of gas in electricity generation, but strong competition from coal

Natural gas is the largest source of energy in electricity generation. As seen in Figure 2, gas plants typically covered over half of all generation up to 2010. Between 2010 and 2015, the share of gas decreased from about 63 per cent to 44 per cent while the share of coal grew rapidly, boosted by more favourable coal/gas competitiveness. By 2015, the mix was split between gas (44 per cent), coal (37 per cent), renewables (14 per cent) and nuclear (4 per cent).²⁷

Figure 2: Electricity generation mix, 1990-2015 (PJ)



Note: ** estimates
 Source: Central Bureau of Statistics, retrieved February 2017²⁸

In 2016, provisional data shows an increase in the role of gas in the mix thanks to lower gas prices and higher coal prices in the second half of the year. There was clear evidence of demand response from the power sector, and data from ENTSO-E shows the share of gas climbed to 66 per cent, close to its 2010 level [Figure 3].²⁹ Higher power demand in the second half of 2016 was met by natural gas, while generation from the other fuels show a more modest increase. This trend was also observed in some other European countries.

According to the same (provisional) data, renewable energy reached 12 per cent of the mix, essentially from wind (7.1 per cent), and biomass (3.2 per cent) burned in coal-fired plants. Solar and hydro have a much smaller role in the mix (1.4 per cent and 0.1 per cent respectively).

²⁷ IEA (2016), Electricity Information, p.III.353
²⁸ <http://statline.cbs.nl/Statweb/?LA=en>
²⁹ <https://www.entsoe.eu> (retrieved February 2017)

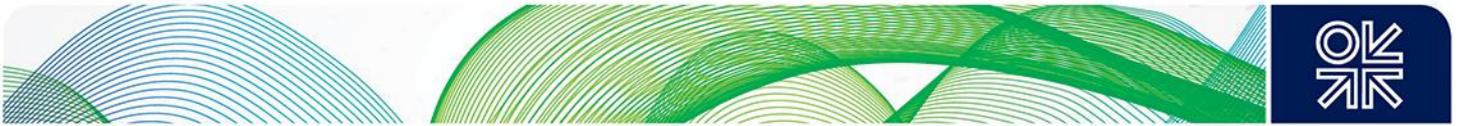
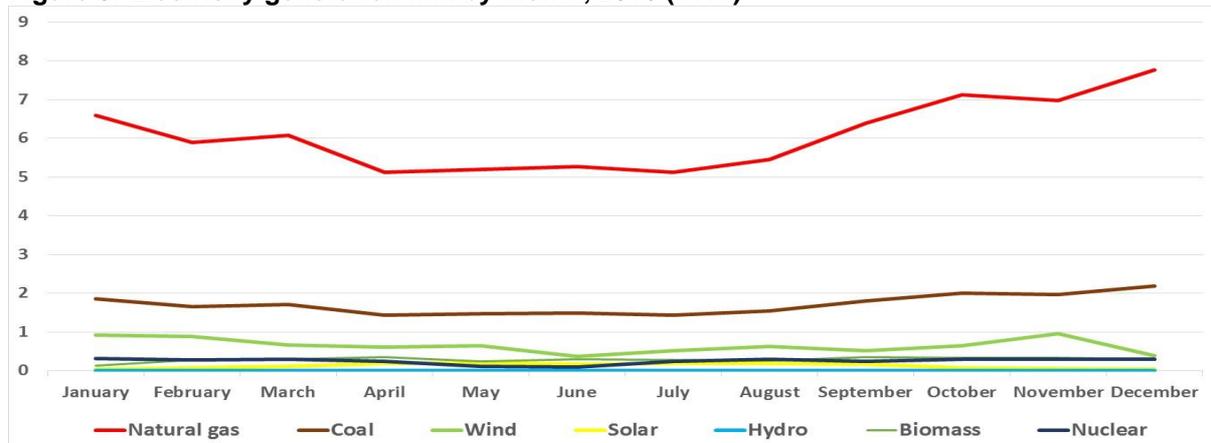


Figure 3: Electricity generation mix by month, 2016 (TWh)



Source: ENTSO-E, retrieved February 2017³⁰

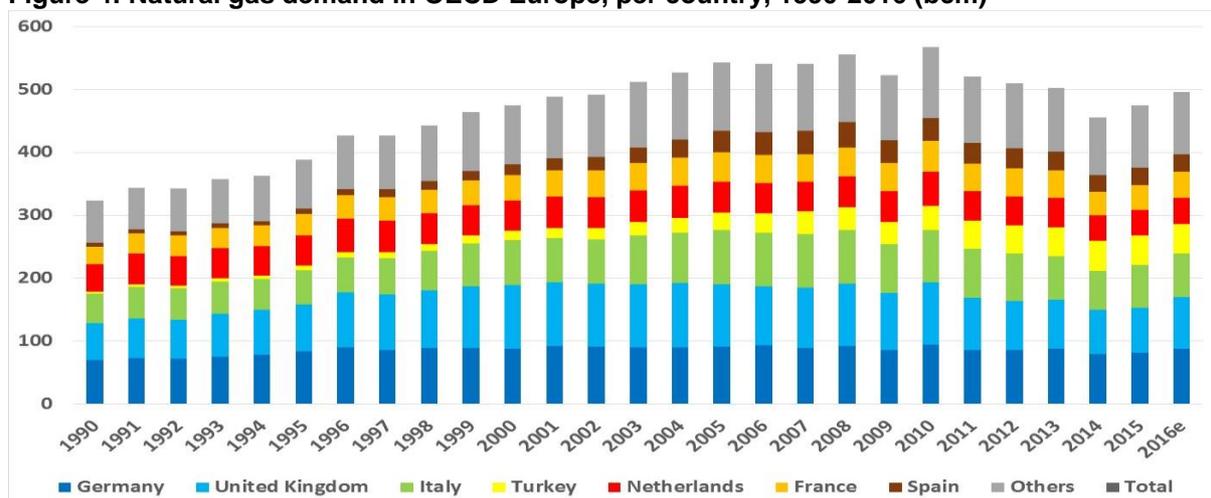
1.1.2. Specificities of the Dutch gas market

A major gas market driven by the residential sector

The Dutch gas market is the fourth largest national gas market in the EU and the fifth largest in OECD Europe (which includes Turkey). It is a mature market, and as such is not displaying the major growth which would be expected in a young market. As in other parts of Europe, gas demand declined between 2010 and 2014 as a consequence of the economic situation and changing energy markets (falling electricity demand, increased efficiency, increasing renewable generation and gas-to-coal switching),³¹ but recovered some market share in 2015 and 2016 [Figure 4].

In 2016, natural gas demand reached 40 bcm, down from 52 bcm in 2010 (which was a year of exceptionally high demand in the Netherlands as well as in Europe due to a combination of economic recovery after the 2009 shock and exceptionally cold weather).³²

Figure 4: Natural gas demand in OECD Europe, per country, 1990-2016 (bcm)

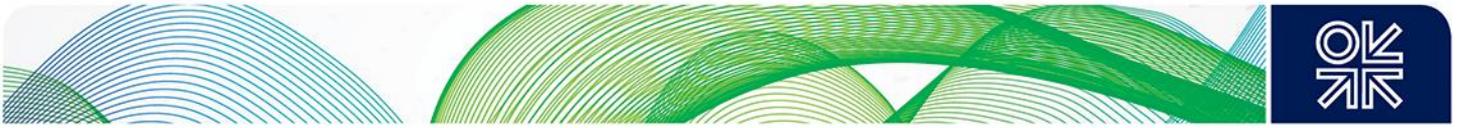


Sources: IEA, Natural gas information 1990-2015, author's assumptions for 2016

³⁰ <https://www.entsoe.eu>

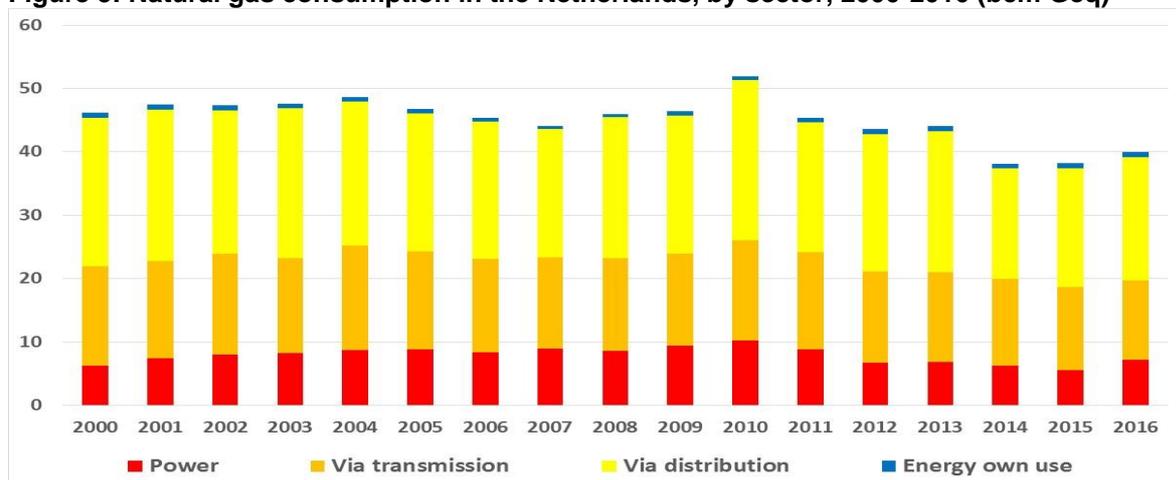
³¹ See Honore A. (2014) for more details

³² Central Bureau of Statistics, <https://www.cbs.nl/en-gb>, retrieved in February 2017



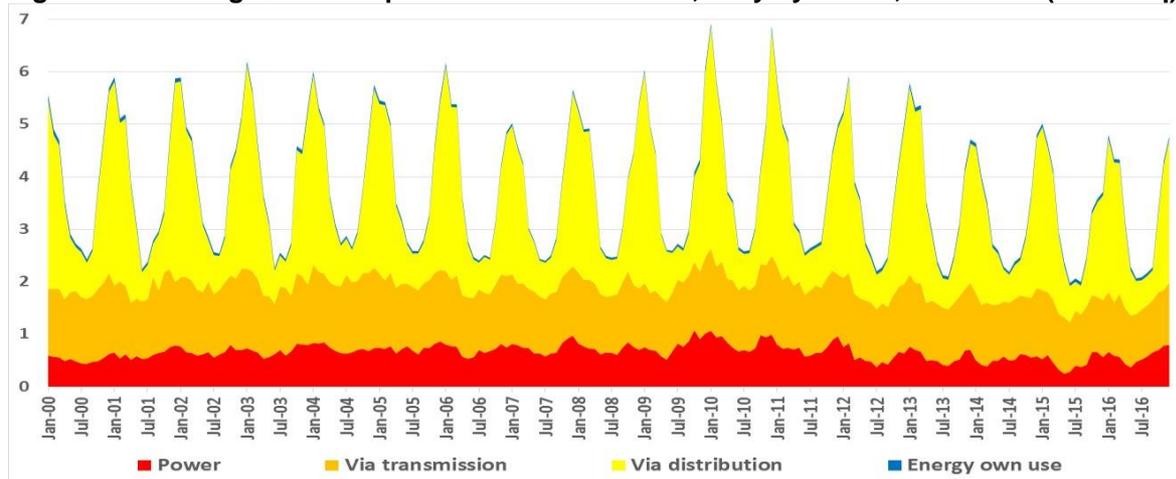
Gas demand is driven by deliveries via the distribution network, as seen in Figure 5 and Figure 6. This includes the supply of natural gas by gas distribution companies directly to end consumers, which are mainly small consumers, including households (49 per cent in 2016). Residential gas demand is particularly sensitive to temperatures as 98 per cent of households use gas for cooking and for space heating.³³ Deliveries via the transmission network (direct supply from the main transmission network to end users, except for the power plants) account for the second highest share (32 per cent), followed by gas used in power plants (18 per cent). CHPs consume about 60 per cent of the gas used in the power sector, while the rest is consumed by utilities. The country enjoys a fairly energy-efficient economy, including the industrial and power sectors. The largest share of industrial gas demand comes from the chemical and petrochemical sector.³⁴

Figure 5: Natural gas consumption in the Netherlands, by sector, 2000-2016 (bcm Geq)



Source: Central Bureau of Statistics, retrieved in February 2017³⁵

Figure 6: Natural gas consumption in the Netherlands, daily by sector, 2000-2016 (bcm Geq)

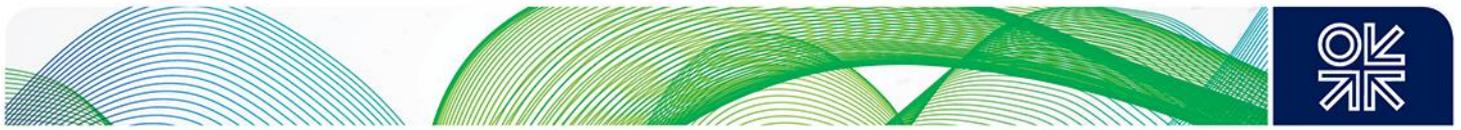


Source: Central Bureau of Statistics, retrieved in February 2017

³³ All houses must be connected to the gas grid according to the law. <https://www.government.nl/topics/energy-policy/contents/natural-gas>. As a result of the gas distribution network covering most of the country, the share of district heating in the heating market is very small.

³⁴ IEA (2016), Natural gas information, p.IV.284

³⁵ <https://www.cbs.nl/en-gb>



2 types of gas: L-gas and H-gas

There are two (primary) types of gas qualities in the Dutch system:³⁶ one with a low-range calorific value below 10.5 kWh/cm (L-gas) with a relatively large proportion of nitrogen, and one with a high calorific value ranging from 10.5 to 12.8 kWh/cm (H-gas).

- L-gas comes from the Groningen field and from smaller fields in the Netherlands and Germany or it can be converted from H-gas by adding nitrogen. L-gas can therefore be sourced from Russian and Norwegian gas, which has been mixed with nitrogen³⁷ to achieve the same calorific value as that of the gas from Groningen. As a result, there are actually different types of L-gas. Gas extracted from the Groningen field is from the lower range of calorific value, and is sometimes called G-gas. It is mainly used for the Dutch market. L-gas is mainly used for export, and has slightly higher calorific value than G-gas. In this paper, all low calorific gas is called L-gas.
- H-gas comes from some small Dutch fields onshore and offshore and from imports, for instance from Russia, Norway and Liquefied Natural Gas (LNG) imports.

L-gas is the norm in the Netherlands as all domestic appliances (gas cookers and boilers) are designed to operate using this type of gas. This specificity is also found in countries which import Groningen gas: Belgium, Germany and Northern France. Because of an expected drop in the production of the Groningen field and a strong decline in production from the Dutch small fields and German fields, measures have been considered such as investment in conversion facilities. However, continuous expansion of nitrogen installations is expensive and given the size of Groningen gas production, the decline of output cannot easily be replaced. It will necessitate a transition to a new gas composition: the equipment in the residential sector and in industry sector, which is set to this gas quality, will have to be adjusted to handle gas of different qualities (see Chapters 2 and 3).

The gas industry enjoys an extensive transmission and distribution network developed since the early 1960s, but H-gas and L-gas must be transported on separate networks.³⁸ The residential and commercial sector is designed for L-gas, while the industry and the power sector use both L-gas (about 25 per cent of their demand) and H-gas (75 per cent). The high calorific gas network delivers gas directly to consumers such as power plants, refineries and blast furnaces.

1.2. Future gas demand in a low carbon economy

As in other EU countries, a large share of the energy policy in the Netherlands is dictated by European policies and the future of natural gas demand will be influenced by the direction taken in the transition to a low-CO₂ energy mix. However there is a need to define/redefine the role of gas in delivering the EU's security and decarbonisation objectives. The Netherlands is heading towards a major transition: climate change is one of the main issues in Dutch policies and, as a large producer, natural gas used to have a fairly positive image in the country as a relatively safe, affordable and clean fuel. But the political impact of the earth tremors has been drastic and consideration for the safety and health of the people of Groningen has dramatically changed public opinion about gas. A strong desire to be energy-neutral and a fast transition towards an electrification of the economy, without fossil fuels, requires a huge effort and important investments. Alternative scenarios with a gradual decrease of natural gas in the mix would result in faster reduction of CO₂ emissions (when switching from coal to gas plants for instance) and costs would be spread over a longer period (and

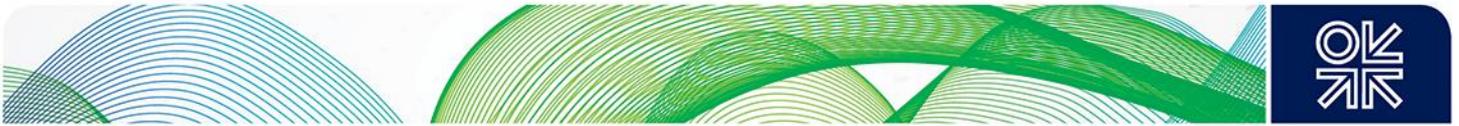
³⁶ There are others, but to simplify, it is possible to classify natural gas into two main qualities: high calorific gas and low calorific gas.

Note: the Wobbe index (= calorific value divided by the square root of the gas density relative to air) is the most important factor for the end user demand, not specifically the calorific value. The "Regeling gaskwaliteit" contains the Wobbe ranges for each type of gas including a summary of the gas composition. See <http://wetten.overheid.nl/BWBR0035367/2016-04-01> for more information about gas compositions.

³⁷ This is done at Gasunie facilities in Ommen, Pernis, Wieringermeer and Zuidbroek.

See for more details: <http://www.nam.nl/gas-en-oliewinning/aardgas-uit-kleine-velden/belang-van-aardgas-uit-kleine-velden.html>

³⁸ <https://www.government.nl/topics/energy-policy/contents/natural-gas>



therefore be easier to manage), but it is not the favoured option as the transition towards a sustainable economy is overwhelmed by an anti-gas sentiment.

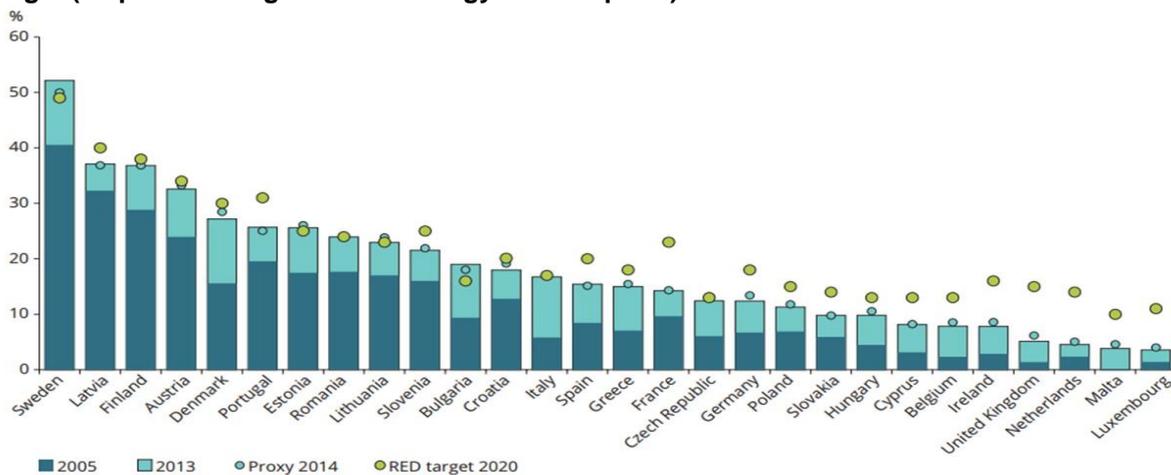
1.2.1. Energy policies that will drive changes in the 2020s and beyond

Dutch targets within the EU energy policies

There are several EU energy policies, but the focus of this paper is on the 2020 energy and climate targets and 2030 climate change package. The three main 2020 targets, also known as the '20-20-20' targets, are: a 20 per cent reduction in EU greenhouse gas emissions from 1990 levels, a 20 per cent share of renewables in the EU's final energy consumption and a 20 per cent increase of the EU's energy efficiency compared to a 'business-as-usual' scenario. For the Netherlands, the national targets correspond to: ³⁹ a 16 per cent reduction of emissions not included in the EU Emissions Trading System (EU ETS), which is binding, a target of 14 per cent renewable energy (binding but likely to be missed, as seen in Figure 7) and 1,5 per cent overall energy savings per year. CO₂ and related emissions have been growing which is making it more challenging to attain the 2020 targets for sectors outside the EU ETS. ⁴⁰

In October 2014, the Member States of the EU agreed to extend the policies up to 2030, with the new targets being: the reduction of greenhouse gas emissions by at least 40 per cent; an increase in the share of renewable energy to at least 27 per cent; and a reduction in the total energy use in the EU of at least 27 per cent. There are no specific levels per country, only regional targets.

Figure 7: Share of energy from renewable sources in the EU Member States in 2013 and 2020 target (in per cent of gross final energy consumption)



Source: EEA Report (2016), Renewable energy in Europe 2016, Recent growth and knock-on effects, p.19

October 2012: Building bridges

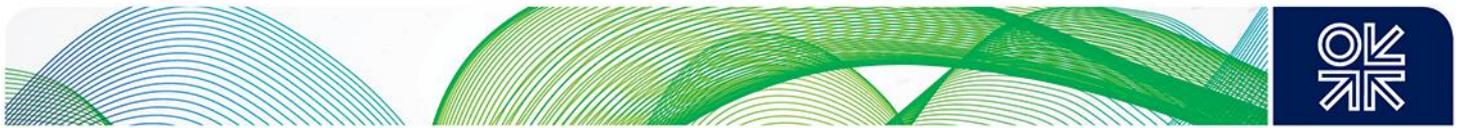
On 29 October 2012, the coalition between the VVD (People's Party for Freedom and Democracy) and the PvdA (Labour Party) reached an important energy agreement for sustainable development called 'Building Bridges'.⁴¹ The targets decided were a 16 per cent share for renewables by 2020⁴² and a completely sustainable energy supply by 2050. Energy conservation was to be prioritized: the Green Deals approach was to be extended in order to accelerate improvements to the sustainability

³⁹ More information can be found at <https://www.government.nl/topics/climate-change/contents/eu-policy>

⁴⁰ IEA (2014), Energy Policies of IEA Countries, Netherlands

⁴¹ <https://www.government.nl/government/contents/coalition-agreement>

⁴² <https://www.government.nl/government/contents/coalition-agreement/sustainable-growth-and-innovation>



of existing homes, bring down the cost of offshore wind power and promote electric vehicles. None of which are particularly favourable to rising natural gas consumption.

September 2013: Energy Accords

On this basis, the Netherlands adopted the Energy Accords (Energieakkoord) for sustainable growth in September 2013. These were signed by the government with forty seven other organizations. The signatories decided on measures for renewables and energy savings for the next ten years (up to 2023).⁴³ Contrary to previous plans whose implementation relied on several entities, this time the Ministry Department of Economic Affairs was put in charge.

The targets were as follows:

- Energy efficiency savings of 1.5 per cent per year (resulting in a potential reduction of 100 PJ by 2020).
- Investments in renewable energy such as wind and solar to develop low carbon sources in order to reach a 14 per cent share of renewable energy in final energy consumption by 2020, rising to 16 percent by 2023.⁴⁴ This represented a huge increase from only about 5.8 per cent in 2015.⁴⁵ The target was also to reach 6 gigawatt (GW) of onshore wind and 4.4 GW of offshore wind capacity by 2023⁴⁶ (up from 2.9 GW and 1 GW in 2014).⁴⁷
- Closure of the five least efficient coal power plants⁴⁸ built during the 1980s (responsible for high CO₂ emissions): three in 2016 and two others in 2017.⁴⁹

All in all, the Energy Accords envisaged the replacement of natural gas by decarbonized energies especially in the space heating sector (for example, heat pumps). In other sectors, it was accepted that gas might still be needed in power generation as a back-up for renewables or at times of peak demand, processed heat in the industry or for some forms of transport due to the lack of sustainable alternatives.

National Climate Change Conference 2015

In October 2013, the government published its national climate agenda, in anticipation of the 2015 Paris meeting (COP 21)⁵⁰ during which a reduction in CO₂ emissions to almost zero in 2050 was agreed. Authorities, NGOs, and energy players were to cooperate to cut CO₂ emissions, launch CO₂ smart grids in about 100 municipalities and provinces, support further measures to save energy, increase the use of renewables, and develop heat projects. The government also envisaged the

⁴³ The signatories included the national government, energy producers, network operators, construction, housing associations, the chemical industry, employers, trade unions, environmental organizations and more broadly NGOs, other civil society organizations and financial institutions. See <http://www.energieakkoordser.nl/>

⁴⁴ <http://www.energieakkoordser.nl/~media/files/energieakkoord/publiciteit/agreement-on-energy-policy-in-practice.ashx>

⁴⁵ <https://www.cbs.nl/en-gb/publication/2016/41/national-energy-outlook-2016>

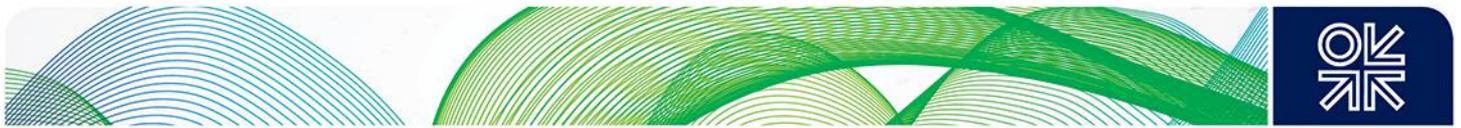
⁴⁶ Sustainable energy is generated from clean, inexhaustible sources and is therefore also called 'renewable energy'. Through the Incentive Regulation for Sustainable Energy (SDE+) a budget is available every year to support projects for a maximum period of 15 years. <https://www.government.nl/topics/climate-change/contents/national-measures>

⁴⁷ IEA (2016), Electricity information, p.III.358

⁴⁸ These plants were Vlissingen (operated by EPZ, 426 MW, built in 1987), Nijmegen/Gelderland (Electrabel, 590 MW, 1981) and Amer-8 (Essent, 645 MW, 1980). They closed down on 1 January 2016. Maasvlakte I and II (Essent, 530 MW each, built in 1988 and 1987) are to close by 1 July 2017

⁴⁹ The Dutch Authority for Consumers and Markets (ACM) refused this decision contrary to fair competition: the loss of 10 per cent of the energy production capacity was not offset by the environmental benefits. As a result, the government introduced minimum efficiency standards requiring large investments to comply with these requirements. Operators of the least efficient plants are better off closing them than investing to comply. See more info: <http://energy.sia-partners.com/dutch-energy-agreement-2013-2023>

⁵⁰ <https://www.government.nl/latest/news/2013/10/04/climate-agenda-mitigation-adaptation-and-business-sense> ; <https://www.government.nl/topics/climate-change/documents/reports/2014/02/17/climate-agenda-resilient-prosperous-and-green>



closure of additional coal-fired power plants, as well as rising CO₂ prices within the EU and the introduction of CO₂ pricing in other countries.⁵¹

December 2016: Energy Agenda

Nationally, the Netherlands needed a follow-up strategy to the Energy Accords in order to provide a long-term plan for the period after 2023. The new 'energy agenda' (Energie Agenda) was proposed in December 2016.⁵² Energy and climate policy should be CO₂-driven, and the target of being nearly CO₂ emissions free by 2050 pursued (highlighting the need for optimal decarbonization pathways notably in the industry and transport sectors which remain CO₂-intensive). The cornerstones of the agenda were energy saving, reduced gas consumption (generally a reduction of fossil fuel dependency) and more investment in renewable energy, especially the use of renewable electricity and heat, and the follow up of expansion of offshore wind in the North Sea after the current plan ends in 2023.

After 2023, the main targets/objectives are:

- Houses / buildings

More renewable electricity and the promotion of sustainable heating and energy savings (the fall in residential gas demand is already due in a large part to energy efficiency improvements). For newly-built houses, the legal requirement to be connected to the gas grid may be abandoned while existing houses will gradually be disconnected from the grid. Even in 2017, it seems that it is rare to see new houses connected to the gas grid. The proposal is for all houses to be disconnected from the gas grid by 2050. This is an incredibly important policy with major implications. Given that there are around 98 per cent of households connected to the gas grid, if these measures are implemented, it would have a major impact on gas demand as a whole, and of course on demand for L-gas in particular. It would also have consequences for the future of the network, which raises the issue of whether it would be worth maintaining in the future. To replace natural gas, other options need to be considered, such as heated waste, heat from industrial processes and geothermal energy. This would necessitate new infrastructure for waste heat distribution, although converting the existing gas network to distribute heat would maybe be a more logical solution.

- Renewables

There will be a 33 per cent increase in financial support for renewable energy, from €9bn in 2016 to €12bn in 2017, but subsidies are expected to be progressively phased out as technologies become more competitive. For instance, the government expects that offshore wind will no longer need subsidies by 2026.⁵³ Exactly how this is going to impact gas demand is unclear.

- Transport

The targets were a reduction in CO₂ emissions of 17 per cent by 2030 and 60 per cent by 2050.⁵⁴ A switch from fossil fuels to biofuels/sustainable energies and fuel-efficient engines is expected together with an increase in the number of fully electric cars and cars running on hydrogen. From 2035, all cars sold should be zero-emissions (namely electric or hydrogen powered vehicles). The railway sector is to switch completely to green electricity, and from 2025, all buses used for public transport must be using renewable energy or biofuel.⁵⁵ Natural gas in transport will therefore not be encouraged.

- Power generation

Although there is nothing specific for or against natural gas in the generation mix, interestingly, there are also no provisions for shutting down any additional coal-fired power stations.⁵⁶ The argument is

⁵¹ <https://www.government.nl/topics/climate-change/news/2016/10/26/national-climate-change-conference-2016-leads-to-significant-reduction-in-co2>

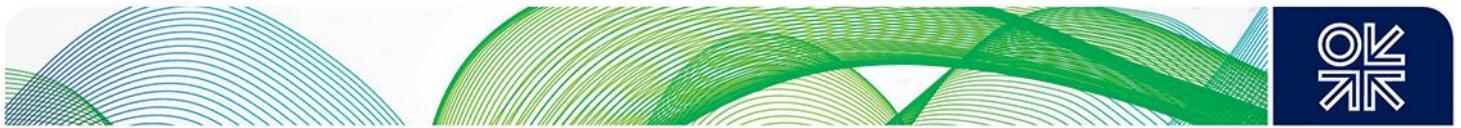
⁵² <https://www.rijksoverheid.nl/documenten/rapporten/2016/12/07/ea> ; for a cost-benefit analysis, see McKinsey (2016), Accelerating the energy transition

⁵³ http://www.enerdata.net/enerdatauk/press-and-publication/energy-news-001/netherlands-plans-phase-out-renewable-subsidies-2050_39214.html

⁵⁴ IEA (2014), Energy Policies of IEA Countries, Netherlands, p.10

⁵⁵ <https://www.rijksoverheid.nl/documenten/rapporten/2016/12/07/ea>

⁵⁶ <http://nltimes.nl/2016/12/07/netherlands-nearly-emission-free-2050-environmental-groups-unimpressed>



that shutting down further (brand-new) coal plants may result in a rise in imports, which could come from electricity produced by more polluting means. However, one could also argue that a shutdown of coal plants and eventually a carbon price (as in the UK which has a national carbon price that comes in addition to the EU ETS carbon price) would help the country switch from coal to gas, and would be an efficient way to curb national emissions while at the same time using assets that already exist... at least until more renewables can be developed.

1.2.2. Expectations and scenarios

The decline of indigenous production, the earth tremors in Groningen and climate change policies have radically changed the situation in the Netherlands. Natural gas is no longer the fuel of choice and it is certainly not at the centre of energy policies. The country will need to find the right balance between transitioning from being a major producer/exporter of natural gas and securing future supplies to its market, while at the same time deciding on the right measures to move towards a sustainable energy system and a decarbonized economy.

National Energy Outlook (NEV) 2016

The National Energy Outlook (NEV)⁵⁷ is an annual official publication which offers an overview of the Dutch energy market. The 2016 edition covers the period from 2000 up to 2035. Two scenarios have been elaborated, the first based on implemented policy and the second on implemented and proposed policy, especially the Energy Accords.

Some of the key aspects of NEV 2016 include:

- Renewable targets

Despite renewables growth, the country is lagging behind its national target for renewable resources, and the target of 14 per cent by 2020 is not likely to be achieved (it will be closer to 12.5-12.7 per cent), while the 16 per cent target by 2023 might be partially met thanks to the construction of offshore wind farms, in addition to more solar and biomass.

- Efficiency

The objective to save a further 100 PJ by 2020 will be missed (a reduction of only about 68 PJ is expected). There will be some growth in electricity consumption but only a moderate one due to energy conservation measures.

- Heating sector

In the residential sector, good insulation will become the norm but also new equipment such as geothermal or solar-thermal heat will be developed in new houses. By 2035, NEV 2016 expects that 88 per cent of the households will still be connected to the gas grid, but expects this to be reduced in the longer term. For instance, in Amsterdam⁵⁸ the city council has put forward plans to eliminate gas-fired cooking and central heating by 2050. About 70,000 homes are already on district heating networks, about 10,000 homes will be disconnected from the gas network during 2017, and 50,000 new homes expected to be built in the next ten years will not have gas heating or cooking facilities. Instead they will be heated by surplus heat generated by industry (assuming financial support from the government can be secured). This marks a significant change for the future of natural gas. A major share (>90 per cent⁵⁹) of the housing stock in 2050 will still date from the 2010s, but this evolution will mean much less gas demand for the heating sector sometime in the future.

- Greenhouse gas emissions

GHG emission levels should be decreasing more rapidly towards 2020 and be around minus 23 per cent compared to 1990. However, between 2020 and 2030, the decline will come to a virtual halt due

⁵⁷ Annual publications compiled by ECN, PBL (two research institutes) and CBS (Statistics Netherlands), with contributions by the Netherlands Enterprise Agency (RVO.nl). At the time of writing, the most recent NEV was published in November 2016. <http://www.pbl.nl/en/publications/national-energy-outlook-2016>

⁵⁸ <http://www.dutchnews.nl/news/archives/2016/11/amsterdam-homes-to-be-gas-free-by-2050/>

⁵⁹ Discussions with Gasunie



to a resurgence of fossil fuels in power generation as the country expects to become a net exporter of electricity (following the final decommissioning of Germany's nuclear plants). After 2030, emissions will decrease further thanks to a higher renewables share, leading to a 30 per cent reduction by 2035 compared to 1990 levels. These scenarios are dependent on the coal/gas use in power and therefore are subject to much uncertainty.

- Coal

By early 2017, there were five remaining coal plants with a total capacity of 4.7 GW⁶⁰ (1.2 GW built in the 1990s, and three new and highly-efficient plants built in 2014-2015). These coal plants are efficient enough to meet the new requirements under the Industrial Emissions Directive (IED), and there has been no opt out and no plants have been put in a transitional national plan (TNP).⁶¹ Given the declining gas production, increased gas dependence and slow renewables development, these coal plants represent some security for power generation. They can also burn biomass, and therefore contribute to the renewables target.⁶² A question mark remains over the closure of older coal power plants, and potentially that of the newer plants in the future.

- Nuclear

The only existing nuclear plant at Borssele is expected to run until 2033, but there is no clear signal on what will happen after the end of its lifetime (despite the will to decarbonize the energy sector).

What does this mean for natural gas?

The government expects that natural gas will still be an important source of energy 'in the years to come' as gas is seen as a safe, reliable, and affordable energy for the future.⁶³ Nonetheless, energy policies are focusing on climate change issues and greenhouse gas (GHG) emissions reduction thanks to rising renewable energies and better efficiency. The role of gas seems to have gone from being the fuel of choice to a default fuel, the one that will make the transition possible (although coal is also part of this story) and which will provide the necessary back-up when gaps between energy balances arise in the future.

- In the power sector, 4.5 GW of gas fired power plants have been mothballed between 2012 and 2016 [Figure 8] and online gas plants ran at about 35 per cent load factor in 2015, down from about 45 per cent in 2012.⁶⁴ Tennet, the national electricity transmission system operator, expects the capacity gas-fired power stations to decrease from 15.5 GW in 2016 to 10 Gw in 2031, while mothballed gas plants will rise to 6.3 GW (from 4.6 GW) [Figure 9].⁶⁵ There is still a future for gas-fired power stations in the Netherlands, but they seem to be increasingly destined to be used as a back-up for renewables, especially wind. This transition will not happen in a few weeks or years, but the market is already preparing for this eventuality. An example of an innovative business model was the agreement between the gas trading company GasTerra⁶⁶ and the energy company Eneco whereby gas supplies are dependent on the wind: volumes and prices of gas delivered increase or decrease depending on the anticipated wind speed.⁶⁷

⁶⁰ Platts, Power in Europe, 30 January 2017, Dutch coal/carbon decision delayed, p.30

⁶¹ For more information on the IED, see <http://ec.europa.eu/environment/industry/stationary/ied/legislation.htm>

⁶² <http://energy.sia-partners.com/dutch-energy-agreement-2013-2023>

⁶³ <https://www.government.nl/topics/energy-policy/contents/natural-gas>

⁶⁴ Author's calculations from IEA data on power generation (IEA, Electricity information, various reports) and Tennet data on capacity (Rapport Monitoring Leveringszekerheid 2016(2015-2031)).

⁶⁵ Tennet (2016), Rapport Monitoring Leveringszekerheid 2016 (2015-2031), p.48

⁶⁶ Gas Terra is the incumbent in charge of buying and selling nearly all indigenous gas production and maximizing the value of Dutch natural gas. It is owned by the Dutch state (50 per cent), Anglo-Dutch major Shell (25 per cent) and US producer ExxonMobil (25 per cent)

⁶⁷ If wind speeds are low, the volume and price of gas supplied goes up and vice versa. <http://www.gasterra.nl/en/news/press-release-agreement-eneco-and-gasterra>

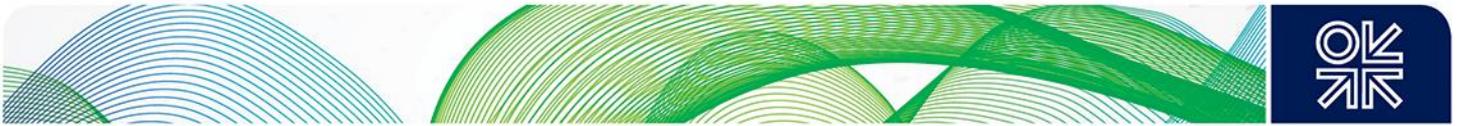
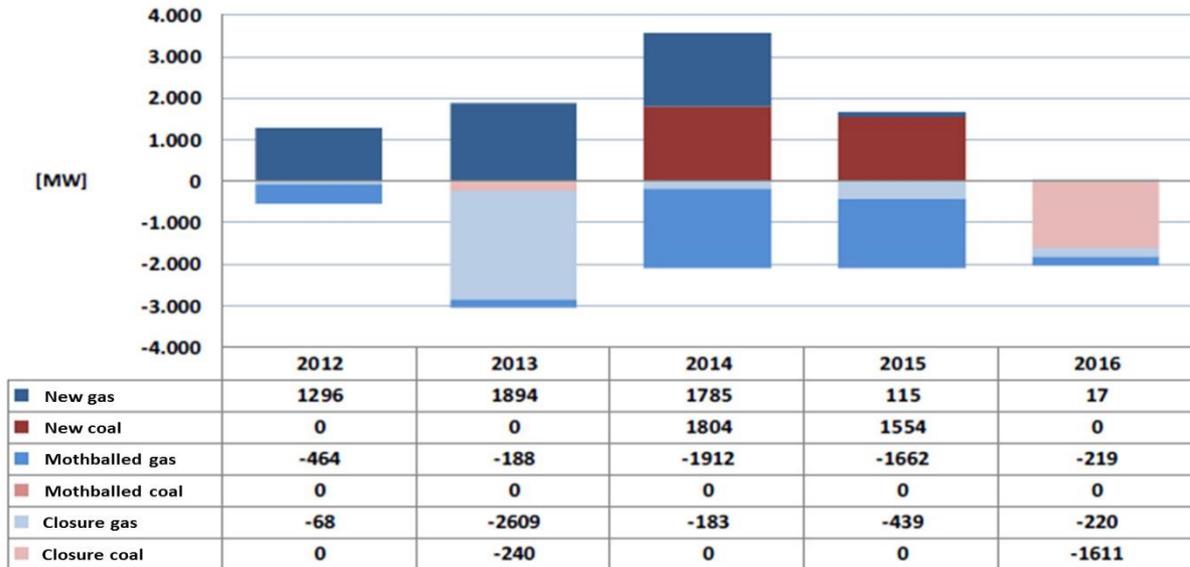
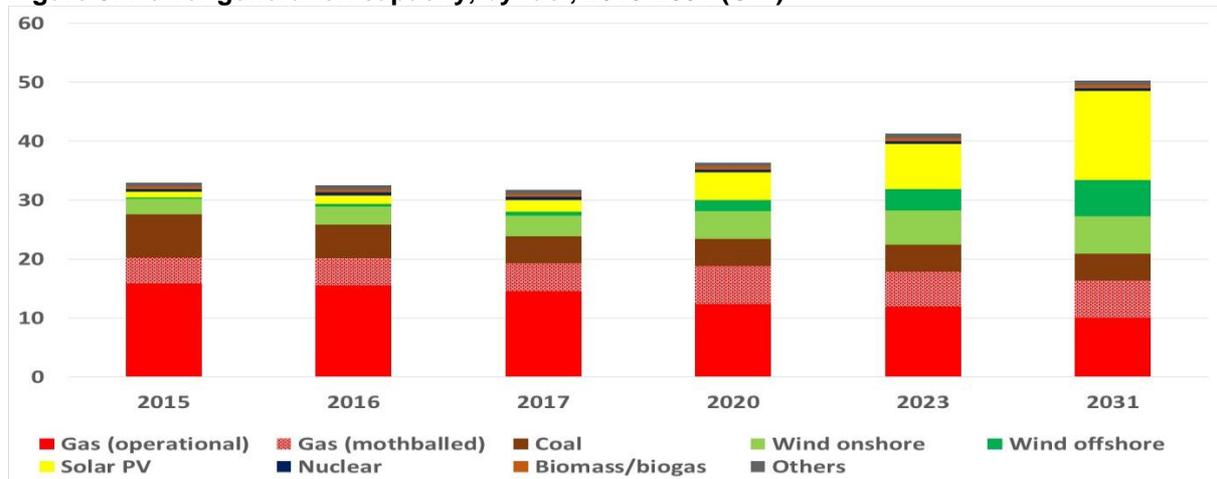


Figure 8: Changes in conventional power generation capacity, 2012-2016 (MW)



Source: Tennet, Rapport Monitoring Leveringszekerheid 2016 (2015-2031), p.16⁶⁸

Figure 9: Power generation capacity, by fuel, 2015-2031 (GW)



Source: Tennet, Rapport Monitoring Leveringszekerheid 2016 (2015-2031), Author's elaboration from data on p.48⁶⁹

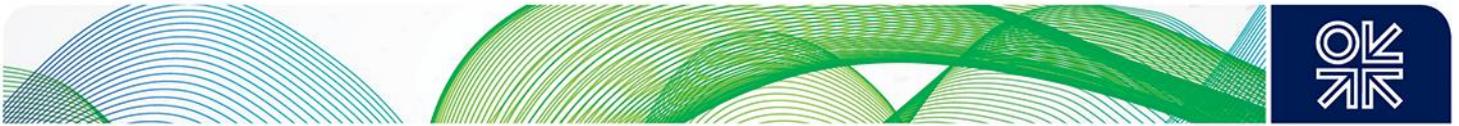
- In the residential/heating sector, a gradual (and definitive) decline of L-gas consumption is to be expected, with an acceleration post 2030 (see Chapter 3). It is unclear how much of this will be replaced by H-gas, but the general aim seems to favour any renewable solutions (geothermal, heat pumps) ahead of gas.
- In the industrial sector, the transition to renewables will happen slowly where possible, efficiency measures will tone down any growth in economic activity and ultimately, gas prices will determine the level of consumption.

⁶⁸

http://www.tennet.eu/fileadmin/user_upload/Company/Publications/Technical_Publications/Dutch/Rapport_Monitoring_Leveringszekerheid_2015-2031_.pdf

⁶⁹

http://www.tennet.eu/fileadmin/user_upload/Company/Publications/Technical_Publications/Dutch/Rapport_Monitoring_Leveringszekerheid_2015-2031_.pdf



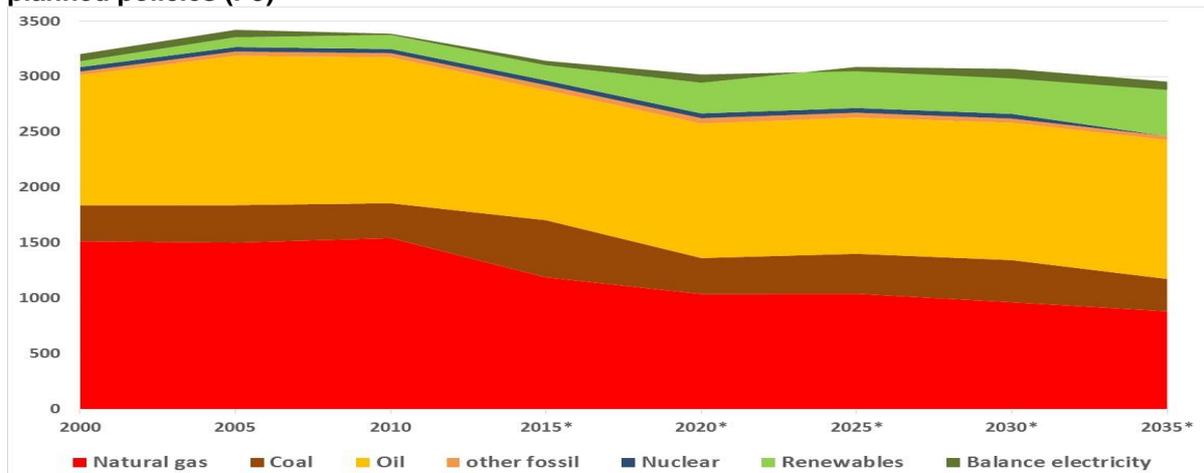
Scenarios for natural gas demand

There is a history of overestimating gas demand in Europe, at least since the early 2000s. Historical forecasts been revised downwards several times and one needs to be careful not to put too much weight on numbers for future gas demand. However, a rough idea of what all these assumptions would mean for the TPES, generation mix and gas demand is interesting.

The NEV 2016 proposes two scenarios: the following chart show the scenarios based on implemented and planned policy. The scenarios shown below are the latter (i.e. planned policy). Details on the main assumptions can be found in the initial document,⁷⁰ but briefly, one can note that economic activity increases slowly (GDP grows from an index of 117 in 2015 to 164 in 2035), gas prices decline from 21 €/cm to 18 €/cm in 2020 before climbing to 30 €/cm in 2035 and CO₂ prices rise from 8 €/tons in 2015 to 39 €/tons in 2035.

Primary energy shows a slow decline due to heat consumption going down, while electricity demand is rather flat. In the other sectors, the service sector declines sharply, as well as the residential sector and agriculture. Energy demand in the industry and traffic/transport sectors is more or less constant. As for natural gas, after a dramatic decline between 2010 and 2015, the trend keeps going down but at a much slower pace up to 2035 [Figure 10]. This is the result of flat TPES and a growing share of renewables, as well as continued competition from coal until the late 2020s. Gas demand therefore declines from about 34 bcm in 2015 to 29.5 bcm in 2020 and 25 bcm in 2035.⁷¹

Figure 10: TPES: historic and future scenarios (post 2015) with the impact of existing and planned policies (PJ)



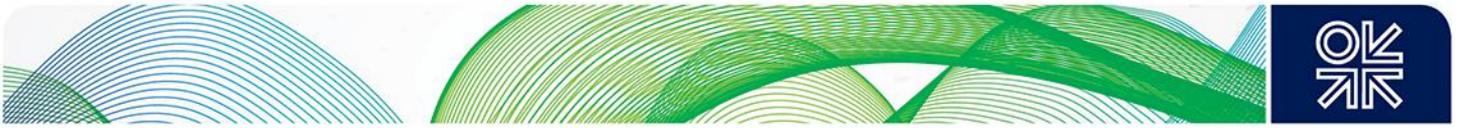
Source: Author's elaboration from Central Bureau of Statistics, Tabel 4b: Energieverbruik (vastgesteld en voorgenomen beleid), see also p.73 of main report⁷²

Scenarios for electricity generation show a growth from 100 TWh in 2016 to 140 TWh in 2035 due to the electrification of the economy and exports (the country is expected to become a net power exporter by around 2023). The mix is however expected to change quite significantly up to 2035 as seen in Figure 11. Rapid renewables growth post-2015 is the main characteristic, especially thanks to wind generation, but solar and biomass also contribute. Electricity generated from gas and coal is expected to decline steadily from 2016 to 2020 (due to the closure of the remaining coal plants under

⁷⁰ English version: <http://www.pbl.nl/en/publications/national-energy-outlook-2016>, pp.6-7

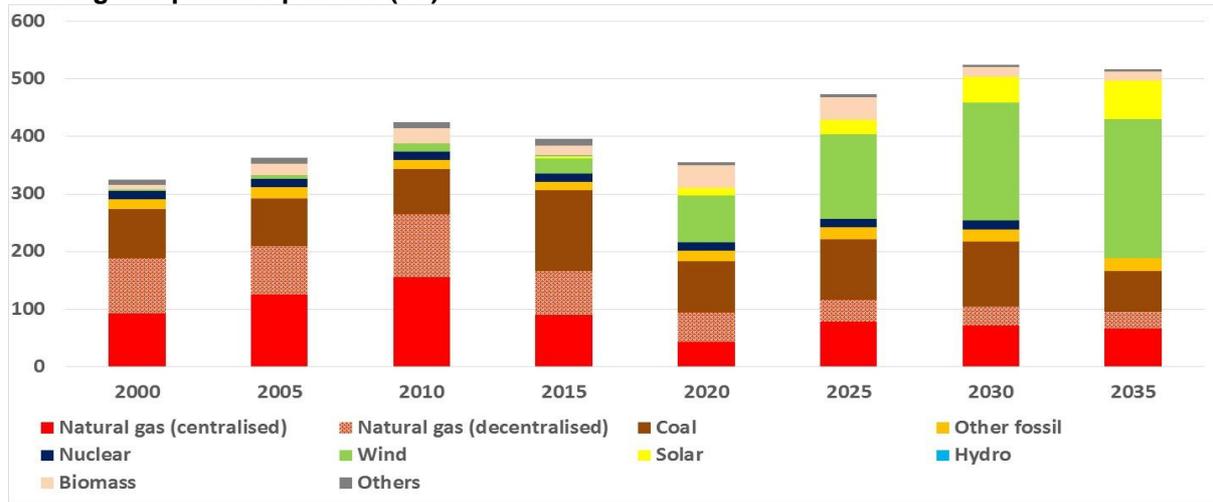
⁷¹ Original data in PJ, converted using Gasunie unit converter: <https://unit-converter.gasunie.nl/> .
<http://www.pbl.nl/en/publications/national-energy-outlook-2016>, p.9. Summary in English. Original document: <https://www.ecn.nl/publicaties/PdfFetch.aspx?nr=ECN-O--16-035>, p.115 (in Dutch only)

⁷² <https://www.ecn.nl/publicaties/PdfFetch.aspx?nr=ECN-O--16-035>



the Energy Accord, and increased interconnection capacity with Germany and Denmark which will facilitate cheaper electricity imports), but then generation from fossil fuels increases again after 2020 until about 2030 to fulfill growing electricity demand. Post 2027, coal finally declines in the mix, being replaced by renewables. Gas also shows a small decline as gas plants are used increasingly as a back-up for renewables (rather than as baseload or mid-merit).

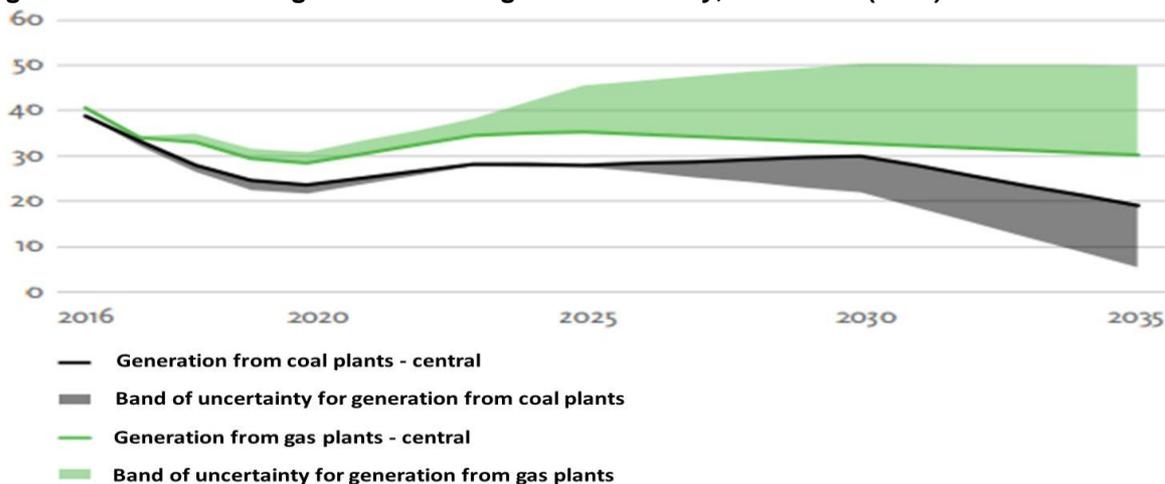
Figure 11: Electricity generation: historic and future scenarios (post 2015) with the impact of existing and planned policies (PJ)



Source: Author's elaboration from Central Bureau of Statistics, Tabel 13b: Aanbod van elektriciteit1 (vastgesteld en voorgenomen beleid), see also p.115 of main report⁷³

The future role of coal and gas, and competition between the fuels in power generation is of course difficult and uncertain to predict. Figure 12 shows the band of uncertainty of generation between the two fuels.

Figure 12: Gas and coal generation – range of uncertainty, 2016-2035 (TWh)

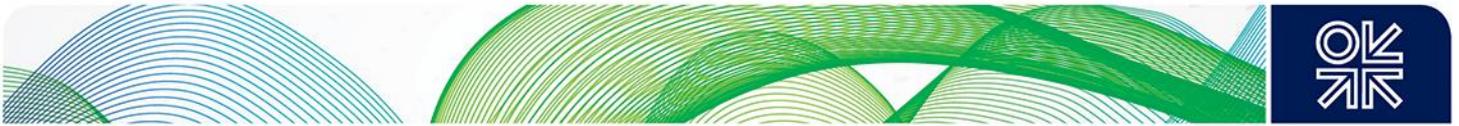


Source: Central Bureau of Statistics, p.115⁷⁴

To achieve these scenarios, a dramatic change in the generation capacity fleet will need to occur. In 2017, the market is oversupplied with no real signals for additional investments. Nonetheless, these

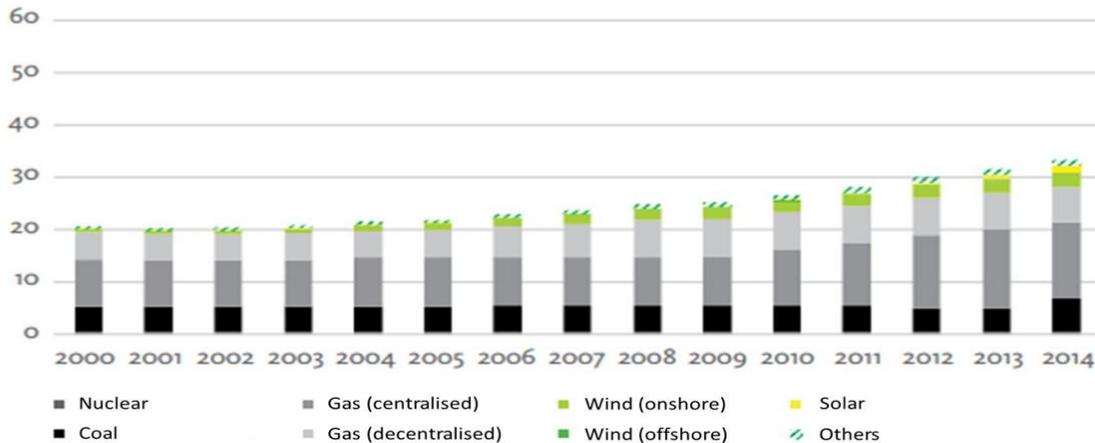
⁷³ <https://www.ecn.nl/publicaties/PdfFetch.aspx?nr=ECN-O--16-035>

⁷⁴ <https://www.ecn.nl/publicaties/PdfFetch.aspx?nr=ECN-O--16-035>



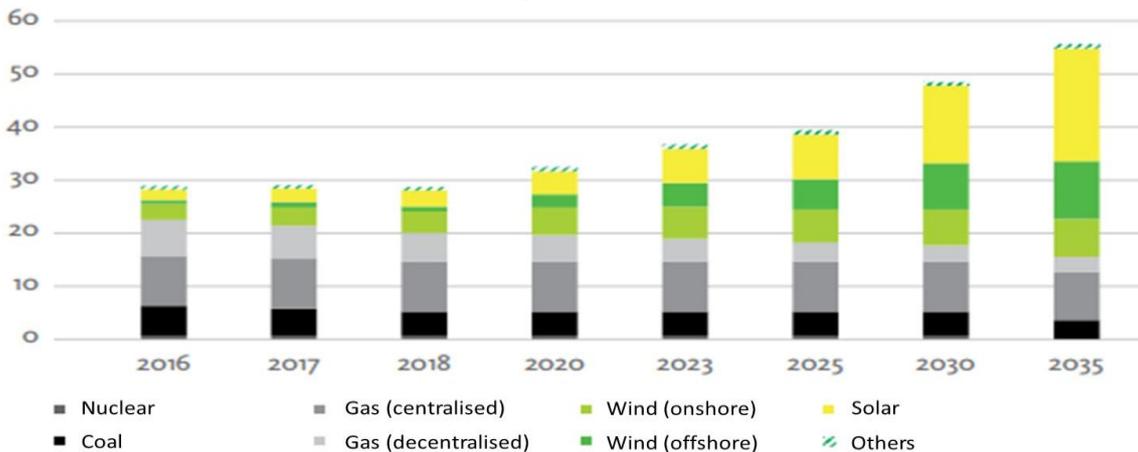
scenarios are based on a transformation from a fleet which is essentially focused on fossil fuel as seen in Figure 13, to new additions of renewables, especially wind (onshore and offshore post 2020) and also solar, as seen in Figure 14.

Figure 13: Installed capacities in the power generation sector, 2000-2014 (GW)



Source: Central Bureau of Statistics, p.115⁷⁵

Figure 14: Installed capacities in the power generation sector, 2016-2035 (GW)



Source: Central Bureau of Statistics, p.115⁷⁶

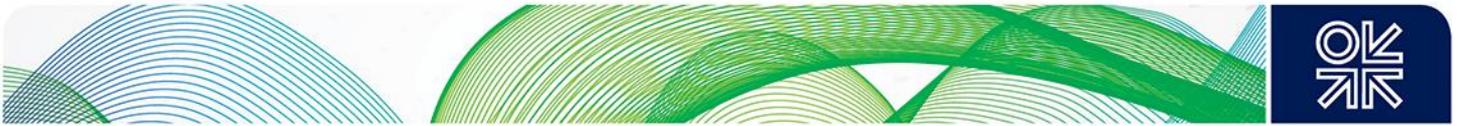
NEV is the official document that presents scenarios for the future energy outlook in the Netherlands. However, it only focuses on/tests the implemented policy and proposed policy, while new policies are not considered. As a result, the government is likely to fall short on some of its targets. For instance, reaching the CO₂ targets for 2023/2030 will require additional measures and they are therefore not likely to be met in the NEV scenarios.

Other scenarios are available, notably from Gasunie in its Network Development Plan 2015.⁷⁷ The company looks at three scenarios (each considering the case of average and cold winters). In the 'green focus' scenario, electricity generation is determined by environmental issues and gas loses market share to renewables (but acts as a back-up to these intermittent resources when needed) but wins market share from coal beyond 2020. In this scenario, in an average year (as opposed to a 'cold'

⁷⁵ <https://www.ecn.nl/publicaties/PdfFetch.aspx?nr=ECN-O--16-035>

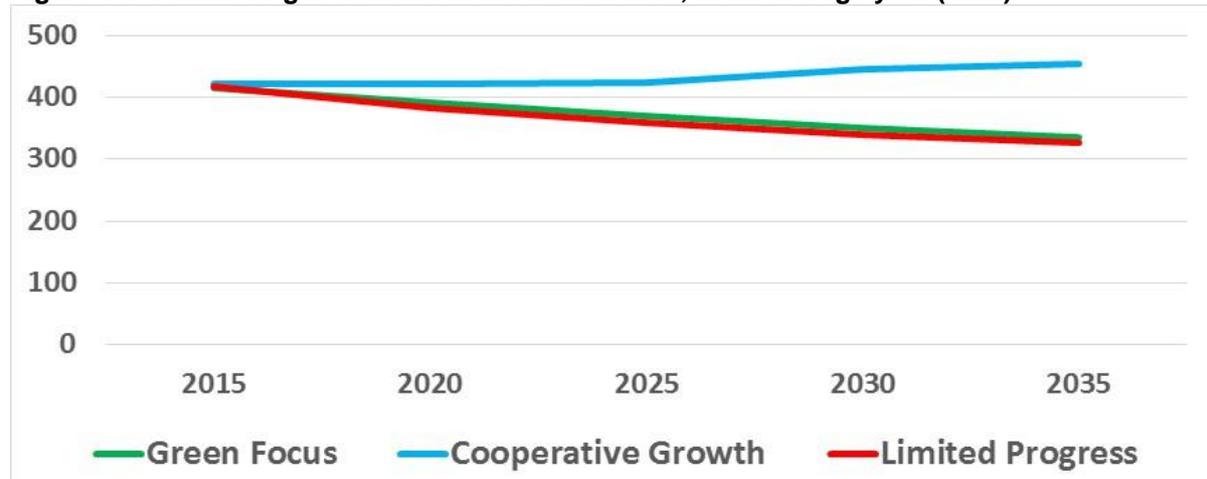
⁷⁶ <https://www.ecn.nl/publicaties/PdfFetch.aspx?nr=ECN-O--16-035>

⁷⁷ <https://www.gasunietransportservices.nl/en/network-operations/maintenance-of-transmission-system/network-development-plan-nop>



year), natural gas demand reaches 38 bcm in 2020 and 35 bcm in 2030 (down from 43 bcm in 2015).⁷⁸ Only in the 'cooperative growth' scenario (with more limited renewable capacity installed, no change in the merit order between coal and gas until 2025, and limited changes in the heating sector) does gas demand increase to 2035 (43.5 bcm in 2025 and 46.5 bcm in 2035) [Figure 15].

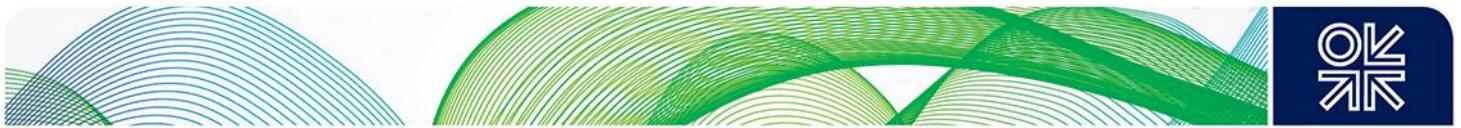
Figure 15: Volume of gas demand in the Netherlands, in an average year (TWh)



Source: Gasunie (2015), Network Development Plan 2015, p.23⁷⁹

In these scenarios, natural gas is expected to play a radically different role than it has had historically. Gas demand is expected to decline but at the same time, gas will remain important in the Dutch energy system even if only as the default fuel that everyone can count on when other options fail or need back-up. But in a context of declining indigenous (and flexible) production and rising import dependency, how will the country adapt to this new deal?

⁷⁸ Original data given in TWh/year. It was converted using Gasunie's unit converter: <https://unit-converter.gasunie.nl/>
Note 1: the document was published in July 2015, therefore the data for 2015 is also an assumption, which may explain the discrepancy with the data given in the NEV 2016.
Note 2: 'Green focus' and 'Limited progress' scenarios show very similar outlook. This is surprising and the reason why is not explained in the NDP. See pp.22-24
⁷⁹ Data available at <https://www.gasunietransportservices.nl/en/network-operations/maintenance-of-transmission-system/network-development-plan-nop>



II. Declining indigenous production

2.1. Groningen production: an earlier decline

In 2016, the Netherlands produced about 47.4 bcma of natural gas, which accounted for about 10 per cent of OECD Europe gas demand and about 118 per cent of national gas demand.⁸⁰ Production was 42 per cent down from 2013, a consequence of the production caps imposed on Groningen field extraction, which accounted for more than half (57 per cent) of total gas production [Figure 16].⁸¹

Figure 16: Natural gas production from Groningen and small fields, 2010-2016 (bcm)



Source: Central Bureau of Statistics, retrieved February 2017⁸²

As seen in Chapter 1, about 75 per cent of the initial reserves in the giant Groningen gas field have been produced, and although there are still about 841 bcm Geq underground, future production forecasts predict a decline. This second chapter focuses on the decline of Groningen gas production, changes since 2012, expectations for the future and possible alternative solutions for the Netherlands.

2.1.1. Groningen gas production and earth tremors: not a new discovery

Groningen at the centre of the Dutch gas system

After the oil crisis of 1973, the Groningen field became the balancing field for the Dutch gas system. Thanks to its natural geology, production could easily be adjusted to respond to seasonal variations in gas demand, notably (but not exclusively) from residential end-users, as seen in Figure 17.⁸³

The role of swing producer implies some uncertainty over annual output, but in order to keep flexible output for as long as possible, a maximum level was established for the field's production. For instance, following on this logic, the production from the Groningen field was capped at 425 bcm for the period 2006-2015 (i.e. about 42.5 bcm per year). Production peaked in 2013 at nearly 54 bcm,⁸⁴ a year with an especially cold and long winter.

⁸⁰ Author's estimates based on IEA, monthly data: <https://www.iea.org/statistics/monthlystatistics/monthlygasstatistics/> (retrieved in February 2017)

⁸¹ Argus data, <http://www.argusmedia.com/> (retrieved in February 2017)

⁸² <https://www.cbs.nl/en-gb/news/2017/09/gas-exports-halved-in-the-past-three-years>

⁸³ <https://www.government.nl/topics/energy-policy/contents/natural-gas>

⁸⁴ <http://www.nam.nl/feiten-en-cijfers/gaswinning.html#iframe=L2VtYmVkl2NvbXBvbmVudC8/aWQ9Z2ZFd2lubmluZyNOYWltdGFiLWRvd25sb2Fkcy01MiM1MDYzNDc3OTg0M2MyOGI0YThjYTc2OTBiZjhiNQ>

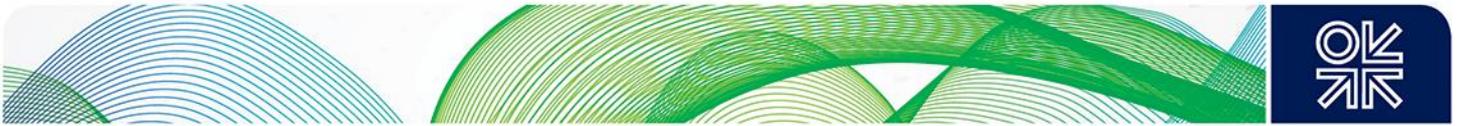
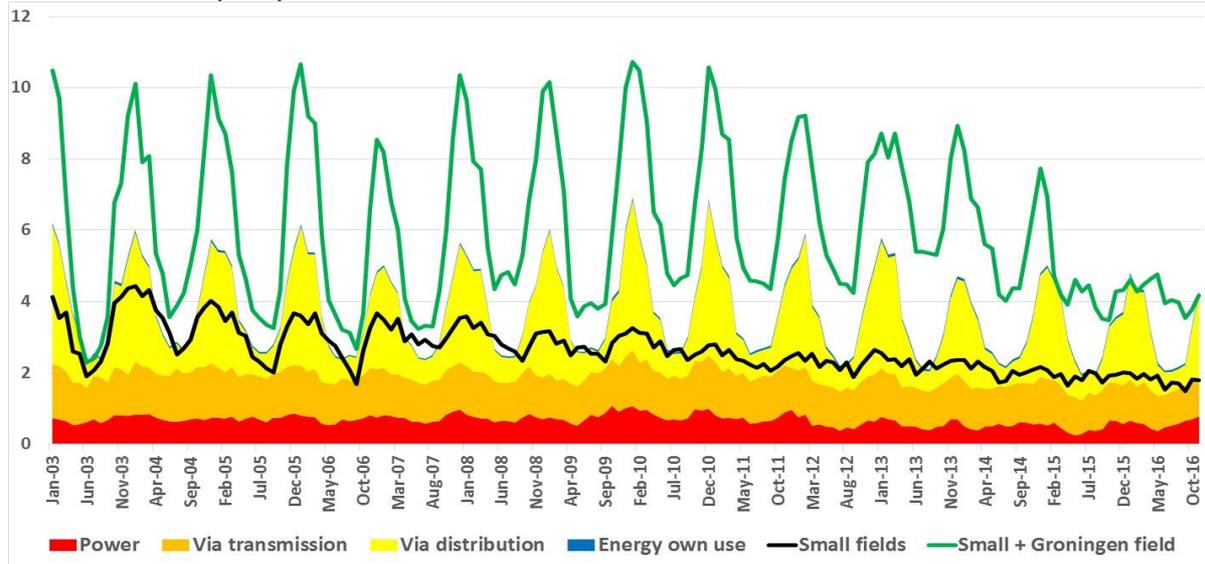


Figure 17: Natural gas demand fluctuations and indigenous production, January 2003–November 2016 (bcm)



Sources:

+ Demand data: Central Bureau of Statistics, retrieved in February 2017⁸⁵

+ Supply data: Argus data, retrieved in February 2017⁸⁶

Earth tremors: a game changer from 2012

Earth tremors in the Groningen region linked to the field's production have been known and recorded since the early 1990s,⁸⁷ but they became more frequent and more intense when gas output increased post-2008 [Figure 18].⁸⁸ Not only did the earth tremors become more frequent, but the seismicity (number of events and magnitude) which had originally been confined to the centre of the field, started to expand outwards over the field, and larger seismic events also began to spread out from the centre and occur closer to the earth's surface. It is believed that 30,000 buildings were damaged by the earth tremors, but luckily no serious physical injuries have so far been reported. The earth tremor Huizinge in August 2012 was a turning point for gas extraction in Groningen. This tremor had a magnitude of 3.6 on the Richter scale, the strongest caused by gas extraction thus far in the Netherlands. The tremor was felt more acutely by local residents than previous seismic activity and, in addition to the material damage it caused, it raised many concerns over the safety of gas extraction.⁸⁹ It is important to note here that these tremors have nothing to do with the type of problems often mentioned in the case of unconventional gas developments (fracking). Production in the Groningen region is from conventional gas resources, and has nothing to do with fracking.

After the Huizinge quake, the Minister of Economic Affairs requested an amended production plan for the Groningen field, which NAM submitted at the end of 2013.⁹⁰ Due to declining reserves, the

⁸⁵ <https://www.cbs.nl/en-gb>

⁸⁶ <http://www.argusmedia.com/>

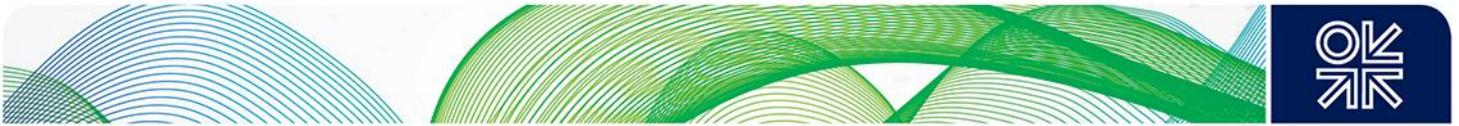
⁸⁷ The first event in the Groningen gas field occurred on 4 December 1991 and had a magnitude of $M_L=2.4$. <http://www.nlog.nl/en/groningen-gasfield>

⁸⁸ Technical reports can be found at <http://www.nlog.nl/en/node/536>. The websites of Kennislink (in Dutch only) also provide information on earth tremors induced by gas production.

<https://www.nemokennislink.nl/publicaties/zwaardere-aardbevingen-door-gaswinning-groningen>

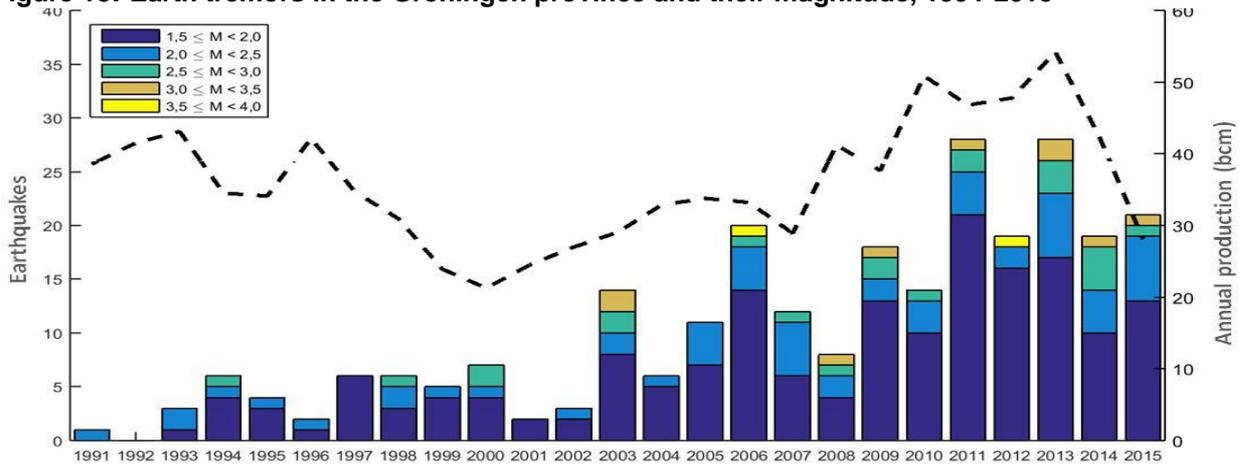
⁸⁹ <https://www.onderzoeksraad.nl/en/onderzoek/1998/earthquake-risks-in-groningen>

⁹⁰ Production permits in the Netherlands are granted on the basis of the production plan which describes how NAM must produce gas safely and responsibly. <http://www.nam.nl/english-information.html>



general trend was for a continuous decline over the coming decades,⁹¹ but due to earth tremors, the decline in production happened faster than anticipated. Since 2014 the volume of gas produced from the Groningen gas field has been determined by the Minister of Economic Affairs, and annual production as well as seasonal fluctuations have fallen sharply.

Figure 18: Earth tremors in the Groningen province and their magnitude, 1991-2015



Source: TNO report, retrieved in February 2017⁹²

2.1.2. A maximum production set at 24 bcma for the gas year 2016-17 but revised down to 21.6 bcma for the gas year 2017-18

Following the 2012 earthquake in Huizinge, it became urgent to find a compromise between the safety of the population of Groningen and the security of supply for the millions of households that depended on Groningen gas. A 2015 report conducted by the Dutch Safety Board found that the safety of residents in the Groningen area had not been given a high enough priority by NAM or other parties such as the Ministry of Economic Affairs (and also the State Supervision of Mines, Energie Beheer Nederland (EBN), Shell, ExxonMobil and GasTerra).⁹³ The report noted that:

“The parties concerned deemed the safety risk to the population to be negligible and thus disregarded the uncertainties surrounding this risk assessment. The Dutch Safety Board therefore concludes that the parties concerned failed to act with due care for citizen safety in Groningen with regard to the earthquakes caused by gas extraction.”⁹⁴

This is in addition to the fact that local people have seen few benefits from the gas revenues in terms of regional development.

Groningen production cap: several revisions⁹⁵

- In January 2014, in response to growing concerns about seismic activity, the maximum production from Groningen was set at 42.5 bcm for 2014, 42.5 bcm in 2015, and 40 bcm for 2016. Production in the areas most at risk was also reduced by 80 per cent and limits were placed on

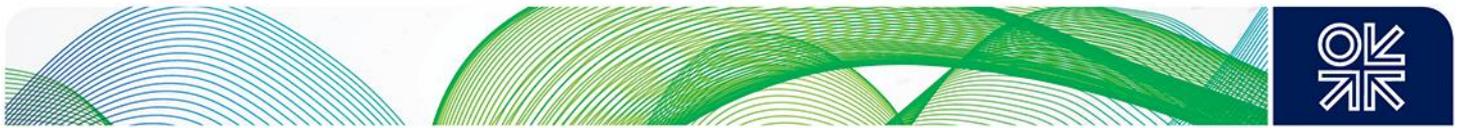
⁹¹ Gas production from the Groningen field was expected to end around 2080. <http://www.nlog.nl/en/groningen-gasfield>

⁹² TNO (2016), Groningen field 2013 to present, Gas production and induced seismicity, TNO 2016 R10425, <http://nlog.nl/en/groningen-gasfield-0>

⁹³ <http://www.gasterra.nl/en/news/the-seinen-scale>

⁹⁴ <https://www.onderzoeksraad.nl/uploads/phase-docs/844/972d8bf7f1d1summary-gaswinning-groningen-en.pdf>, p.6

⁹⁵ News about decisions on Groningen production: <https://www.rijksoverheid.nl/onderwerpen/aardbevingen-in-groningen/nieuws>. Additional information: <http://www.nlog.nl/en/groningen-gasfield>. For details about the (long) process before a decision is made, see <http://www.gasterra.nl/en/news/gaswinningsbesluit-groningen-een-werkbaar-compromis>



total output with a maximum of 3 bcm for the Loppersum clusters (Leermens, Overschild, de Paauwen, Ten Post, Het Zand).⁹⁶

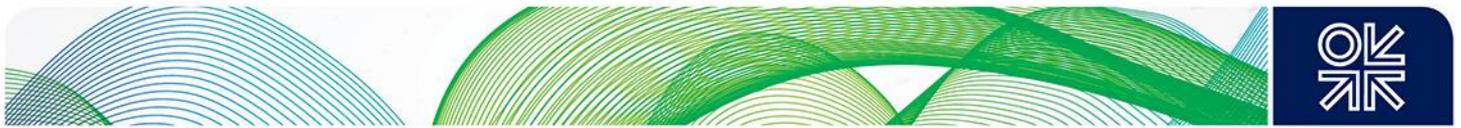
- In December 2014, the cap was revised downwards from 42.5 bcm to 39.4 bcm for 2015, and from 40 bcm to 39.4 bcm for 2016. The maximum 3 bcm for the Loppersum clusters was maintained, and a maximum 9.9 bcm for the clusters close to Hoogezand-Sappemeer (Kooipolder, Slochteren, Zuiderveen, Spitsbergen, Tusschenklappen, Froombosch, Sappemeer) for the period 1 October 2015 until 30 September 2016 was decided, in addition to a maximum of 2 bcm for the Eemskanaal cluster.
- In February 2015, the maximum total production was set at 16.5 bcm for the first six months of 2015.
- In June 2015, the maximum total production was set at 13.5 bcm for the last six months of 2015. As a result, the total for 2015 was capped at 30 bcm (instead of 39.4 bcm), in addition to a single net extraction from the gas storage in Norg of 3 bcm. This measure was possible thanks to a warm winter and sufficient storage levels. The following years were capped at 33 bcm per year (so the maximum production for 2016 was also revised down from 39.4 bcm to 33 bcm).
- In November 2015, the State Council ordered further cuts in gas production: the Court ruled that production be limited to 27 bcm for the gas year 2015/2016, until the Minister of Economic Affairs took a new resolution on NAM's production plan. An upper limit of 33 bcm was set in the event of a severe winter.
- In June 2016, the State Council ordered a cap of 24 bcma over the next five years with 6 bcma of extra gas being allowed to be produced in a cold gas year.⁹⁷ Extraction should also be spread evenly over the year and kept at a stable level with minimal fluctuations. The cluster structure was to be maintained; the Loppersum cluster is available only to guarantee the security of supply when needed. On 1 October 2016, the decision was made for gas production in the gas year 2016-2017. NAM is to submit a new extraction plan in 2020 and a new natural gas extraction decree will be released before 1 October 2021.⁹⁸ The volumes have been set at a level which enables contractual obligations to be met, as well as guaranteeing security of supply in the Dutch gas market. An additional production of up to 1.5 bcm is also allowed if there are any disruptions to other sources of low-calorie supply, such as constraints to conversion facilities. The reduction in production has resulted in fewer, and less intense, earth tremors. The cap of 24 bcma of gas produced, combined with as uniform as possible rate of extraction was expected to reduce the problem further. Additional measurement of the effects of these limits on gas production on seismicity was to take place up to 2021, with an annual adjustment of the cap to maintain security of supply if needed.
- On 21 December 2016, a hearing was held at the Dutch Council of State after a group of eight individuals submitted an appeal against the government's production plan as an 'urgent request', calling for an immediate halt to gas production or, failing that, a reduction to less than 12 bcma. They demanded a suspension of the cap until a final ruling was made. Early in January 2017, the Council rejected the appeal. It found that a '(partial) suspension of gas extraction would have far-reaching consequences for households, institutions and businesses in the Netherlands', and also for other countries in the region. There had been no increase in seismic activity in the region following the reduction in output in recent years and any further reduction in production could make it difficult to meet low-calorie heating demand in northwest Europe. The court said that more thorough research into the objections against the current production plan, such as the time frame of five years, will have to be carried out for the full hearing, which was planned on 22 May 2017. The decision was then to be taken 'a few months' after the hearing. In total, the court has received 22 admissible appeals from individuals and environmental organisations as well as the province of Groningen and regional municipalities.⁹⁹
- In mid-February 2017, the Groningen production cap was again debated in the Dutch second chamber, which almost unanimously agreed that Groningen production should be cut again and

⁹⁶ <http://www.nlog.nl/en/groningen-gasfield>

⁹⁷ <https://www.government.nl/topics/energy-policy/news/2016/06/25/extraction-of-natural-gas-in-groningen-reduced-to-24-billion-cubic-metres> in EU Quaterly report Q2 and Q3 2016. A very cold winter is defined as 2,300 degree days

⁹⁸ <http://www.nam.nl/gas-en-oliewinning/groningen-gasveld/kabinetsbesluit-winningsplan.html>

⁹⁹ Argus, 24 February 2017, Dutch court to hear Groningen case in May



that this should become a central task for the new government following the general elections on 15 March 2017 (the motion did not specify any figures at which production should be capped in future years). In their manifestos for the general election, some parties called for a lower cap with suggestions ranging from zero to 24 bcma (while other parties did not mention the Groningen production cap).¹⁰⁰ A motion, which called for the government to withdraw the production plan and to 'come up with a clear plan for phasing out' production from the field 'with concrete interim targets for the coming years', was rejected.¹⁰¹

- In April 2017, the government announced a plan to lower the Groningen cap by 10 per cent to 21.56 bcma for the 2017-18 gas year.¹⁰² The decision followed an increase in seismic activity in the Groningen area and advice by the Dutch state supervision of mines to further reduce the cap.¹⁰³ The 10 per cent reduction will apply to all caps for Groningen production, including the maximum amount of extra production in a cold year. This would limit output even in an exceptionally cold year to 27 bcma.¹⁰⁴ A more extensive and efficient use of quality conversion could offset this lower Groningen output.¹⁰⁵ Nitrogen quality conversion facilities operated at 56.7 per cent of capacity in October 2016-March 2017 and created around 6.3 bcm of pseudo-Groningen gas.¹⁰⁶ Increasing this to 85 per cent could create about 3.1 bcm more of this gas, enough offset the reduced cap.¹⁰⁷
- As a response to the government's plans to further reduce the Groningen production cap, the Dutch council of state postponed the hearing until 13 July 2017. A ruling on the case was expected to follow a few months after it is heard.¹⁰⁸

Rapid decline of production

Gasunie Transport Services (the Dutch system operator, GTS) calculated that 24 bcma was sufficient but a minimum of 21-22 bcma would be required to provide security of supply to the Dutch market and neighbouring countries that import Groningen gas.¹⁰⁹ This corresponds to about 30-33 bcma less than the volume produced in 2013. As a result, since the introduction of the caps, annual production has declined sharply as seen in Figure 19. Fluctuations have happened in the past, especially after the 1973 oil crisis, but this time, there is little to no prospect for a potential future recovery.

In addition to annual volumes (spread out during the gas year, which runs from October to September), the State Supervision of Mines¹¹⁰ also advised against major fluctuations within the gas year as this could increase the number and magnitude of earth tremors in the region. Fluctuations

¹⁰⁰ There appear to be some uncertainty and even discrepancy between political wishes for gas production (between zero to about 24 bcma for the candidates who have mentioned numbers) and how much of the revenues from gas production would be required to carry out the economic programmes proposed by some candidates. More info can be found at <http://www.rtvnoord.nl/nieuws/174273/Politiek-over-de-gaswinning-de-woorden-versus-de-cijfers> (last visited in February 2017).

¹⁰¹ Argus, 22 February 2017, Dutch lower house approves motion on Groningen gas cap

¹⁰² A new production plan could be published in mid-to-late May.

¹⁰³ Dutch producer Nam said that there had been a higher frequency of seismic activity around some of the Groningen field's Loppersum well clusters since late October 2016 (and remained high at the start of 2017). The seismic activity in the region does not exceed the limits set in the government's production plan for the Groningen field.

¹⁰⁴ Argus, 20 April 2017, Groningen output cap for cold year to be lowered

Note: The additional production of up to 1.5bn m³ allowed in case of disruptions to other sources of low-calorie supply could be reduced to 1.35bn m³ but the minister did not specifically mention this potential for extra offtake.

¹⁰⁵ The Dutch system operator GTS had found that a minimum of 21-22 bcma would be required to meet security of low-calorie supply in northwest Europe. Argus, 20 April 2017, Higher conversion to offset lower Groningen cap: Kamp

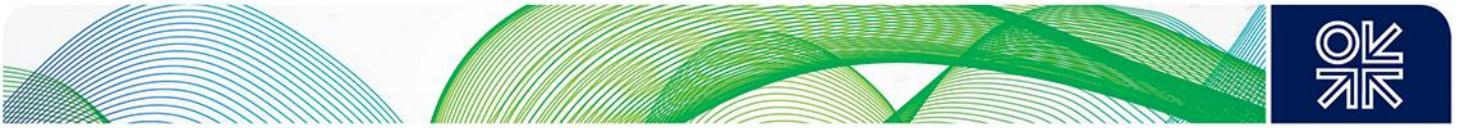
¹⁰⁶ The exact amount created could depend on the Wobbe value of the converted high-calorie gas

¹⁰⁷ GTS aims to use its quality conversion facilities at no more than 77 per cent for prolonged periods in order to provide some flexibility when there are spikes in low-calorie demand, but this was lowered from 85 per cent ahead of the 2016-17 winter. Argus, 20 April 2017, Higher conversion to offset lower Groningen cap: Kamp

¹⁰⁸ Argus, 3 May 2017, Dutch court postpones Groningen hearing

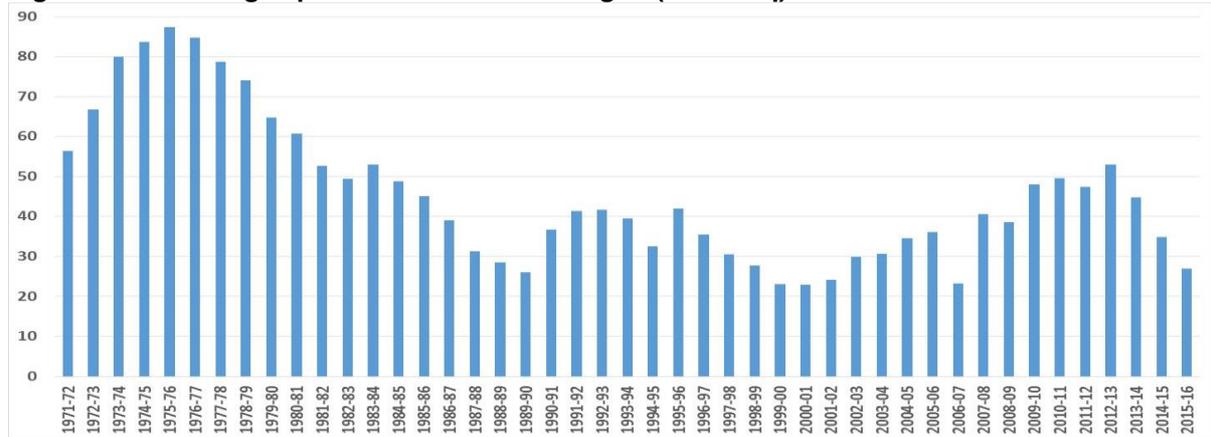
¹⁰⁹ Calculations were made for weather situations as in 50% of the time over the last 30 years. Argus, 20 April 2017, Higher conversion to offset lower Groningen cap: Kamp

¹¹⁰ The Mining Act sets out rules while the State Supervision of Mines is the overseeing body. A new Mining Act is being drafted with amendments that will tighten up the procedure for gas extraction and give local communities a greater say. <http://www.nlog.nl/en/legislation>; <https://www.government.nl/topics/energy-policy/contents/natural-gas>



need to stay within a range of plus or minus 20 per cent per month, but output can vary more freely on a daily or weekly basis. For instance, a 24 bcm cap meant 2 bcma per month, which would limit monthly output to a maximum of 2.4 bcm and a minimum of 1.6 bcm to stay within the 20 per cent range in months with 31 days.¹¹¹

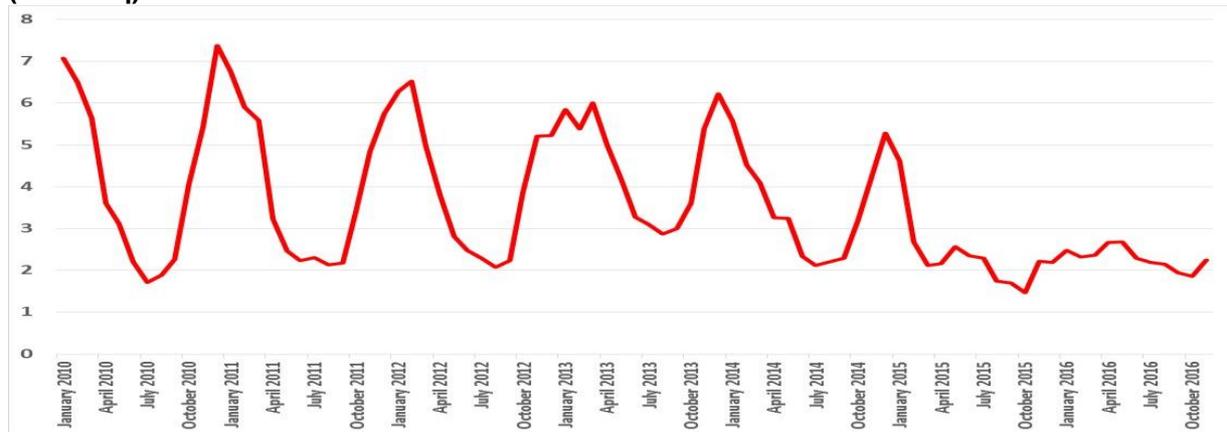
Figure 19: Natural gas production from Groningen (bcm Geq)



Source: NAM (retrieved in February 2017)¹¹²

As a result, the flexibility of production is becoming more and more limited as seen in Figure 20. Considering the high seasonality pattern of Dutch gas demand which is largely driven by temperatures (as well as gas demand from countries which import Groningen L-gas), this decline in flexible production will need to be carefully managed as the field will not be able to play its historical role of winter swing supplier. Still, while the main objective of avoiding seasonal and monthly fluctuations in extraction must be respected as much as possible, security of supply takes priority over the prevention of fluctuations.¹¹³

Figure 20: Natural gas production from Groningen, per month, January 2010-November 2016 (bcm Geq)



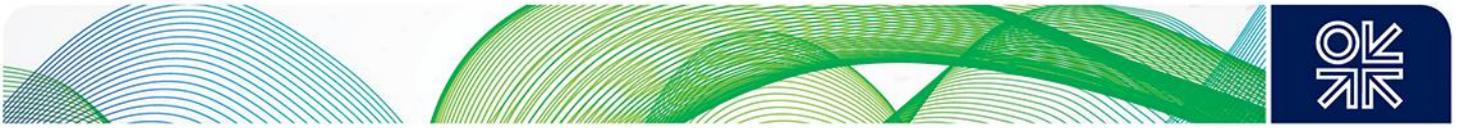
Source: NAM (retrieved in February 2017)¹¹⁴

¹¹¹ There is no daily limit, only a monthly one. Shorter months, especially February, will therefore enjoy a potential higher daily production.

¹¹² <http://www.nam.nl/feiten-en-cijfers/gaswinning.html#iframe=L2VtYmVkl2NvbXBvbmVudC8/aWQ9Z2Fzd2lubmluZyNOYWltdGFiLWRvd25sb2Fkcy01MjM1MDYzNDc3OTg0M2MyOGI0YThjYTc2OTBIZjhiNQ>

¹¹³ <http://www.gasterra.nl/en/news/gaswinningsbesluit-groningen-eeen-werkbaar-compromis>

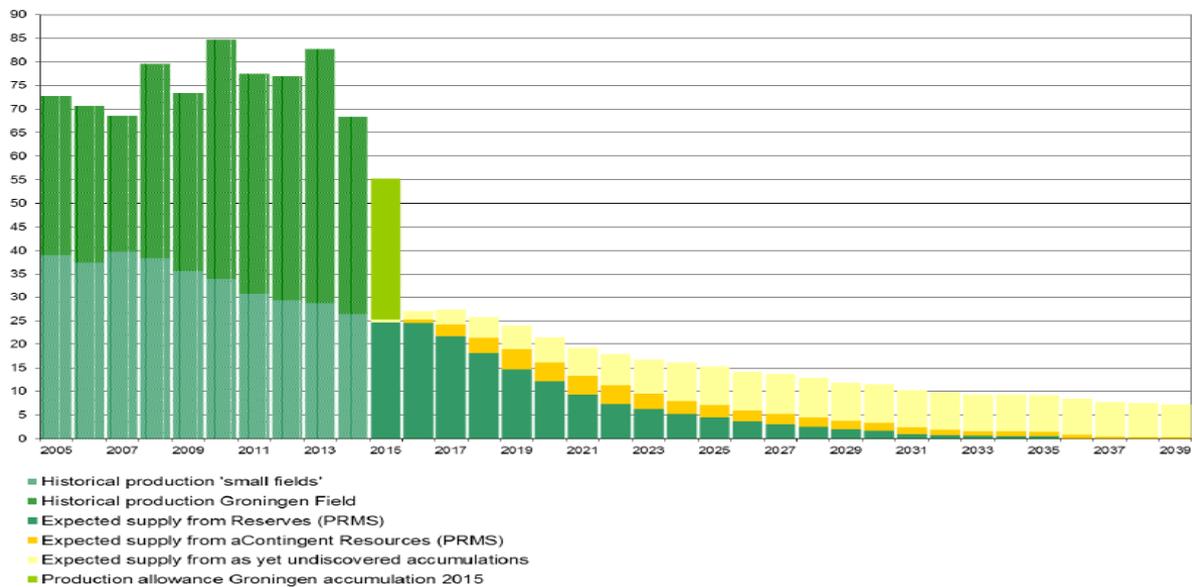
¹¹⁴ <http://www.nam.nl/feiten-en-cijfers/gaswinning.html#iframe=L2VtYmVkl2NvbXBvbmVudC8/aWQ9Z2Fzd2lubmluZyNOYWltdGFiLWRvd25sb2Fkcy01MjM1MDYzNDc3OTg0M2MyOGI0YThjYTc2OTBIZjhiNQ>



Future production caps?

There has been a complete change in the Dutch gas outlook since 2013. Uncertainties about future levels of natural gas production have been so high that in 2015, the Ministry of Economic Affairs did not even provide an estimate for the future production of the Groningen Field after 2015 so 'as not to make assumptions on decisions for future policy' in its Annual Review (p.25) [Figure 21].

Figure 21: Historical production of natural gas in the Netherlands, 2006-2014 and future production from small fields in 2015-2039 and Groningen estimate -only- for 2015 (bcm Geq)



Source: Ministry of Economic Affairs (June 2015), 2014 Annual Review, p.26

The future level of Groningen gas production is highly uncertain, even before 2021, and no-one can tell what the future cap will be although it almost certainly will not be raised and may well be lowered. The following remarks provide some food for thought:

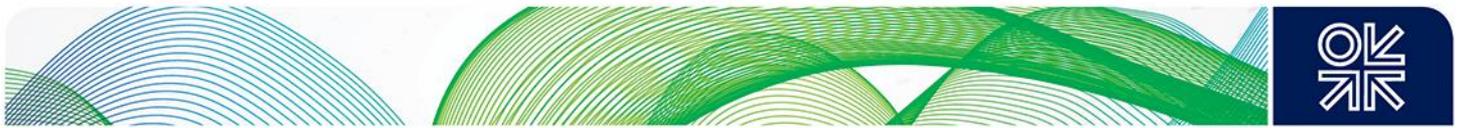
- The earth tremors caused by the extraction of natural gas in Groningen seem to be more problematic than natural earth tremors of the same magnitude. A 3.6 tremor/quake magnitude on the Richter scale is often felt indoors by people but not necessarily felt outdoors. It rarely causes damage, although the shaking of indoor objects can happen and be noticed. An induced earthquake (resulting from human activity) happens at a lower depth and as a result creates more damage on the surface according to KNMI (the Royal Netherlands Meteorological Institute).¹¹⁵
- Safety risks were addressed by halving gas production compared with 2012 and by reinforcing homes and other buildings.¹¹⁶ There were thirteen earth tremors with a magnitude greater than 1.5 in 2016, the lowest number since 2007 and down from 32 in 2013 before the caps were introduced. In addition, there was no earth tremors above 2.5 recorded, for the first time since 2002.¹¹⁷ However, the frequency of earth tremors has increased since October 2016 and the Dutch state supervision of mines requested that NAM carry out further research into the possible causes.¹¹⁸

¹¹⁵ Gas Strategies, 8 May 2015, Groningen tremors: what now for the Dutch giant?

¹¹⁶ <https://www.government.nl/documents/speeches/2016/09/20/speech-from-the-throne-2016>

¹¹⁷ Argus, 5 January 2017, Groningen seismic activity falls further

¹¹⁸ Argus, 31 March 2017, NAM sees no "obvious cause" for Loppersum tremors



- The earthquake-proof level of production is unknown and there is a lack of consensus on what the safe level should be between stakeholders, politicians and local residents. The next five years will be used to analyse the question for future caps.¹¹⁹
- Natural gas deposits in the Groningen gas field formed in coal seams hundreds of millions of years ago. The gas then moved up to the porous sandstone layers (Rotliegend).¹²⁰ While the initial reservoir pressure was 347 bar, it has declined to 95 bar by 2016 as a result of reservoir depletion, but the field could still produce gas as the abandonment pressure is estimated at about 10 bar.¹²¹ So there seems to be no geological reason for a rapid shut down of the field.
- The gas will be extracted more slowly than anticipated and as a result, the Netherlands could extract the gas over a longer period and, in theory, be able to meet a larger proportion of its gas needs for longer than previously assumed.
- There are expectations of lower demand for L-gas from Groningen after 2020 as importing countries (Germany, Belgium and France) switch to H-gas systems (see Chapter 3), four years earlier than the previously anticipated 2024 (which was expected due to normal decline of the field).
- The Groningen cap is based on expected consumption rather than contractual obligations, so a possible future level of output cannot be estimated based on GasTerra's obligations.¹²²
- Safety issues are being looked at by the Minister of Economic Affairs, the State Supervision of Mines, NAM and many other institutions but the Minister of Economic Affairs has the obligation to provide energy supply security.¹²³ Therefore, a total shutdown of Groningen production would create a very complicated situation; at least until a transition to an alternative energy system has been put in place.
- Even though lowering production does not eliminate the possibility of an earth tremor, the Safety Board does not advise a further reduction in production levels 'at the moment' as cold winters would lead to fluctuations in production, which in turn would increase the risk of earth tremors.¹²⁴ The impacts of lower gas production from Groningen are indeed felt more in winter when gas demand for heating is higher.
- In February 2017, Prime Minister Mark Rutte said that the cap would be reduced "if necessary" to guarantee the safety of Groningen residents.¹²⁵
- The government plays a central role in natural gas production, and the 2017 parliamentary elections have shown how the different political parties approach the gas issue.¹²⁶ All the opposition parties were critical of natural gas production and aimed for even lower levels than in 2016. Following the second chamber elections in March 2017, various parties (the Green party, the Party for Freedom, Democrats 66 and the Christian Democratic Appeal) will form a new Dutch government, and at the time of writing it was too soon to know if this new coalition will have consequences for the production cap (earlier than 2021).
- Court actions to shut Groningen down completely have so far been unsuccessful, but this may not be the case in the future, especially if there is further serious seismic activity.

There has been a need to find alternatives to Groningen gas since 2013, and this will continue to be the case until the markets switch to H-gas systems. A combination of measures would ease the transition. These alternatives are considered in the next section.

¹¹⁹ For additional details on the geology of the region and the impact of gas production on earth tremors, see <http://energypost.eu/groningen-gas-production-earthquakes-safety-cost/>

¹²⁰ <http://www.nam.nl/gas-en-oliewinning/groningen-gasveld/belang-van-groningen-gasveld.html#iframe=L2VtYmVkl2NvbXBvbmVudC8/aWQ9Q2hhcnRzL2dhc3dpbm5pbmcvdG90YWFsLWJhc2li>

¹²¹ <http://www.nlog.nl/en/groningen-gasfield>

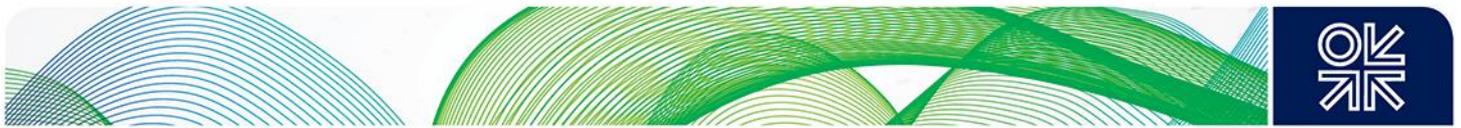
¹²² The expected demand was determined by system operators Dutch GTS, French GRT Gaz and Belgian Fluxys, the Dutch government said.

¹²³ The 2004 Gas Act establishes responsibilities related to gas crises. The ultimate responsibility remains with Dutch Ministry of Economic Affairs even if GTS can be put in charge of some aspects by the Minister. For more info, see GTS (2015), Preventive Action Plan, <https://www.rijksoverheid.nl/>

¹²⁴ <https://www.government.nl/topics/energy-policy/news/2016/06/25/extraction-of-natural-gas-in-groningen-reduced-to-24-billion-cubic-metres>

¹²⁵ Argus, 31 March 2017, Groningen gas cap must prioritise Dutch safety: OVV

¹²⁶ More info can be found at <http://www.rtvnoord.nl/nieuws/174273/Politiek-over-de-gaswinning-de-woorden-versus-de-cijfers> (last visited in February 2017).



2.2. Replacing Groningen gas: what are the alternatives?

Analysing the best alternatives to Groningen gas would necessitate a whole paper on its own to look at the impacts, costs on public finances, feasibility, security and time-frame for each option. Such an in-depth study is not within the scope of this paper, but this section offers a cursory examination of the possibilities for consideration. It looks at production from small gas fields in the Netherlands, storage options, import possibilities and demand-side responses.¹²⁷

2.2.1. Small fields

The Groningen field holds by far the largest gas reserves in the Netherlands, but as seen in Chapter 1, there are also many - much smaller - gas fields both on- and off-shore. These fields are more complicated and expensive to exploit (in terms of exploration and drilling) for the lower volumes produced, but the Small Field Policy introduced in 1974 guarantees a buyer for this gas. This policy was largely successful in developing new reserves,¹²⁸ and by 2016, there were over 250 gas fields [see map in Appendix 1], both on land and off-shore in the North Sea.¹²⁹ However, these reserves still represent only 185 bcm (Geq), or about 28 per cent of the remaining gas in Groningen,¹³⁰ and are mostly in mature fields which are becoming depleted. Production peaked in 2000, and has been in steady decline since. From the mid-2000s, sales have declined by about 2 bcm per year to reach about 21 bcma in 2016.¹³¹ The decline is likely to continue as the implementation of new projects is being made less viable by low gas prices, difficulty in obtaining licenses and social and political pressures.

Small fields are still expected to help meet gas demand in the Netherlands, as seen in Figure 22. On this chart, Groningen's production was expected to remain equal to the maximum 24 bcma for the gas year 2016-17 for about ten years or until the projected decline of production due to low gas reserves passes below this cap (after 2025). It is hoped that the cap on maximum production will keep gas being produced for longer (deferred production), although this cannot be guaranteed. Small fields are also in decline but contribute to the annual supply of the market, especially in offshore fields. Their decline may be faster than previously anticipated: expected small field production capacity was revised down to 76.3 mcm/d in 2017 from the forecast of 86.4 mcm/d a year earlier.¹³² With annual demand also falling, it may not be until around 2030 - 2035 that natural gas imports outweigh exports and the country becomes a net annual gas importer.¹³³

Declining production is expected to continue as output from mature fields drops faster than new projects are being developed.¹³⁴ In addition, investments in new gas production are not attractive, Returns on investment in the gas sector are under pressure due to low oil and gas prices, and this casts a shadow on scenarios for future production which may not even be realized.

¹²⁷ For more detailed analysis including all these aspects, see http://www.ce.nl/publicatie/maatschappelijke_effecten_van_alternatieven_voor_gasproductie_uit_het_groningenveld/1691 (in Dutch), or <https://www.rvo.nl/sites/default/files/2016/05/Alternatives%20for%20dealing%20DEF.PDF> (English)

¹²⁸ <http://www.gasterra.nl/en/products-and-services/todays-market/dutch-small-field-policy>

¹²⁹ Onshore fields are located in the provinces of Friesland, Drenthe, Overijssel, North Holland, South Holland, and at the edge of the province of Groningen. <https://www.government.nl/topics/energy-policy/contents/natural-gas>

¹³⁰ <http://nlog.nl/en/oil-and-gas-fields-overview>

¹³¹ Author's estimate from Argus data & <http://jaarverslag2015.gasterra.nl/en/gas/procurement>

¹³² Some of the Dutch onshore fields were halted completely at the beginning of 2017 and the production in the rest of the fields was also much slower than a year before. Offtake in 2016 was 58.6 mcm/d across the entire year, the lowest since at least 2003. Argus, 20 April 2017, GTS expects slower decline of Dutch small fields

¹³³ <https://www.ecn.nl/publicaties/PdfFetch.aspx?nr=ECN-O--16-035>, p.121

¹³⁴ <http://www.nlog.nl/en/production-and-injection-data>

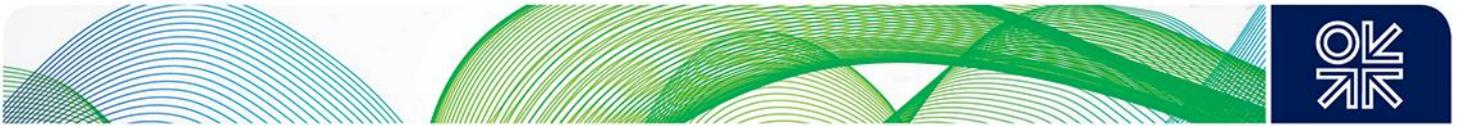
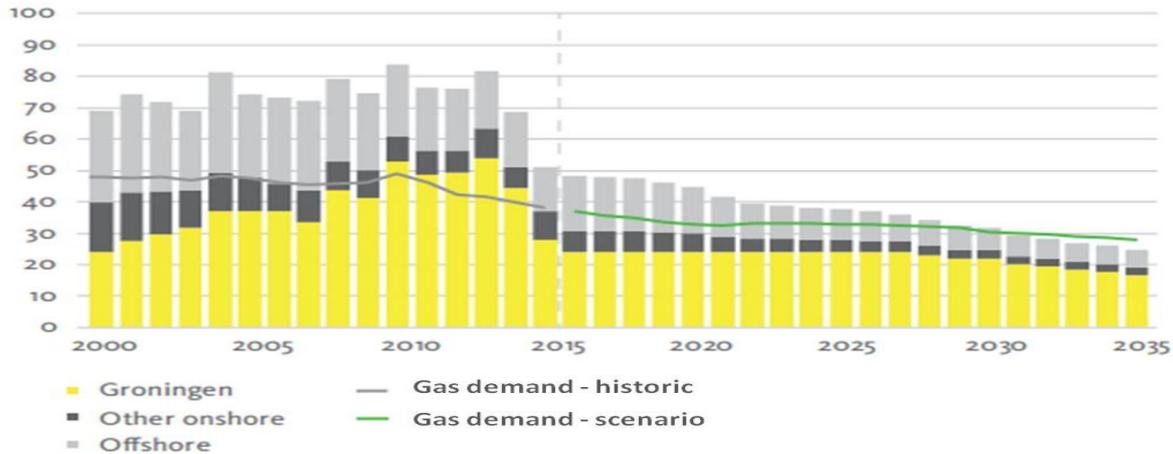


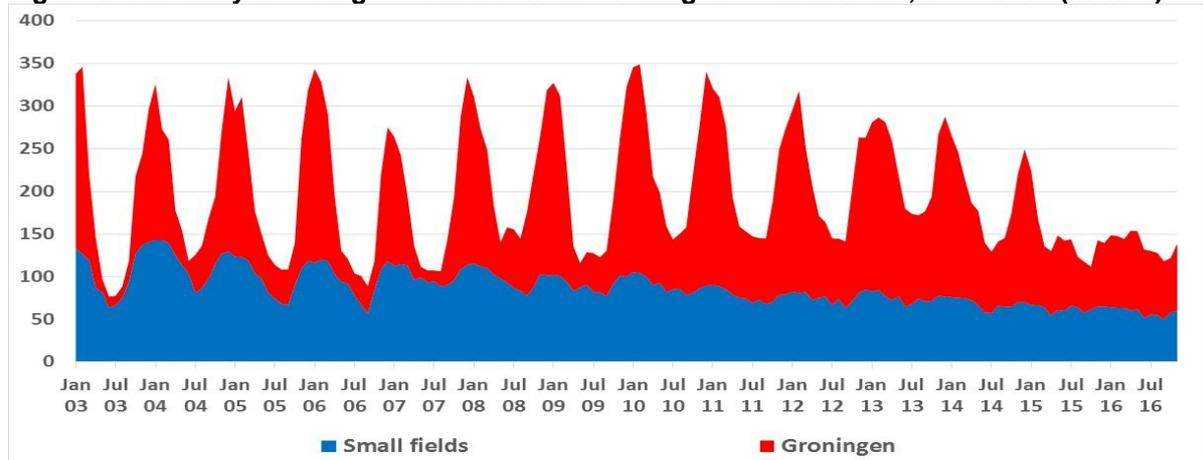
Figure 22: Natural gas production and demand, 2000-2035 (bcm Geq)



Source: Nationale Energieverkenning 2016, p.121¹³⁵

The majority of the seasonal flexibility of the Dutch gas production came from the Groningen field as previously mentioned, but it is worth noting that the small fields also used to display some fluctuations, at least up to the mid-2000s. In line with their annual decline, the variations between summer and winter production has also disappeared [Figure 23].

Figure 23: Monthly natural gas available from Groningen & small fields, 2003-2016 (mcm/d)



Source: Argus data¹³⁶

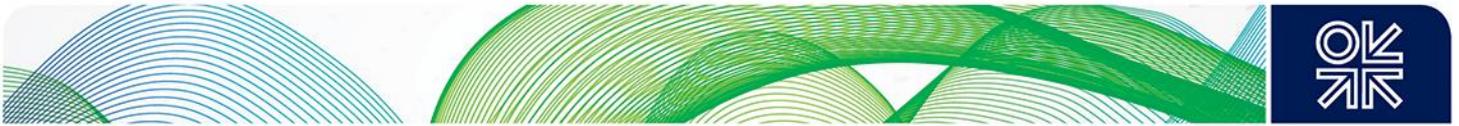
Small fields do contribute to overall output, but their annual output is in decline, with limited to non-existent possibilities of future increases; also the seasonal flexibility is gone. Additional alternatives are in place already and new ones will need to be initiated in order to manage the Dutch gas market and its export commitments, as seen especially since 2013.

2.2.2. Other options

Despite the drastic curtailment of Groningen production, the country has not suffered any specific disruption in gas supplies: volumes committed on the domestic market or abroad were delivered and prices on the Title Transfer Facility (TTF: the Dutch gas hub) have remained within an expected

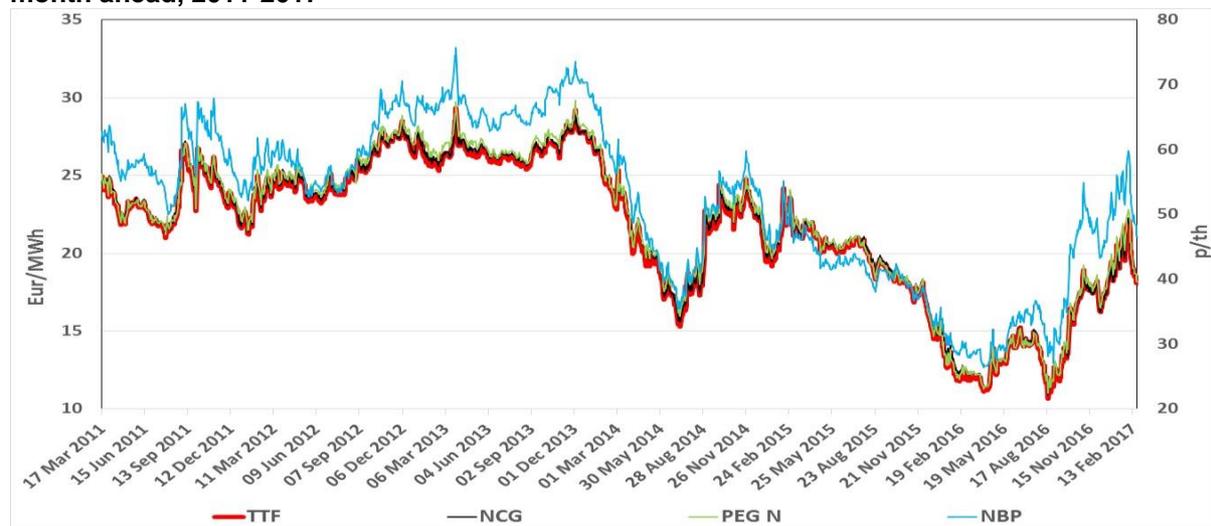
¹³⁵ <https://www.ecn.nl/publicaties/PdfFetch.aspx?nr=ECN-O--16-035>

¹³⁶ <http://www.argusmedia.com/>



volatility band, even during the winter.¹³⁷ The cold winter of 2016/2017 did push prices up as demand for low-cal gas rose, but this was not dissimilar to what happened to hub prices in other markets [Figure 24]. Production, quality conversion, H-gas and L-gas storage, and imports have been well used and a major shortfall has not happened. As for the impact on gas prices, the effects were limited as Northwest Europe has been long in flexible gas over the same period. In the longer term, other measures are being taken to reduce further dependency on Groningen gas such as the option of converting appliances, replacing natural gas in the mix by renewables, and green gas.¹³⁸

Figure 24: Natural gas prices on the TTF, NCG, PEG Nord (€/MWh) and NBP prices (p/th), month ahead, 2011-2017



Source: Argus data¹³⁹

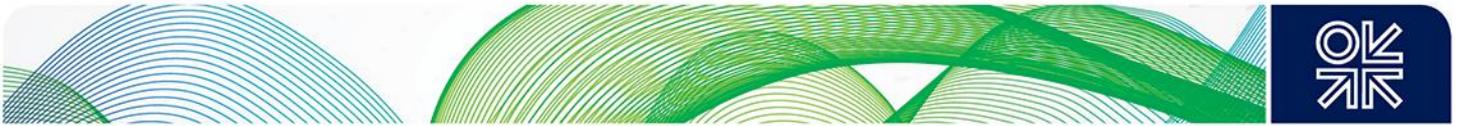
In 2015, GasTerra bought 70.3 bcm of gas from the Groningen field (42 per cent), small fields (31 per cent), but also from trading hubs (17 per cent) and imports (10 per cent) to help cover the shortfall in Groningen production.¹⁴⁰ This represented 12 bcm of gas through European hubs and 6.9 bcm through imports from Norway, Russia, Germany and the United Kingdom.¹⁴¹

Short term: Storage, imports and quality conversion

- Storage: ensure flexibility and security of supply

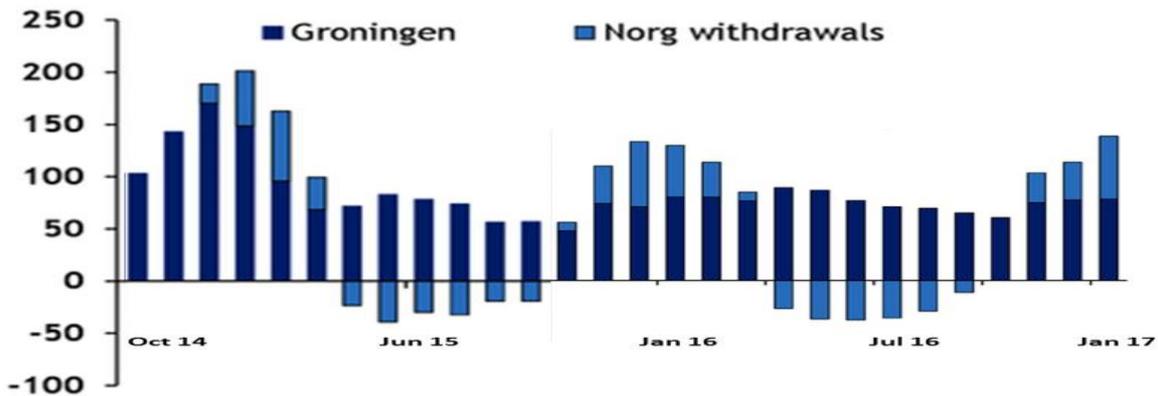
As of December 2016, gas storage in the Netherlands represented a total working volume of about 15 bcma.¹⁴² The Norg storage facility, operated by NAM, is used to tailor Groningen production. The facility was expanded in 2014 and has a technical capacity of 7 bcma. L-gas stored in this depleted

¹³⁷ Note 1: There is no separate market for I-gas, so there is only one TTF price based on the total supply/demand balance.
 Note 2: Security of supply for small consumers in the Netherlands ultimately relies on the Minister but suppliers are responsible to ensure both the capacity and the volumes to supply their customers. GTS is then in charge of keeping enough capacity and volumes in the system to supply customers in case daily temperatures fall between -9°C and -17°C, although the latter would probably only happen once in fifty years (a stricter standard than the one in twenty years established by the European standard). This supply standard is established under the "Decision on Security of Supply Gas Act". GTS (2015), Preventive Action Plan in the Netherlands, <https://www.rijksoverheid.nl/>
¹³⁸ The outlook for unconventional gas production was non-existent at the time of writing (early 2017). The government decided to rule out shale gas exploration and developments in the country until 2020 at least. Unconventional gas production is therefore not considered in this paper due to its high uncertainty. For more information on estimated resources, see US EIA (2013), "Technically recoverable shale oil and shale gas reserves, an assessment of 137 shale formations in 41 countries outside the United States"
¹³⁹ <http://www.argusmedia.com/>
¹⁴⁰ <http://jaarverslag2015.gasterra.nl/en/gas/procurement>
¹⁴¹ <http://jaarverslag2015.gasterra.nl/en/gas/supply-and-sales>
¹⁴² Original data in TWh. Conversion done using the Gasunie converter: <https://unit-converter.gasunie.nl/>. Source data: Gas Infrastructure Europe, Gas Storage Data Set, December 2016, <http://www.gie.eu/index.php/maps-data/gse-storage-map>



field is used to add flexibility and adjust the availability of Groningen production for sale. Norg withdrawals enhance security of supply at times of demand fluctuations (mostly in winter when low-calorie demand is typically higher) but also, increasingly, help keep production in the Groningen field flat throughout the year [Figure 25]. L-gas storage also includes the Alkmaar facility (g-gas) as well as the LNG peak shaver facility in Rotterdam (also g-gas).

Figure 25: Norg stock changes vs Groningen output, October 2014-January 2017 (mcm/d)



Source: Argus, 30 November 2016, Nam reduces Norg gas storage capacity & Argus, 22 February 2017, Dutch lower house approves motion on Groningen gas cap

Other storage facilities hold H-gas and provide important seasonal flexibility such as the large-scale Bergemeer gas storage with 4.6 bcma of working capacity, which fully opened in 2015, and was developed with a view to replacing the declining swing capacity of the Groningen field. For shorter-term balancing purposes, there is also the possibility of withdrawing gas from the fast-cycle Zuidwending facility, a salt cavern with a working capacity of just 0.3 bcma but which has a quick response-time.

In addition to the facilities in the Netherlands, there are also nine salt caverns in Epe, Germany, which are connected to the Dutch transmission system and which can provide a further 4 bcma of total working capacity.¹⁴³

Apart from Norg and some caverns at EPE,¹⁴⁴ the gas in storage needs to be converted to L-gas quality to replace gas from the Groningen field.

- Quality conversion

H-gas can be made suitable for appliances designed for use with Groningen gas once converted. GTS typically converts high-calorie to low-calorie supply first through blending, which is the cheaper option. Once blending is close to the maximum possible, then nitrogen is used. The Netherlands can create about 10-11 bcma of L-gas from mixing stations (the total volume depends on the gas content), and it also has the capacity to make about 19-23 bcma¹⁴⁵ of L-gas from H-gas via nitrogen blending at four ballasting facilities: Ommen, Pernis, Wieringermeer and Zuidbroek. Between 2010 and 2016, the production of pseudo G-gas (from n² and blending) increased from about zero in 2010 to about 50-60

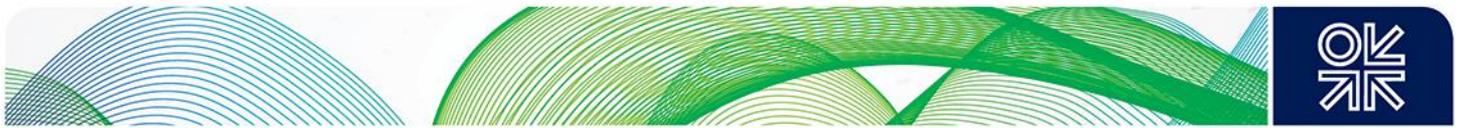
¹⁴³ Not directly connected to the Dutch system, importing countries can also store L-gas as Sediane B in France and the Speicherzone facilities in Germany.

Original data in TWh. Conversion done using the Gasunie converter: <https://unit-converter.gasunie.nl/>. Source data: Gas Infrastructure Europe, Gas Storage Data Set, December 2016, <http://www.gie.eu/index.php/maps-data/gse-storage-map>

¹⁴⁴ EPE facilities store the two gas types: H-gas and L-gas.

¹⁴⁵ The amount of gas that can be mixed to create low-calorie gas of the correct specification depends on the Wobbe value of the high-calorie and low-calorie supply used.

Argus, 15 April 2015, Dutch mulling using Groningen only as last resort; Argus, 2 April 2015, NCG low-calorie gas spikes as flexibility tightens



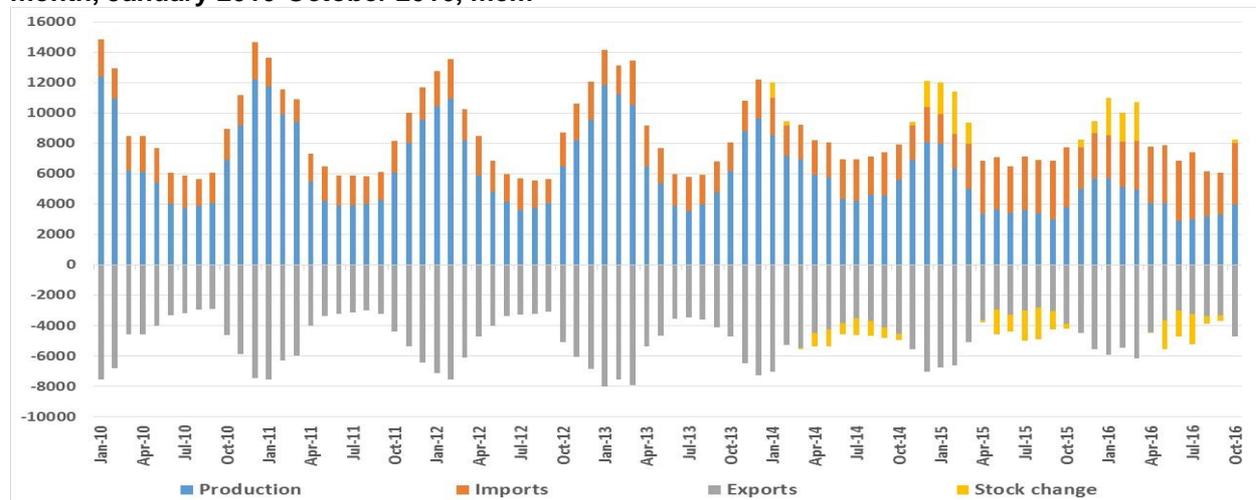
per cent of the total in 2016.¹⁴⁶ In total, the Netherlands created 23.4 bcm of pseudo-Groningen gas in 2016, up from 16.9 bcm a year earlier.¹⁴⁷

GTS typically runs its conversion facilities at about 85 per cent of capacity to keep some flexibility at times of L-gas peak demand, but in the future the company will try to run its sites at 77 per cent of capacity in order to leave room for even more flexibility, according to Minister Kamp.¹⁴⁸ The expansion of the Zuidbroek plant was also envisaged, but the €480 million project is uncertain. The government postponed the investment decision in September 2016 until October 2017. The plant would be operational until the early 2020s, by which time the amount of Groningen gas needed for security of supply is expected to fall (see Chapter 3).¹⁴⁹

- Imports

The balance of imports/exports comes in addition to production volumes managements and storage withdrawals/fill-in as see in Figure 26.

Figure 26: Natural gas production, imports, exports and stock changes in the Netherlands by month, January 2010-October 2016, mcm



Source: IEA Monthly data¹⁵⁰

IEA data shows that the Netherlands imported 38 bcm in 2015, mainly from Norway (19.5 bcm), Russia (8 bcm), other European countries (7.9 bcm), and finally in the form of LNG (2.5 bcm).¹⁵¹ This represented a year-on-year increase of 30 per cent from 29 bcm in 2014 [Figure 27]. Imported gas has traditionally been directed to industry and power plants, but is increasingly being directed at the residential and commercial sector after quality conversion.¹⁵² In contrast to Russian supplies, imports from Norway show seasonal variations, with quantities peaking in winter and then falling in the summer.¹⁵³

¹⁴⁶ Discussions with Gasunie

¹⁴⁷ About 9.22 bcm of low-calorie supply were created using nitrogen in 2016 (of which, 5.99 bcm were created in the winter months) up from 6.29 bcm a year earlier. Argus, 5 April 2017, More quality conversion limits scope for Groningen cuts

¹⁴⁸ Argus, 8 September 2016, Groningen production to be higher in October

In addition to quality conversion facilities, GTS can also order market participants to increase L-gas supply (within the 20 per cent limit) or reduce the amount of H-gas to restore the system balance once conversion sites are at full capacity.

¹⁴⁹ It would bring the total conversion capacity to about 30 bcma by 2019/2020.

¹⁵⁰ <http://uk.reuters.com/article/netherlands-gas-groningen-idUKL8N1BP24X>

¹⁵¹ <https://www.iea.org/statistics/monthlystatistics/monthlygasstatistics/>

¹⁵² BP (2016), Statistical review, p.28

¹⁵³ Imported gas is treated in plants operated by GTS and the cost is included in the transportation tariffs paid by the users of the Dutch grid. Gas Strategies, 13 december 2016, The GasTerra interview: Gertjan Lankhorst, CEO

¹⁵⁴ https://ec.europa.eu/energy/sites/ener/files/documents/quarterly_report_on_european_gas_markets_q2-q3_2016.pdf, p.9

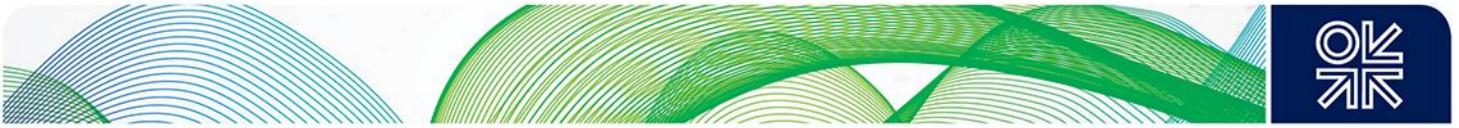
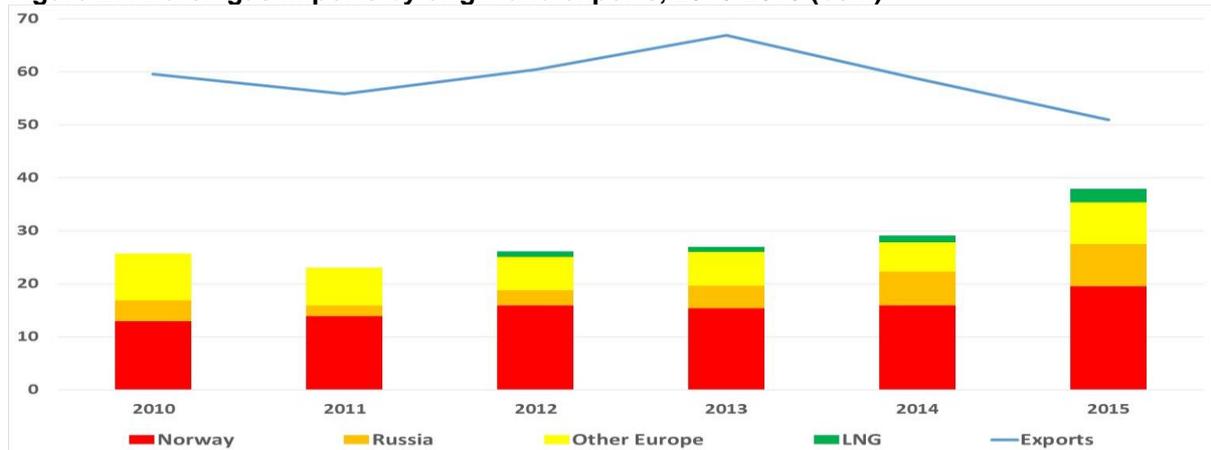


Figure 27: Dutch gas imports by origin and exports, 2010-2015 (bcm)



Source: IEA data, Natural gas information, various issues

Imports are expected to increase in the future from countries such as Norway and Russia, or LNG exports from countries somewhat further away.

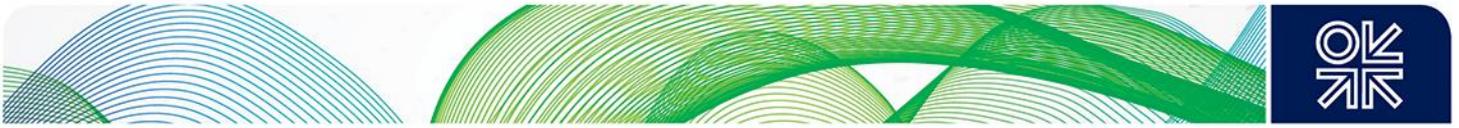
- Further increases in Norwegian imports are uncertain. Their swing capacity relies on production from the Troll field, which is already fully utilized during the winter as are Norway's export capacities to the continent. Post-2020, its total production is expected to decrease slowly in the absence of new field development, and the only possibility of increasing delivery to the Netherlands would be to re-direct some volumes there at the expense of other European importers.
- Only Russia seems to have enough deliverable gas and transportation capacity (not just enough reserves) to increase its exports to Europe/the Netherlands substantially. It would also have the ability to ramp up its production for higher winter deliveries at short notice and at competitive costs. As a result, Russian gas could provide a very important back-up to the Netherlands.
- LNG can be imported via the Gate terminal in Rotterdam (12 bcma capacity¹⁵⁴), or via other European LNG terminals and then transported to the Dutch market. LNG offers greater diversification and with a 25 per cent utilization rate in Europe (2015), there is plenty of potential but prices will need to be at a premium to attract volumes to the Netherlands.

In the longer term, additional solutions can be put in place to reduce dependence on Groningen gas such as replacing or re-fitting old equipment and appliances to use H-gas, lowering the share of gas in the energy mix and improving efficiency. Finally, there is the option to replace natural gas with green gas, which counts towards renewable energy targets and could prolong the life of some gas infrastructure.

Energy transition: replace old appliances, change the mix, improve efficiency and increase green gas usage

- Replacing old appliances to run on L-gas and H-gas
With the decline of Groningen production, the question arises as to whether to expand nitrogen conversion facilities (expensive) or whether it is wiser to modify gas equipment. The Netherlands has started to prepare industrial users and residential consumers for a change in gas composition, and from 1 January 2017, only gas appliances that are able to run on both low- and high-calorific gas are to be sold. This is just the beginning of a long process to convert (adapt or replace) all gas-consuming appliances (industrial processes, furnaces, boilers, amongst others) to be able to function on H-gas. Areas will be converted in phases so appliances in most houses will start to be replaced sometime

¹⁵⁴ GIIGNL (2016), The LNG Industry, Annual Report, p.31



during the 2020s/2030s. L-gas networks will also need to be adjusted: the gas networks in many cities are in need of renovation or replacement, which ties in with the need to modernize the heat supply which could be in the form of gas-to-heat network conversion.¹⁵⁵ The country is not expected to convert fully before 2030.¹⁵⁶ There have also been discussions with importing countries (Germany, Belgium and Northern France) to start replacing Groningen gas with high-calorific gas as of 2020 (see Chapter 3).¹⁵⁷

- Replace natural gas in the mix and improve efficiency

Replacing appliances with new models will help to improve efficiency, and better insulation in houses will help to reduce gas demand. As long as equipment is being replaced, there could also be some switching to other fuels. With increasing protests and rumbling discontent over natural gas exploitation since 2013, this option is likely to gather some political and public support. Almost 60 per cent of the energy consumed in the Netherlands is by the heating sector (boilers, water but also in industry processes). In its vision for heating,¹⁵⁸ the government has put forward proposals on how to make houses and buildings climate-neutral. The objective is to use less gas in residential homes and businesses and more renewables (such as geothermal heat for instance¹⁵⁹) and residual heat to heat properties over the next few years. If this happens, it will be another step to shift dependence away from Groningen gas.

The transition to a sustainable energy supply is a long process, and the share of renewable energy sources is still small. Fossil fuels and especially natural gas (if one is serious about the reduction of CO₂ emissions), will continue to play an important role in the mix up to 2020 and probably beyond to 2030. In the future, some of the gas demand could also come from green gas, a carbon-neutral, renewable source of energy.

- Green gas

Green gas would face much less public opposition than the continued use of natural gas, which ultimately is a fossil fuel albeit the cleanest one. The Dutch government has plans for the production of 3 bcm of biogas by 2030 and 20 bcm by 2050,¹⁶⁰ but this does raise network issues: in order to distribute this biogas, a gas network will be needed. The target also poses another problem: the Netherlands does not seem to have enough biomass to produce such volumes and will have to rely on imports. Green gas may not compare with natural gas production in 2016, but coupled with a reform of gas demand and better energy savings, it could still play a major role in the transition towards a decarbonised economy. Exactly when this may happen on a large scale is uncertain as existing techniques to produce green gas (fermentation or gasification) need more time to be developed further.¹⁶¹

The sharp drop of Groningen production and the continuous decline from small fields are changing the energy landscape in the Netherlands and may also accelerate the transition to a less gas-intensive market. The impacts will not only be felt nationally, but also outside its borders: from the Netherlands' point of view but also for neighbouring countries. The role of the Netherlands in a European context is looked at in Chapter 3.

¹⁵⁵ <https://www.rijksoverheid.nl/ministeries/ministerie-van-economische-zaken/nieuws/2015/04/02/kabinet-stimuleert-overstap-van-gas-naar-duurzame-warmte>

¹⁵⁶ The conversion from L-gas to H-gas is also going to be an important issue for importing countries (Germany, France and Belgium). This is discussed in Chapter 3. <http://jaarverslag2015.gasterra.nl/en/gas/supply-and-sales>

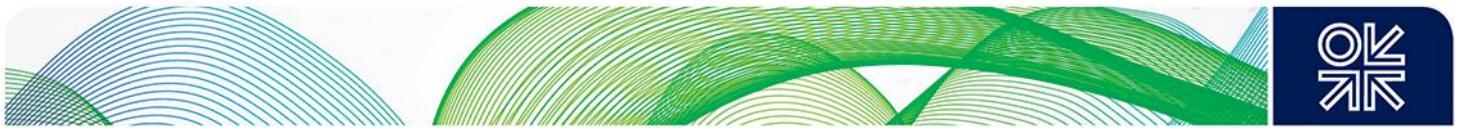
¹⁵⁷ <http://www.gasterra.nl/en/products-and-services/todays-market/groningen-gas-and-high-calorific-gas>

¹⁵⁸ <https://www.rijksoverheid.nl/ministeries/ministerie-van-economische-zaken/nieuws/2015/04/02/kabinet-stimuleert-overstap-van-gas-naar-duurzame-warmte>

¹⁵⁹ For more information, see <http://www.gasterra.nl/en/news/heat-homes-with-green-gas-and-geothermal-technology>

¹⁶⁰ IEA (2014), Energy Policies of IEA countries, The Netherlands, 2014 review, p.140

¹⁶¹ See examples of on-going projects, see <http://www.gasterra.nl/en/news/bio-rights-and-gasterra-sign-the-biggest-dutch-green-gas-agreemen>; <http://www.gasterra.nl/en/news/gasterra-and-partners-are-increasing-the-pressure-of-fermentation>; <https://www.gasunie.nl/uploads/bestanden/96edc302-a457-4242-8449-c257f6b38a4c>



III. Dutch gas in the European context

3.1. The journey from net exporter to net gas importer

The previous chapters have focused on assumptions for future gas balances in the Netherlands, without considering the implications for the rest of Europe. However, the rapid changes that are happening in the Dutch gas market are also incredibly important trends for the entire European gas market. The future impact of Dutch gas production and consequently gas exports to the rest of Europe is equally dramatic. The amount of gas Europe has already lost from the Netherlands, and the rate at which the rest will disappear has perhaps been under-appreciated. Within a five-year period, H-gas exports will decline and disappear altogether (by the early 2020s); L-gas exports are halved by 2025 and disappear by 2030. The production surplus (production minus demand) fell from about 40 bcm in 2013 to only about 10 bcm three years later. By 2030, it will likely have disappeared altogether.

This chapter starts by taking a closer look at the way the Netherlands interacts with other gas markets and how the country is planning to smooth the necessary transition from major gas exporter to future gas importer. It then turns to the consequences for the importing countries, especially the ones that import Groningen gas to supply their domestic market: Germany, Belgium and France.

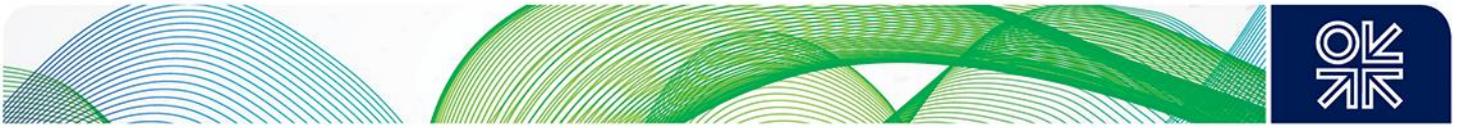
3.1.1. Dutch gas at the heart of (North West) Europe

A well connected gas network

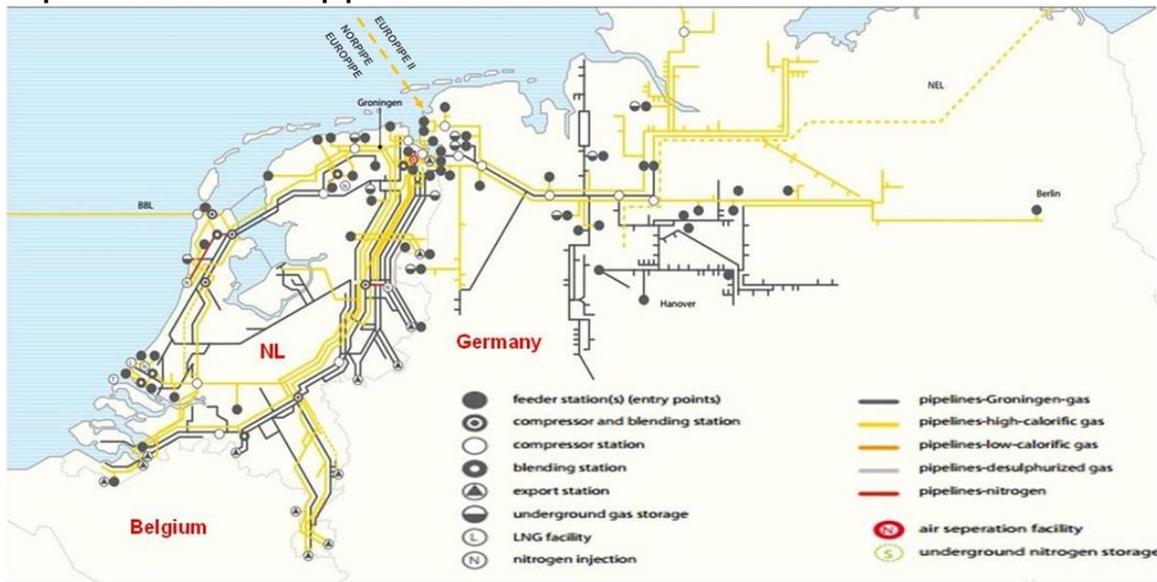
The Dutch gas industry is well integrated into the North West European gas market. The extensive gas network comprises 12 050 km of pipelines in the Netherlands and in parts of northern Germany, 50 entry points (mainly from Dutch gas fields), 1 100 delivery stations, and it is directly connected to four countries via 25 interconnection points [Map 1].

Gas can be both exported and imported via connections with Belgium and Germany. Gas can be imported indirectly from the UK via Belgium and its bi-directional interconnector with the UK. However, gas can only be exported via the connection with the UK (the Balgzand-Bacton Line) and only imported via the connection with Norway.¹⁶²

¹⁶² IEA (2014), Energy Policies of IEA Countries, Netherlands



Map 1: The Netherlands' pipeline network

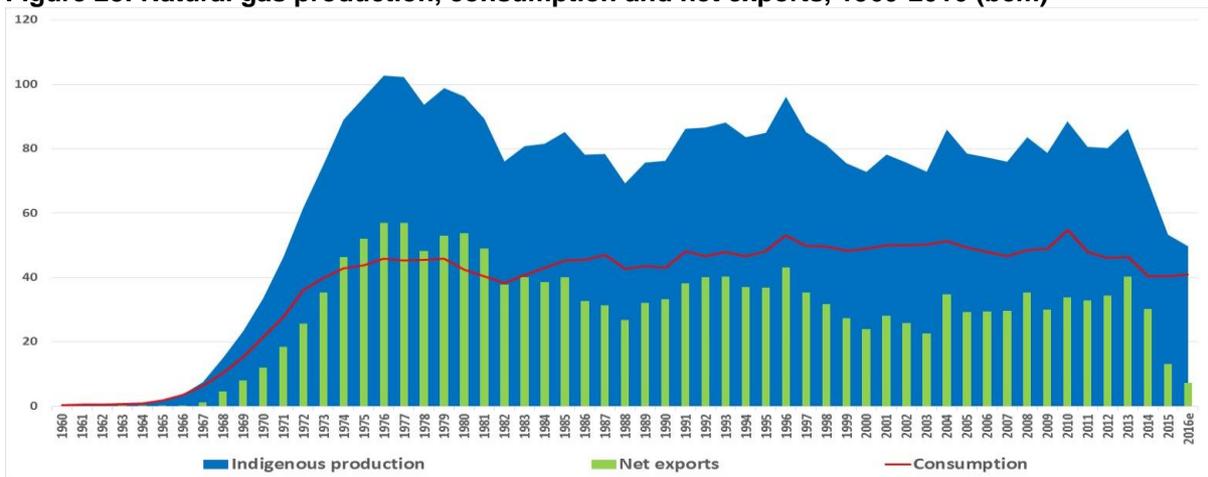


Source: The Dutch Gas Hub (2011)¹⁶³; author's additions

Becoming a net gas importer

In 2015, the Netherlands exported 50.9 bcm of natural gas according to IEA data.¹⁶⁴ Germany received the bulk share with 34 bcm. The other main importers were Belgium with 7.4 bcm, France 5.3 bcm, Italy 5 bcm, and the UK 3.4 bcm. In the same year, the Netherlands imported nearly 38 bcm of gas. Net exports have fallen dramatically since 2013 as seen in Figure 28, although on an annual basis, the Netherlands is still a net exporter (as of 2016).

Figure 28: Natural gas production, consumption and net exports, 1960-2016 (bcm)



Source: IEA data, Natural gas information, various issues

Viewed on a monthly basis, the country became a net importer for the first time in fifty years in May 2015 as seen in Figure 29. It happened again in the third quarter of 2015 and in mid 2016 as gas suppliers filled storage in preparation for winter.

¹⁶³ <https://www.government.nl>

¹⁶⁴ IEA (2016), Natural gas information, p.II.30

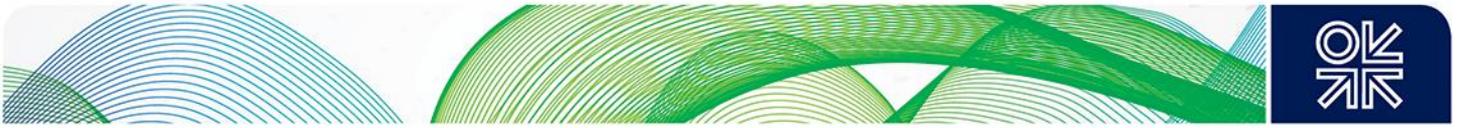
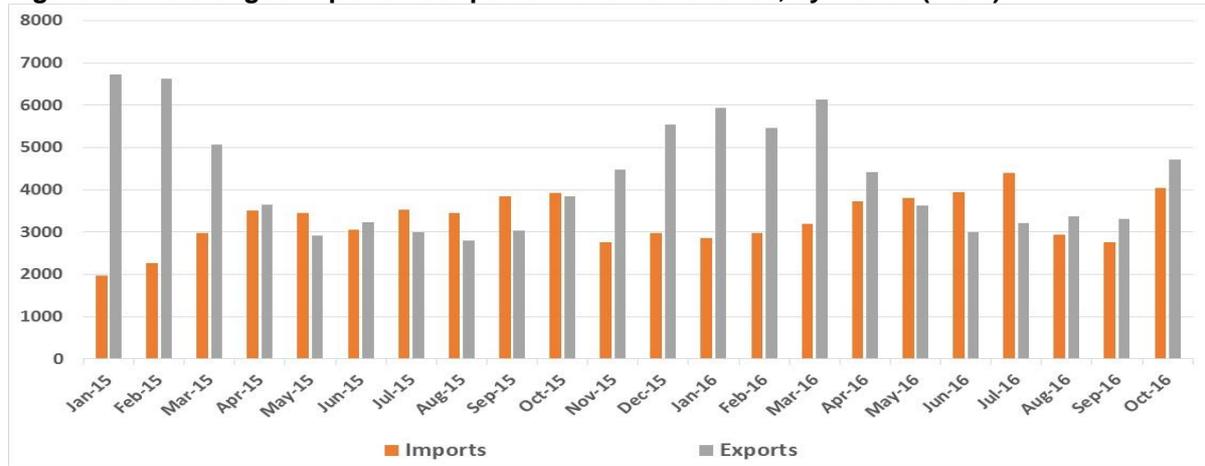


Figure 29: Natural gas imports vs exports in the Netherlands, by month (mcm)

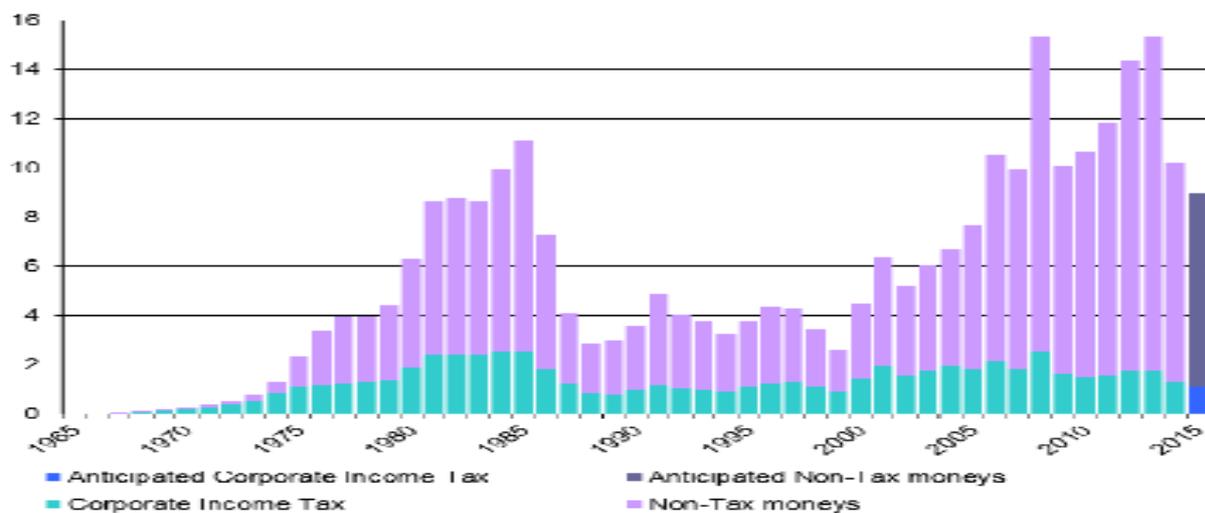


Source: IEA Monthly data¹⁶⁵

Financial impacts

Over its 45 years of exploitation, the natural gas industry in the Netherlands has brought more than €265bn to the state [Figure 30].¹⁶⁶

Figure 30: Natural gas revenues 1965 – 2015 (bn euros)



Source: Ministry of Economic Affairs (June 2015), 2014 Annual Review, p.145

Dutch natural gas exports have more than halved since 2013 to less than 2 per cent of total exports in 2016 as seen in Figure 31, and were worth €8.2bn in that year. However, in order to meet foreign supply obligations, natural gas imports have increased by 55 per cent since 2013 (from Norway, Russia, and LNG for which global competition exists), bringing the natural gas trade surplus down from €9.8bn in 2013 to €2.7bn in 2016 [Figure 32].

¹⁶⁵ <https://www.iea.org/statistics/monthlystatistics/monthlygasstatistics/>

¹⁶⁶ <http://aardgas-in-nederland.nl/nederland-aardgasland/aardgas-en-de-economie/>

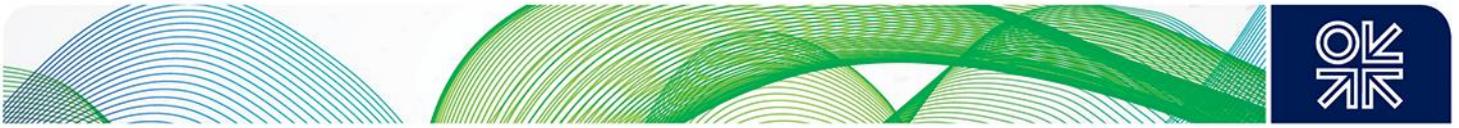
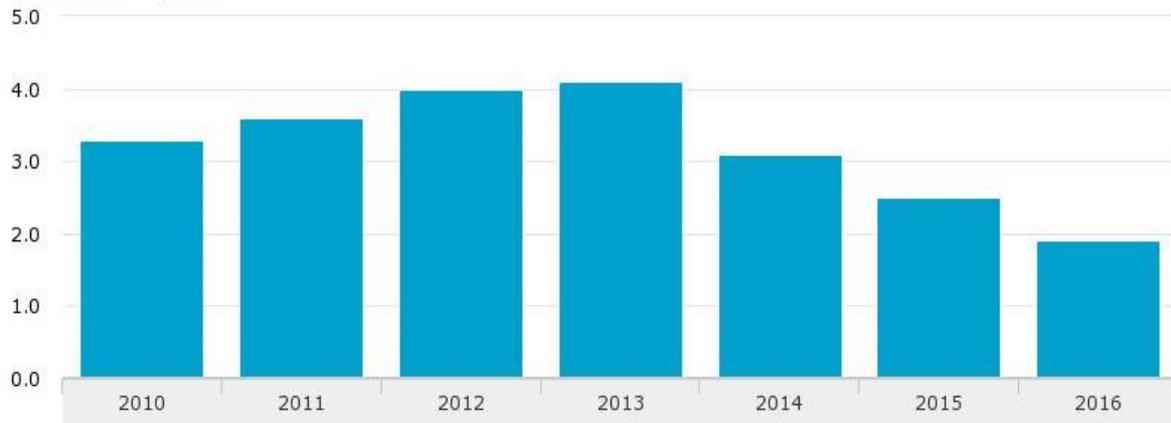
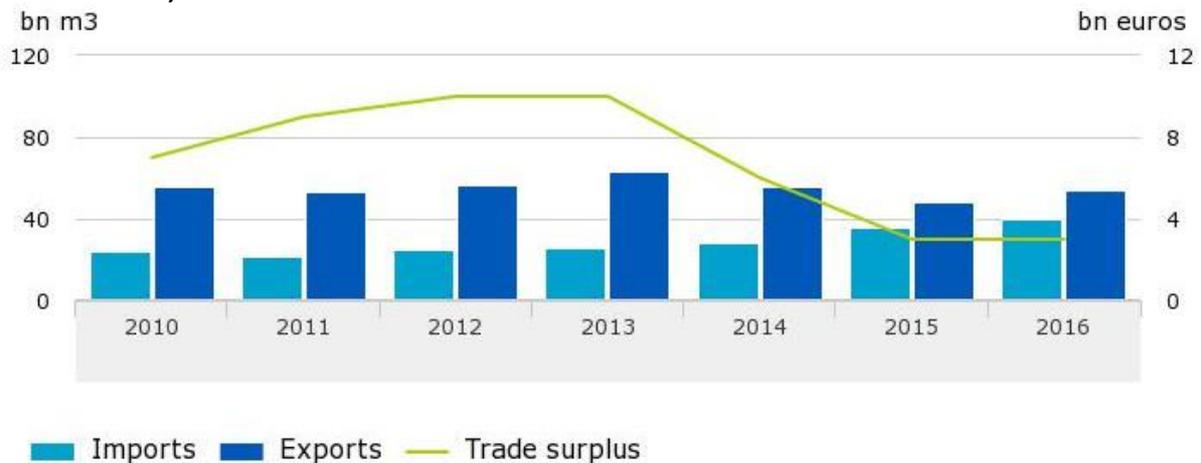


Figure 31: Dutch natural gas exports as per cent of total exports, 2010-2016 (per cent)



Source: Central Bureau of Statistics, retrieved in March 2017¹⁶⁷

Figure 32: Dutch natural gas, import and export volumes and trade surplus, 2010-2016 (bcm and bn euros)



Source: Central Bureau of Statistics, retrieved in March 2017¹⁶⁸

This transition will continue to have a strong impact on government revenues. In 2013, ABN AMRO stated that as a rule of thumb, lowering gas production by 1 bcm was equal to a drop in gas revenues of about €200 million.¹⁶⁹ With lower gas prices in 2016, this figure may be an overestimate, but a significant drop in revenues is still to be expected.¹⁷⁰

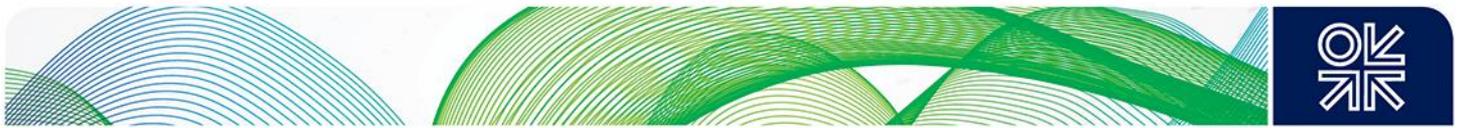
As a result of all these changes, the Netherlands designed a new strategy in order to manage the transition in a smooth and orderly way. The government chose to transform the country into a gas hub and re-invent the role of Dutch gas in the European market.

¹⁶⁷ <https://www.cbs.nl/en-gb/news/2017/09/gas-exports-halved-in-the-past-three-years>

¹⁶⁸ <https://www.cbs.nl/en-gb/news/2017/09/gas-exports-halved-in-the-past-three-years>

¹⁶⁹ ABN AMRO, 26 June 2015, Energy Monitor July

¹⁷⁰ For 2015, GasTerra's numbers show that both the volume of gas sold (70.3 bcm, compared to 81.3 bcm in 2014) and the total revenue (14.7 billion euros, compared to 19.5 billion euros in 2014) have fallen. This was mainly due to the cap on production from Groningen and the decrease in production from the smaller fields, but also due to lower gas prices.



3.1.2. Adapting to the new order: measures to smooth the transition

Examples some measures that were taken before the earth tremors

- Within the contractual obligations, GTS/Gasunie started discussions with importing countries (Germany, Belgium and France) about the L-gas to H-gas transition.
- NAM installed compressor units on top of the field to maintain G-gas volume and flexibility.
- The Norg facility was expanded.
- NAM built a dedicated pipeline between the Norg facility and the Groningen field (the NorgroN pipeline) to guarantee flexibility and swing capacity.
- GTS expanded its nitrogen capacity, including the addition of a nitrogen cavern to meet peak demand in the L-gas system.

The gas roundabout

Falling indigenous production has already changed export and import flows, but the Netherlands has been preparing for the transition to a net gas importer for some time. In 2005, the government mooted the idea of becoming the 'gas roundabout' for northwest Europe. The concept was to transform the country into a gas hub: a central position for gas transportation, transit, trade, and storage [Figure 33]. This position was expected to enhance the future security of gas supplies for the Netherlands and continue to earn revenues from gas activities.

Despite the existence of an extensive gas network, the government still invested several billions of euros to develop additional infrastructure in the country and interconnections with other countries. These included the BBL pipeline with the UK, the NordStream and NEL pipelines in Germany, and the new GATE LNG terminal which links the Dutch system to a wider range of potential suppliers and also with Gasunie's network expansion in the German market (see Map 1, p.45).¹⁷¹

The construction of the single gas market and notably the development of the European transport capacity platform (PRISMA) for the auctioning of cross-border gas transmission capacity should bring additional support to the Dutch project, with a more efficient use of cross-border facilities and a better functioning (North-Western) regional gas market.

The increase in gas volumes being transported via the Netherlands is expected to increase the availability of gas for the internal market, ensure flexibility and hopefully shield the market from future price shocks due to supply and demand imbalances.¹⁷² In a country where gas represents about 40 per cent of the primary energy demand and is present in all sectors of consumption, securing supply and flexibility is of primary importance.

Nonetheless, this concept has also been criticized. Some critics claimed that having infrastructure located in the Netherlands was no guarantee that gas would be available for customers in the country as it could just as easily be re-exported.¹⁷³ In addition, depending on one's views, while the gas roundabout could be seen as part of the transition to a decarbonized future, it could also be seen as chaining the country's economic and energy system to natural gas for longer period, which could result in a possible conflict of interests with proposed energy policies (see Chapter 1).

¹⁷¹ For additional details about entry/exit capacity to the Dutch gas market and scenarios up to 2035, see Gasunie (2015), Network Development Plan 2015, <https://www.gasunietransportservices.nl/en/network-operations/maintenance-of-transmission-system/network-development-plan-nop>

¹⁷² <https://www.gasunie.nl/en/definitions/gas-roundabout>

¹⁷³ http://www.courtsofaudit.nl/english/Publications/Audits/Introductions/2012/06/Gas_roundabout_benefit_need_and_risks

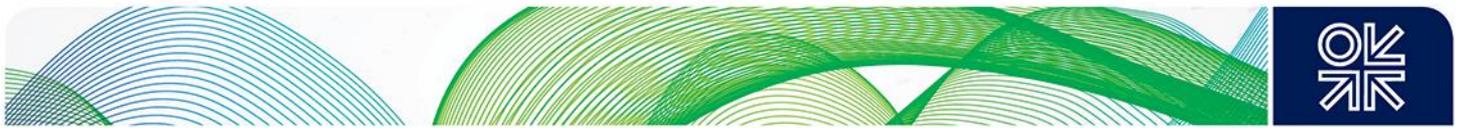


Figure 33: The gas roundabout



Source: Gasunie

No new export contracts and increased short-term purchases on the TTF

In addition to national demand, the Netherlands needs to secure supplies to its export markets. Until early 2017, GasTerra has been able to meet its contractual obligations, but has declared that it will not renew or extend existing agreements when they come to an end.¹⁷⁴ For instance, the 8 bcma gas contract between GasTerra and Centrica which ended in December 2016 has not been renewed (the contract was for delivery of 5 bcma in the winter and 3 bcma in the summer). Contractual export obligations are therefore going to decline gradually until the end of the 2020s, as seen in Table 2. In the meantime, GasTerra will still need to secure gas to meet its low-calorie export commitments which will drop slightly over the coming years, but only fall sharply in 2024.

Portfolio management and short-term purchases on the TTF will increasingly compensate for the decline in L-gas production and will help Groningen production to stay within the monthly limits. The Dutch TTF started in 2003, and since late 2013 it has become a major European benchmark hub.¹⁷⁵ In the second half of 2016, preliminary forecasts suggest that the TTF even overtook the UK-based NBP hub in total volume of trades (OTC + exchange).¹⁷⁶ L-gas and H-gas are not traded separately at the Dutch TTF: the quality will be defined only at the (quality) specific export station, but the capacity that can be contracted will be lowered by GTS in the period 2020-2030 by about 10 per cent per year (in other words, L-gas can be bought, but there is a need for available L-gas exit capacity otherwise L-gas cannot be brought to the customer).¹⁷⁷

¹⁷⁴ There has been no news long-term contract signed since 2009.

¹⁷⁵ The TTF (Title Transfer Facility) has been in operation since November 2002 when Gasunie established this virtual trading point for natural gas in the Netherlands.

For more info, see Heather P. (2015), The evolution of traded gas hub, p.19. For information on the development of TTF (and other European hubs), see various papers by Patrick Heather: <https://www.oxfordenergy.org/authors/patrick-heather/>

¹⁷⁶ The churn ratio at the TTF is expected to have been 2.5 times that of the NBP in 2016. Discussions with Patrick Heather, for more information, see publication on European gas updates (forthcoming 2017, OIES website)

¹⁷⁷ Discussions with Gasunie

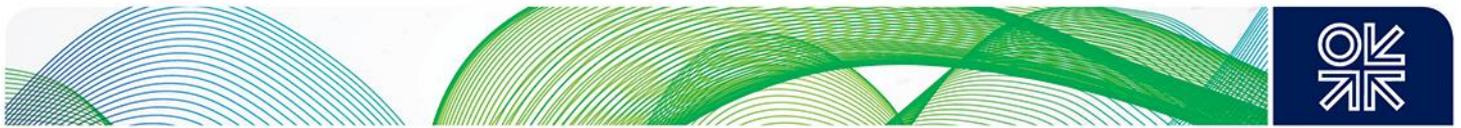


Table 2: GasTerra contractual export obligations, 2014-2029 (bcm)

Gas year	Low-calorie minimum	Low-calorie maximum	High-calorie minimum	High-calorie maximum
2014-15	28	34	18	23
2015-16	28	34	14	15
2016-17	26	32	7	15
2017-18	26	32	6	8
2018-19	26	31	4	6
2019-20	24	29	4	6
2020-21	24	29	4	6
2021-22	24	28	0	1
2022-23	23	28	0	1
2023-24	23	27	0	0
2024-25	12	14	0	0
2025-26	9	10	0	0
2026-27	4	5	0	0
2027-28	3	3	0	0
2028-29	1	2	0	0

– Dutch government 2013 study

Source: Dutch government in Argus News, 7 September 2016, Engie's Groningen view is distorted: Gasterra

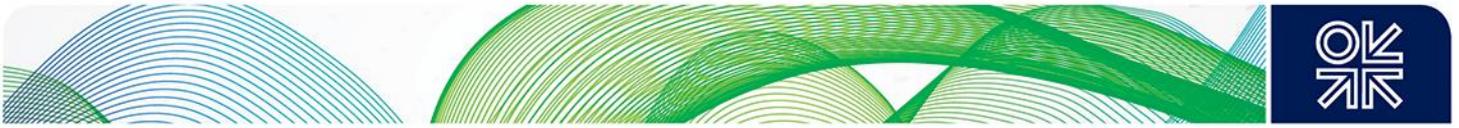
3.2. Impacts on importers of Dutch gas

According to the IEA data, the Netherlands exported gas to six countries in 2015: Belgium, France, Germany, Italy, Switzerland and the UK.¹⁷⁸ As already mentioned, a significant drop in Dutch gas production/exports is expected when the country becomes a net importer in the 2030s (or maybe even in the 2020s if changes in production levels occur faster than anticipated at the time of writing this paper). Dutch gas will need to be replaced by other gas, essentially non-European imports as regional production is in decline everywhere (apart from Norway, but the outlook there is not particularly optimistic either).¹⁷⁹ Dutch gas sometimes represents a high share of a country's import mix and/or significant volumes as seen in Figure 34, and in order to find non-Dutch sources of H-gas countries will have to look to other suppliers, essentially Norway, Russia, North Africa in southern European markets, LNG imports from an even larger range of suppliers, and finally from the spot markets. Whether these options have enough reserves, production capacity and/or can be commercially attractive to replace the 40 bcm of Dutch gas surplus (2013 data) is beyond the scope of this paper, but this issue has been looked at in other OIES papers, available to download on our website.¹⁸⁰ This final section focuses only on the neighbouring markets that import and are dependent on L-gas from the Netherlands to supply part of their demand, namely Germany, Belgium and northern France.

¹⁷⁸ IEA (2016), Natural gas information, p.II.42

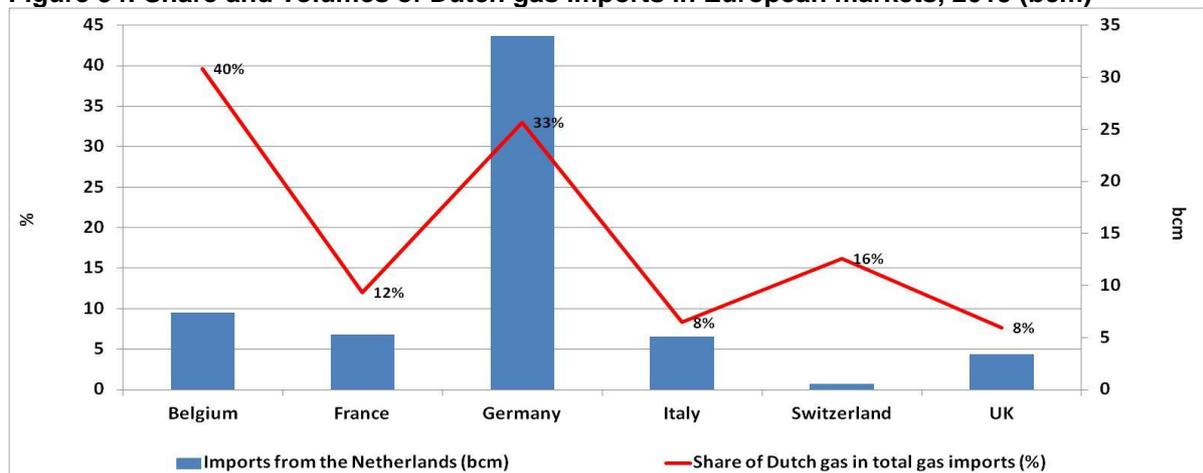
¹⁷⁹ From about 256 bcm of regional production in 2016 (Europe = EU28 + Albania + Norway + Switzerland + Turkey), expected production drops to 212 bcm in 2020 and 146 bcm in 2030. Out of the 111 bcm decline in gas production in Europe by 2030, about 30 bcm alone can be attributed to the Netherlands. Source: Author's estimates

¹⁸⁰ For more information on natural gas supply options to Europe, see publications on <https://www.oxfordenergy.org/gas-programme/>. Some suggestions: Rogers H. (2017), The Forthcoming LNG Supply Wave: A Case of 'Crying Wolf?', <https://www.oxfordenergy.org/publications/forthcoming-lng-supply-wave-case-crying-wolf/>; Pirani S. (2016), Azerbaijan's gas supply squeeze and the consequences for the Southern Corridor, <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2016/07/Azerbaijans-gas-supply-squeeze-and-the-consequences-for-the-Southern-Corridor-NG-110.pdf>; Aissaoui A. (2016), Algerian Gas: Troubling Trends, Troubled Policies, <https://www.oxfordenergy.org/publications/algerian-gas-troubling-trends-troubled-policies/>; Stern J., Yafimava K., Rogers H., Pirani S., El-Katiri L., Honoré A., Henderson J., Hassanzadeh E., Dickel R. (2014), Reducing European Dependence on Russian Gas – distinguishing natural gas security from geopolitics, <https://www.oxfordenergy.org/publications/reducing-european-dependence-on-russian-gas-distinguishing-natural-gas-security-from-geopolitics/>. See also: Corbeau A.S., Ledesma D. (ed.) (2016), LNG Markets in Transition: The Great Reconfiguration, OIES/KAPSARC, <https://www.oxfordenergy.org/shop/lng-markets-in-transition-the-great-reconfiguration/>



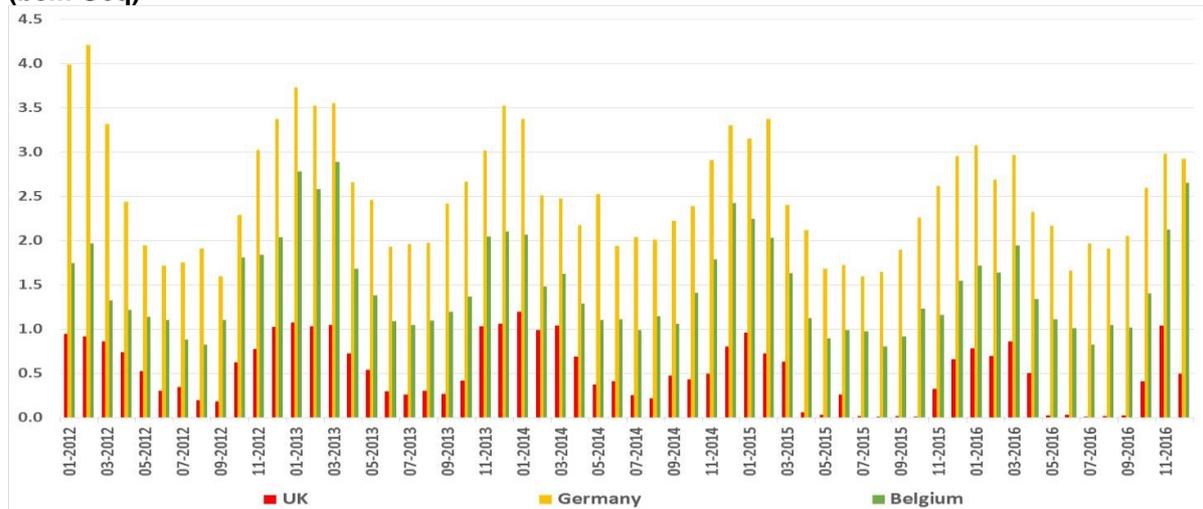
Lower caps on Groningen production raised concerns in importing countries over security of supply and the impact on gas prices. As of early 2017, there have been no shortfalls and no severe price peaks, possibly because exports are part of long-term contractual agreements which flatten fluctuations on the L-gas market and also because the global supply of gas has not been tight over the past three to four years, including in north-west Europe. Nonetheless, as seen in Figure 35, GTS data shows that the Netherlands has lowered gas exports since the government's decisions to cap Groningen gas production. It has essentially flattened deliveries throughout the year to Germany and to a lesser extent to Belgium (although the winter of 2016 shows a peak at the end of the year as a result of much colder temperatures). Exports to the UK have also declined, and the end of the GasTerra/Centrica contract in December 2016 will offer some relief for Dutch exports, especially in winter. It is believed that the general decline in gas exports have focused on H-gas rather than the L-gas deliveries, which are essentially long-term contractual commitments.

Figure 34: Share and volumes of Dutch gas imports in European markets, 2015 (bcm)



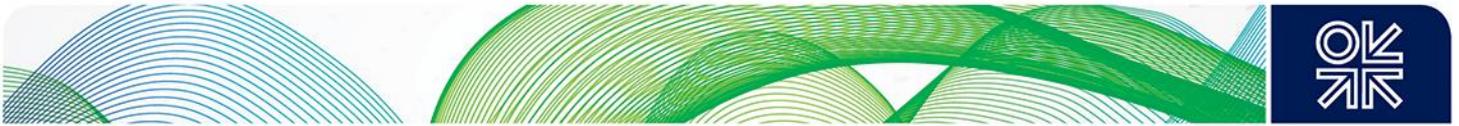
Source: IEA (2016), Natural gas information, pp.II.30-31

Figure 35: Natural gas exports to the UK, Germany and Belgium, monthly variations, 2012-2016 (bcm Geq)



Source: GTS data, retrieved in February 2017

Gas supply has nonetheless become tighter in winter months as the Groningen field and production in the small fields are increasingly not able to provide (large) winter flexibility. Countries that are dependent on L-gas need to find other swing sources to provide seasonal volumes of gas. Unfortunately, other seasonal swing sources (of H-gas) are also mature and in decline (especially in the UKCS as seen in Figure 36). Gas markets need to adapt to this evolution and find new ways to

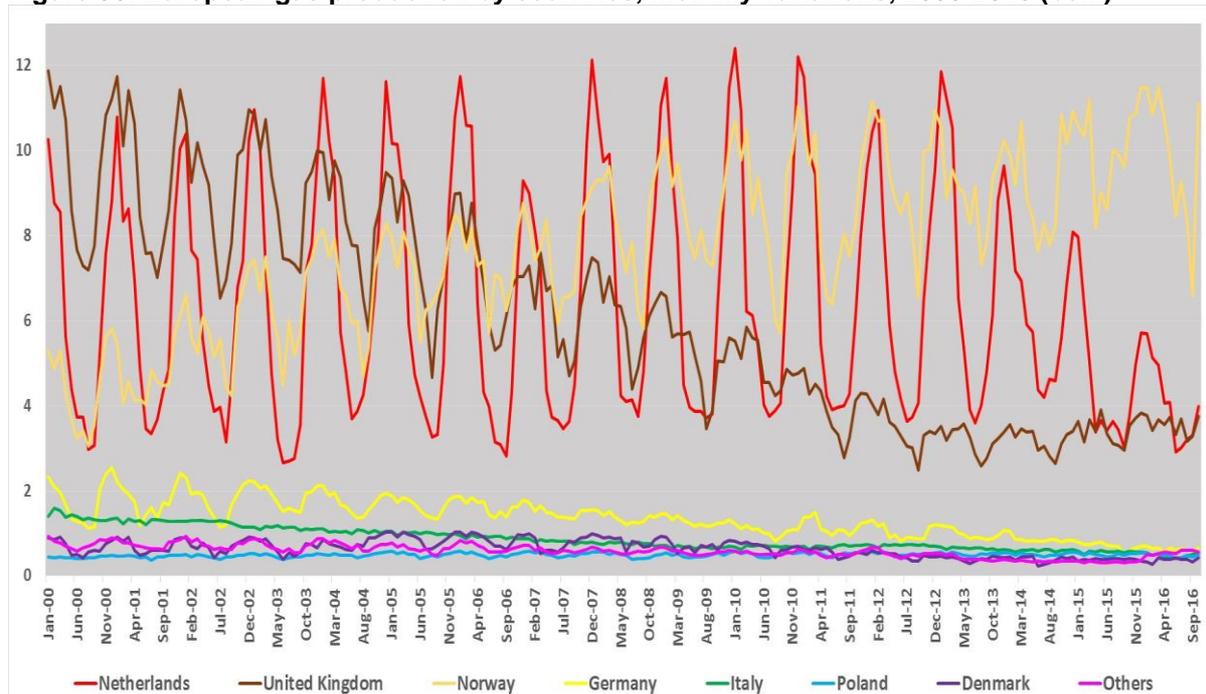


deal with seasonality. This may not be too critical an issue as long as the global market is long (which is expected to continue until the 2020s), but countries need to prepare now.

Belgium, Germany and Northern France have developed some of their infrastructure to accommodate Groningen gas quality. A decrease in Dutch gas production and potentially gas exports to these countries will have an impact, and they need to prepare for major investments to anticipate any future security of supply issues. The options are similar to those open to the Netherlands: to increase gas conversion stations and nitrogen production capacity; to increase flexibility to accommodate variations in demand by increasing storage capacity of H-gas; if necessary, to improve import options/capacity of H-gas; to prepare transition measures which enable different quality gas to flow through the networks and to be used by appliances; and finally, to ultimately promote other fuels in the heating sector, including green gas. Due to their import dependence on the Netherlands and the relatively short life remaining of contractual commitments (most will end in the 2020s), these countries need to act quickly to move from an L-gas to an H-gas infrastructure. They will need to do this even faster than the Netherlands which can still count on some production in the 2030s and beyond. This long and complicated process has started or is actively being planned in all three countries.

Germany, Belgium and France had been planning to convert their low calorific systems to high calorific systems by 2030, but as a result of Groningen curtailments, this transition will happen sooner than expected as exports will also decline faster or end earlier than anticipated (due to no renewal possibilities of gas contracts). The Netherlands has agreed with Germany to cut supplies from Groningen by 10 per cent per year from 2020, which should end any exports from the field by 2030. Agreements were also made with France and Belgium to reduce offtakes from 2024, and this has been brought forward to 2020 following new discussions.¹⁸¹

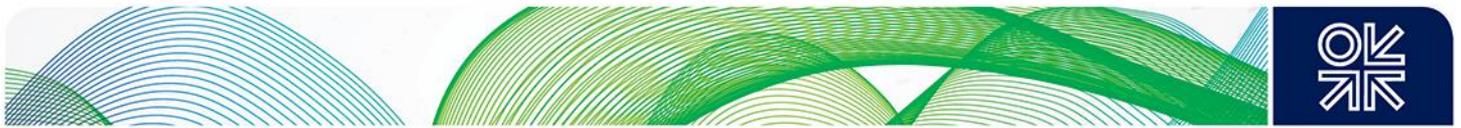
Figure 36: European gas production by countries, monthly variations, 2000-2016 (bcm)



Source: IEA, Monthly data, retrieved in February 2017¹⁸²

¹⁸¹ <http://uk.reuters.com/article/netherlands-gas-groningen-idUKL8N1BP24X>

¹⁸² <https://www.iea.org/statistics/monthlystatistics/monthlygasstatistics/>



3.2.1. Germany

Germany is the largest gas market in Europe. In 2015, it consumed 81 bcm of natural gas, directed essentially to the residential and commercial sector (40 per cent), but also the industrial sector (27 per cent) and power generation (21 per cent).¹⁸³ About 45 per cent of the market is supplied with L-gas which is imported from the Netherlands (27 bcm Geq in 2016¹⁸⁴) but also produced locally (8.7 bcm in 2015¹⁸⁵). Germany also has 1.6 bcm of L-gas storage capacity (the EPE and Speicherzone facilities). The L-gas network is located in the northern and western part of the country, near the Dutch border, while the rest of the country uses H-gas [Map 2]. There are about 4.3 million customers of L-gas, which include households and industries.¹⁸⁶

L-gas and H-gas used to be traded separately at Germany's NCG and Gaspool hubs (in contrast to the Dutch TTF),¹⁸⁷ but since 1 October 2011, the gas market has been divided into only two balancing zones which also became multi-quality market areas. The integration of the L-gas areas into the H-gas trading zones has made it possible to supply L-gas customers with H-gas and vice versa.¹⁸⁸ Mixing plants are used to convert gas both from and to H-gas and L-gas quality, and when physical conversion reaches its maximum, hubs offer commercial conversion possibilities.¹⁸⁹ Both German hubs have been charging conversion fees since the market zone mergers, which were supposed to be phased out by late 2016. However, due to changed circumstances after the cuts to output at the Groningen gas field, the reduction in L-gas conversion fees was delayed due to higher volumes of conversion of H-gas to L-gas.¹⁹⁰

There has been more price volatility on the NCG balancing hub (which accounts for most of the L-gas demand), which has little short-term low-calorie flexibility (most of it is in the Netherlands, not in the German market¹⁹¹). For instance, in the first quarter of 2016, at times prices dropped to almost zero or rose to €200/MWh.¹⁹² Volatility is typically much lower in the summer, but increases in the winter when gas demand triples due to cold temperatures and the need for heating.

Lower caps on Dutch production have not created shortfalls in L-gas deliveries to Germany as of 2017, but both countries have agreed to reduce volumes exported by 10 per cent per year from 2020 until 2030 when all exports will end. German L-gas production is also declining steadily (42 per cent less in 2015 compared to 2010), and this is expected to continue. In order to ensure the security of supply in the areas supplied with L-gas, both the networks and the millions of residential, commercial and industrial gas appliances will have to be gradually converted to H-gas. Contrary to the Netherlands, some appliances (such as central boilers) are already compatible for use with H-gas,¹⁹³ but the full conversion will still be complicated and necessitate large investments and effort. There are

¹⁸³ Shares for 2014. IEA (2016), Natural gas information, p.III.80

¹⁸⁴ GTS data, retrieved in February 2017

¹⁸⁵ IEA (2016), Natural gas information, p.III.80

¹⁸⁶

https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/service/UmstellungLGas.pdf?__blob=publicationFile&v=3

¹⁸⁷ The TTF (Title Transfer Facility) has been in operation since November 2002 when Gasunie established this virtual trading point for natural gas in Netherlands.

¹⁸⁸ The 'Konni Gas' conversion system (BK7-11-002) was introduced to ensure the appropriate allocation of the additional costs incurred by the network operators.

https://www.bundesnetzagentur.de/EN/Areas/Energy/Companies/NetworkAccess_Metering/MarketAreasGas_KOV/MarketAreasGas_node.html

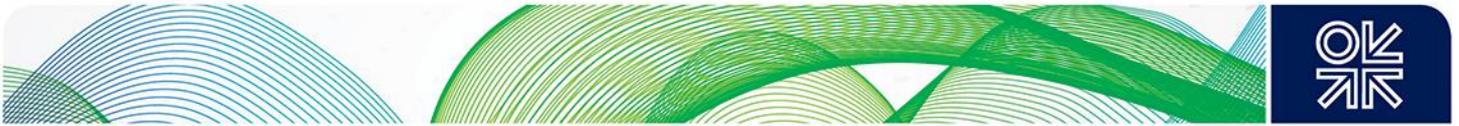
¹⁸⁹ Gas can be converted at Open Grid Europe's Werne and Scheidt mixing plant and the Broichweiden mixing plant operated by Thyssengas. <https://www.net-connect-germany.de/en-gb/Information/Balancing-Group-Managers/Gas-Quality-Conversion/Information-Conversion-Mechanism>

¹⁹⁰ For more info on this, see https://www.bundesnetzagentur.de/DE/Service-Funktionen/Beschlusskammern/1BK-Geschaeftszeichen-Datenbank/BK7-GZ/2016/2016_0001bis0999/2016_0001bis0999/BK7-16-0050/BK7-16-0050_Stellungnahme_1.Konsultation/BK7-16-050_Stellungnahme_PEGAS_English_bf.pdf?__blob=publicationFile&v=3

¹⁹¹ NCG low-calorie balancing prices spike when Dutch quality conversion facilities are close to capacity. But GTS is able to order market participants to increase low-calorie supply once quality conversion sites are at capacity, which helps to lower prices for low-calorie gas.

¹⁹² Argus, 22 July 2016, Low-calorie volatility offers storage opportunity

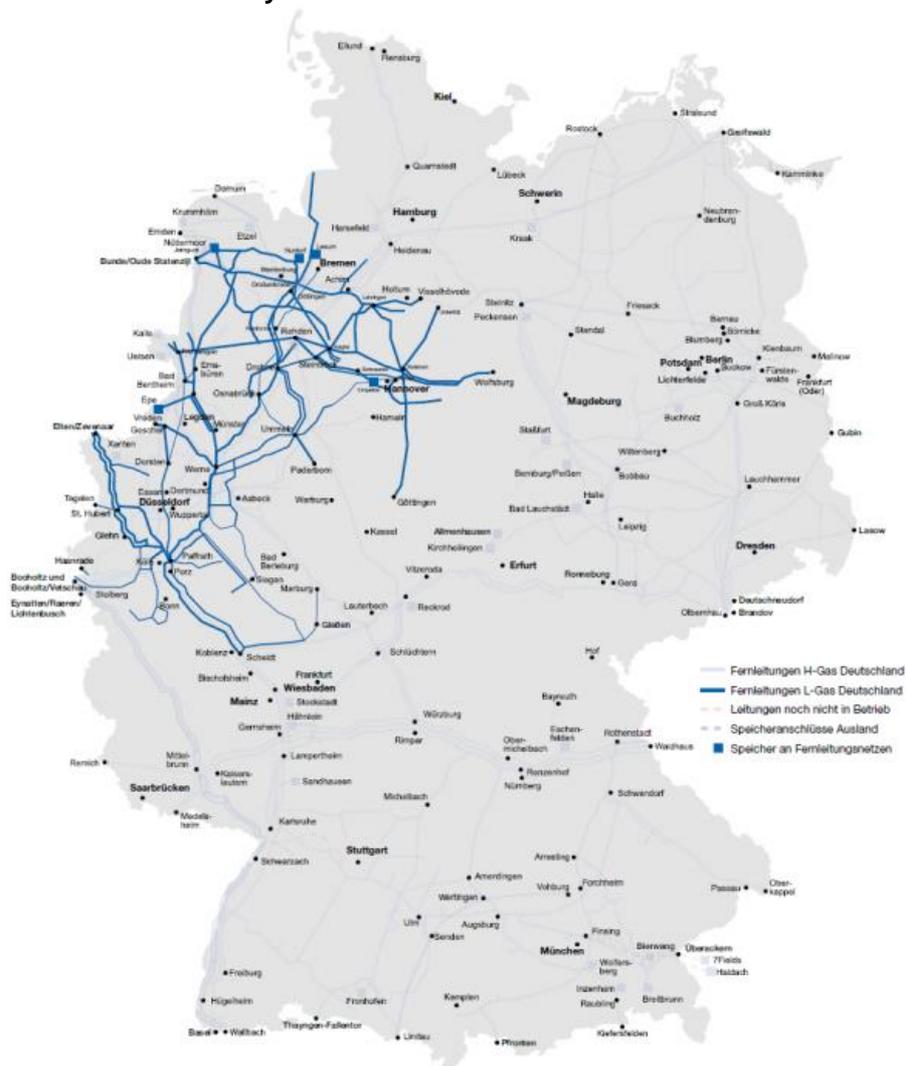
¹⁹³ <http://www.gasterra.nl/en/products-and-services/todays-market/groningen-gas-and-high-calorific-gas>



no plans to increase the amount of quality conversion capacity in the country as this would take too long to build by which time Germany will already be well advanced in converting its system to H-gas.¹⁹⁴

In May 2015, Schneverdingen, a small town in the north of Germany and a pilot project, was the first city to switch its gas supply from L-gas to H-gas.¹⁹⁵ German utility EWE expect to start the transition from L-gas to H-gas systems in 2018 rather than 2021 as originally planned because of the uncertainty of the low-calorie supply situation. The process is to be completed by 2027, two years earlier than anticipated in German system operators' two-year network development plan.¹⁹⁶ Conversion efforts will be intensified in the 2020s for a finish date by 2029/2030 [Figure 37].¹⁹⁷

Map 2: L-gas network in Germany



Source: FNB Gas (2016), Netzentwicklungsplan Gas 2016, p.52

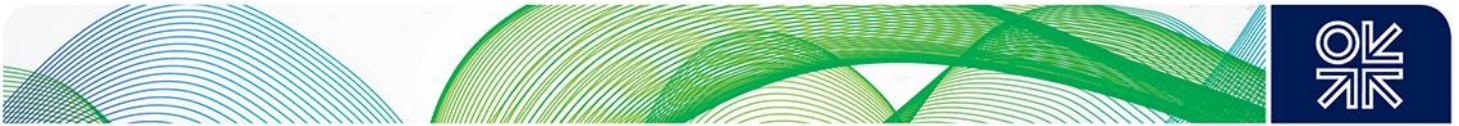
¹⁹⁴ Argus, 22 July 2016, Low-calorie volatility offers storage opportunity

¹⁹⁵ https://www.wingas.com/fileadmin/Wingas/content/06_Presse_Mediathek/Gaswinner/2015_03/PDF/GW0315_EN_30-37_Umstellung.pdf

¹⁹⁶ Argus, 27 April 2017, EWE starts low-calorie gas system conversion early

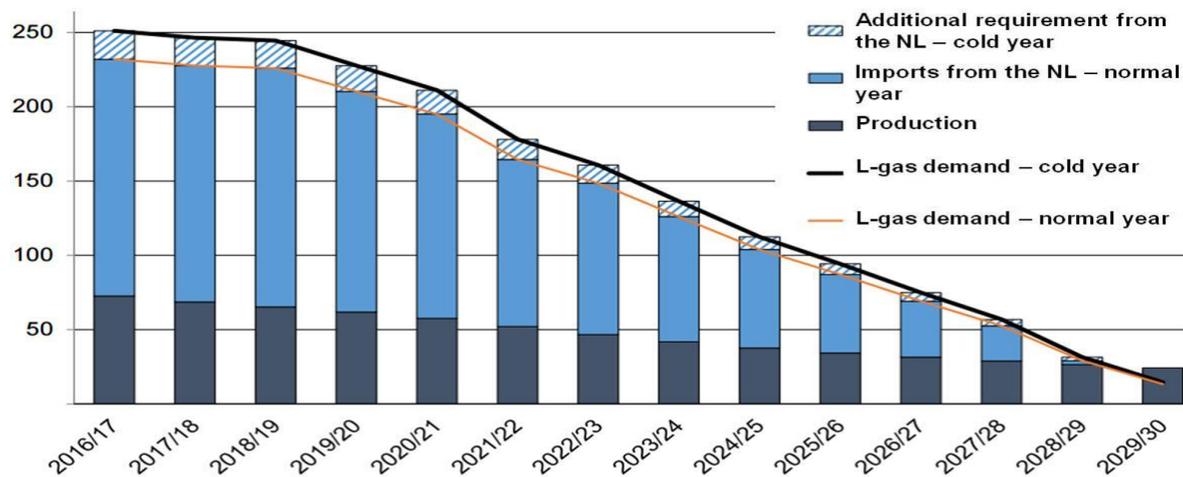
¹⁹⁷

https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/service/UmstellungLGas.pdf;jsessionid=EB2A759457416A0F81800635EA0F20BA?__blob=publicationFile&v=3



The Transport System Operators (TSOs) proposed a comprehensive action plan costing €4.4bn in their 2016 Gas Network Development Plan (NDP).¹⁹⁸ As the conversion process moves forward, more H-gas imports are anticipated. The planned measures anticipate about 800 km of new pipelines and an expansion of the amount of compressor capacity by 551 MW. Low-calorie gas storage facilities are expected to play an important role in the transition to ensure supply security as Groningen production declines. As for smaller customers, efforts have been put in place to explain the various steps of the conversion, and information can be found on the regulator’s website.¹⁹⁹

Figure 37: L-gas demand and supply in Germany, 2016-2030 (TWh/y)



Source: FNB Gas, retrieved in February 2017²⁰⁰

3.2.2. Belgium / France

L-gas from the Netherlands is exported to Belgium, and about half of it transits to Northern France. The demand from end-users connected to the L-gas network is about 10 bcm. Similar preparations to convert their systems are being made in Belgium and France, where the conversion process will start around 2020.

Belgium

Belgium consumed 17 bcm of natural gas in 2015, a third of which goes to the residential and commercial sector, a quarter to the industrial sector and another quarter to power generation.²⁰¹ About 30 per cent of the market is supplied with L-gas which is imported from the Netherlands through interconnections at Hilvarenbeek/Poppel.²⁰² Total entry capacity for L-gas is about 24 bcm

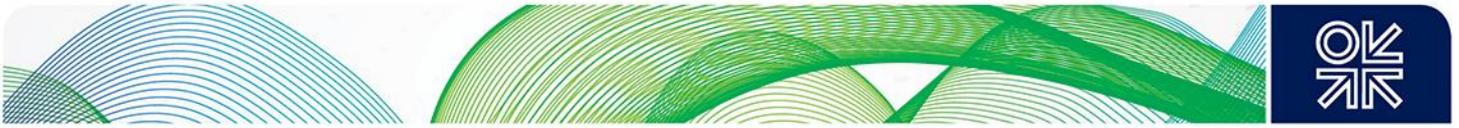
¹⁹⁸ NDP document: http://www.fnb-gas.de/files/2016_04_01-entwurf_nep-gas-2016.pdf; Summary: http://www.fnb-gas.de/files/02_2016_02_25_konsultationsworkshop_nep-gas-2016-l-gas-versorgung.pdf; List of projects, timetable and maps: <http://www.fnb-gas.de/de/fernleitungsnetze/marktraumumstellung/marktraumumstellung.html>

¹⁹⁹ https://www.bundesnetzagentur.de/cln_1421/DE/Sachgebiete/ElektrizitaetundGas/Verbraucher/NetzanschlussUndMessung/UmstellungGasbeschaffenheit/UmstellungGasqualitaet-node.html

²⁰⁰ http://www.fnb-gas.de/files/nep_gas_2016_l-gas-mengenbilanz.pdf

²⁰¹ Shares for 2014. IEA (2016), Natural gas information, p.III.40

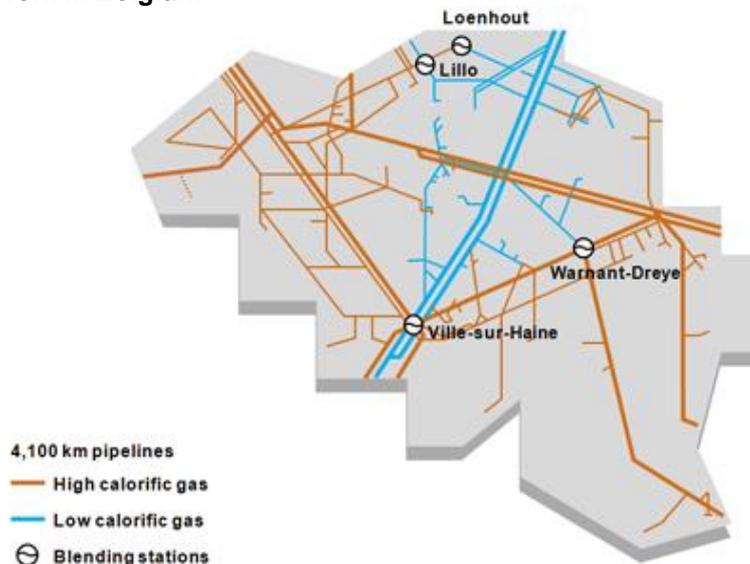
²⁰² Engie, 10 August 2016, Consultation on the draft consent decision of the Dutch Minister of Economic Affairs dated June 24, 2016 in respect of gas extraction at Groningen, <https://www.engie-zakelijk.nl>



and conversion capacity is about 3.5 mcm.²⁰³ Most of the customers connected to the L-gas grid are households, and large cities like Brussels are supplied almost exclusively with L-gas [Map 3].²⁰⁴

As in Germany, gas quality conversion of H-gas into L-gas is seen as costly and energy-intensive, and the conversion of the L-gas network to H-gas is the chosen option. The country plans to start the transition to an H-gas system in 2018 and plans to complete it by 2029. Some conversion pilot projects took place in 2015 whereby twelve industrial customers in the Olen-Tessengerlo-Lommel triangle were switched to H-gas.²⁰⁵ There are about 1,500,000 additional L-gas connections that will need to be converted up to 2030. The discussions on how to manage the conversion have started and a working group within Synergrid (the federation of the Distribution Service Operators (DSOs) and TSOs) was set up to ensure the security of supply of the L-gas market in the meantime.

Map 3: L-gas network in Belgium



Source: Fluxys, retrieved in February 2017²⁰⁶

France

France consumed 39 bcm of natural gas in 2015. Nearly half goes to the residential and commercial sector, 29 per cent to the industrial sector and only about 9 per cent is used in power generation.²⁰⁷ The northern part of the country is supplied with L-gas, which represents about 13 per cent of annual demand and accounts for 1.3 million customers in the distribution system and about 100 industrial customers connected to the transmission network [Map 4].²⁰⁸ L-gas is imported from the Netherlands and additional fluctuations are managed thanks to L-gas storage at Sediane B.

As in the other L-gas importing countries, France is considering its options to convert its L-gas system into an H-gas system. The legal and regulatory framework was set in Article 164 of Law No. 2015-992 of 17 August 2015 on Energy Transition²⁰⁹ and in Decree No. 2016-348 issued on 23 March 2016.²¹⁰

²⁰³ Original data in thousand cubic metres per hour: Total entry capacity for L-gas is about 3130 1000'cm/h and conversion capacity 400 1000'cm/h). CREG (2014), Monitoring report on the security of supply on the Belgian natural gas market, pp.29-30
²⁰⁴ http://economie.fgov.be/nl/binaries/Yearly_monitoring_report_2012_BE_tcm325-234924.pdf

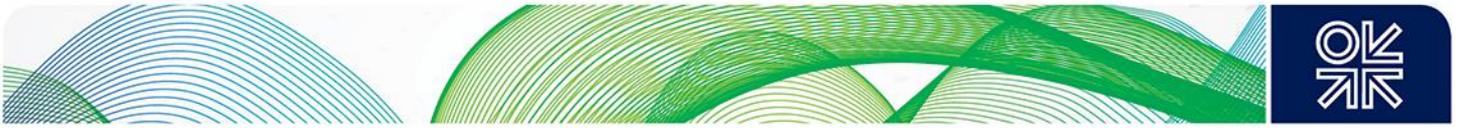
²⁰⁵ http://www.fluxys.com/belgium/en/NewsAndpress/2015/150909_Conversion

²⁰⁶ <http://www.fluxys.com/belgium/en/About%20Fluxys/Infrastructure/BlendingStations/BlendingStations>

²⁰⁷ Shares for 2014. IEA (2016), Natural gas information, p.III.75

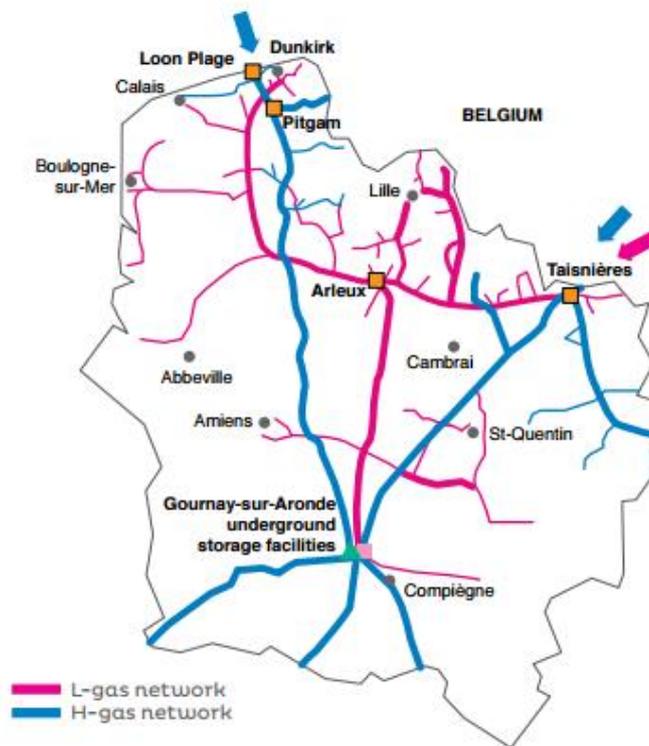
²⁰⁸ Engie, 10 August 2016, Consultation on the draft consent decision of the Dutch Minister of Economic Affairs dated June 24, 2016 in respect of gas extraction at Groningen, <https://www.engie-zakelijk.nl>

²⁰⁹ <https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000031044385&categorieLien=cid>



GRTGaz's 2016 Ten-Year Investment Plan provides some details for the conversion plans.²¹¹ It notes that the conversion process for residential and commercial customers connected to the distribution network can start thanks to the Dutch deliveries of 'L+' gas from 1 April 2016 (to Belgium and France). This type of gas has a Wobbe index which is in the higher reaches of the L- gas range and allows for appliances to be adjusted to use H-gas even before H-gas deliveries start. GRTGaz expects that Sediane B storage will continue to operate with L-gas until 2026, but by that time, imports of L-gas will be much lower as half of the firm entry capacity at Taisnières B will have been converted to H-gas. The full transition to H-gas will be carried out in phases between 2016 and 2029 in the departments of Nord, Pas-de-Calais, Somme Oise and Aisne and is likely to cost about €800 million.²¹²

Map 4: L-gas network in Northern France



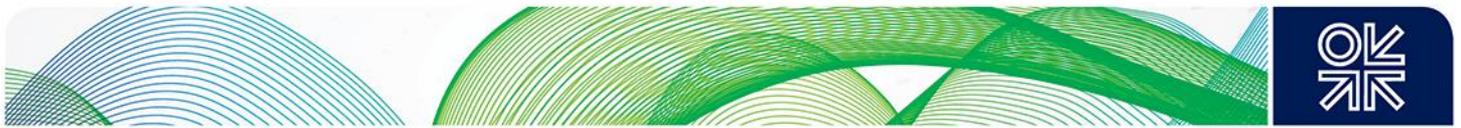
Source : GRT Gaz, Plan Decennal 2016-2025, p.70²¹³

²¹⁰ <https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000032291031&categorieLien=id>

²¹¹ http://www.grtgaz.com/fileadmin/plaquettes/en/2016/Plan_decennal_2016-2025-EN.pdf

²¹² <https://entreprises-collectivites.engie.fr/actualites/conversion-gaz-h/>

²¹³ http://www.grtgaz.com/fileadmin/plaquettes/en/2016/Plan_decennal_2016-2025-EN.pdf



Summary and conclusions

The Netherlands is at a turning point for its economy and energy system. Natural gas has been at the centre of the Dutch economy, energy supply and power generation for about half a century, but its prominent role has been put into question by climate change policies and the need to decarbonize the economy. Renewables and energy efficiency have taken central stage in energy policies while gas is at best the fuel of default, which will help the transition by backing up renewable intermittency and/or provide energy when other options are not sufficient. In a country where 98 per cent of households are connected to the gas network, the progressive disconnection of residential customers from the gas grid by 2050 is a dramatic evolution, which casts an important doubt over the future of gas in the country.

The transition towards a sustainable economy is also overwhelmed by an anti-gas sentiment. A much stronger than usual earth tremor in 2012 caused by the extraction of gas from the Groningen field prompted the government to take action and restrain production from the field to help minimise the seismicity: annual volumes were limited to 24 bcma for the gas year 2016-17 and were to be produced as evenly as possible throughout the year. While this cap was set for five years (until 2021), annual reviews were possible. In April 2017, the government announced a plan to lower the Groningen cap by 10 per cent to 21.6 bcma for the 2017-18 gas year,²¹⁴ following an increase in seismic activity in the Groningen area and advice by the Dutch state supervision of mines to further reduce the cap.²¹⁵ In 2016, gas production from Groningen was less than half the volumes produced just three years previously, with almost no flexibility to cope with seasonality of demand. The impact of the earth tremors on politics has been drastic but maybe equally importantly, consideration on the safety and health of the people of Groningen has changed public opinion about gas dramatically.

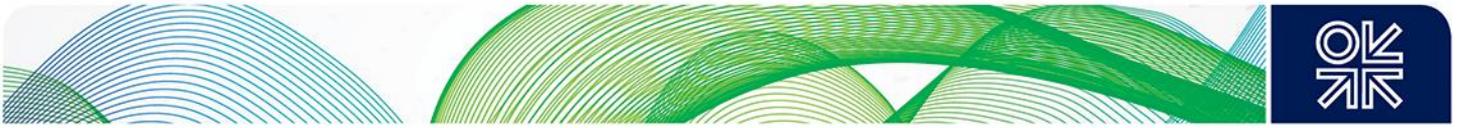
The complete change in the Dutch gas outlook means a major fall in regional production from a European perspective, but nobody seems to be paying much attention to it despite the fact that gas extraction in the Netherlands has fallen from 81.5 bcm in 2013 to 68.6 bcm in 2014, 51.2 bcm in 2015, and 47.4 bcm in 2016.²¹⁶ This is maybe because parties have been prepared for a natural decline of the Groningen field, and despite the rapid drop in production, contractual obligations have been respected. Additionally, security of supply has not been an issue as measures and regulations regarding volumes and flexibility were based on the minimum volume required by GTS. Consequently, there have been minimal impacts on the gas supply and prices in the Netherlands and in importing countries thanks to carefully managed alternative gas options (small fields' production and conversion of H-gas) and export/import balances.

H-gas is available from other sources, essentially from Norway, Russia, North Africa in southern European markets, LNG imports from an even larger range of suppliers, and finally from the spot markets. Whether these countries/markets have enough reserves, production capacity and/or can be commercially attractive to replace 40 bcm of Dutch gas surplus is beyond the scope of this paper, but the question needs to be considered. Regarding L-gas markets, large investments to convert L-gas networks, equipment and appliances to be able to use H-gas are needed and anticipated. The Netherlands is taking steps to transition to an H-gas system while importing countries have already started the process, earlier than anticipated: it is well under way in Germany and is gaining momentum in Belgium and France as all three countries will cease to import Dutch L-gas by 2030. It will then be replaced by imported H-gas, although the exact quantity of additional imports required is uncertain as the energy transition to a low carbon economy will drive the decarbonization of the heating sector (the major consumer of L-gas) in most countries in Europe post-2030.

²¹⁴ A new production plan could be published in mid-to-late May.

²¹⁵ Dutch producer Nam said that there had been a higher frequency of seismic activity around some of the Groningen field's Loppersum well clusters since late October 2016 (and remained high at the start of 2017). The seismic activity in the region does not exceed the limits set in the government's production plan for the Groningen field.

²¹⁶ <https://www.cbs.nl/en-gb/news/2017/09/gas-exports-halved-in-the-past-three-years>



As of early 2017, there were no signs that there would be any major threat to security of gas supply in North West Europe as a consequence of the restrictions taken on Groningen gas production, but the rapid change means a big increase in imports from elsewhere with potential security of supply implications (volumes, capacity, prices, and/or dependence). Dutch production surplus (production minus demand) fell from about 40 bcm in 2013 to only about 10 bcm three years later, and by 2030, it will likely have disappeared altogether. In other words, within a five year period, Dutch H-gas exports fall and disappear (by early 2020s) and L-gas exports will be halved by 2025 and will disappear by 2030. These are important trends not just for the Netherlands but for the whole European gas market. This is a dramatic evolution for the European supply as a whole that is probably well under-appreciated. Regional production peaked in 2004 at 341 bcm and was down to 257 bcm in 2016 (-84 bcm).²¹⁷ This author expects regional production to decline further rapidly: to 212 bcm in 2020²¹⁸ and to 146 bcm in 2030.²¹⁹ This scenario accounts for 111 bcm decline between 2016 and 2030, of which 30 bcm come from the Netherlands alone. This scenario was calculated in May 2017, but there is a risk that Groningen production could be reduced even further before 2021. Court actions to completely shut the field's production down have so far been unsuccessful, but this may not be the case in the future.²²⁰ Additional revisions from the Government are also to be expected, probably on an annual basis, especially if there is further serious seismic activity in the Groningen area.

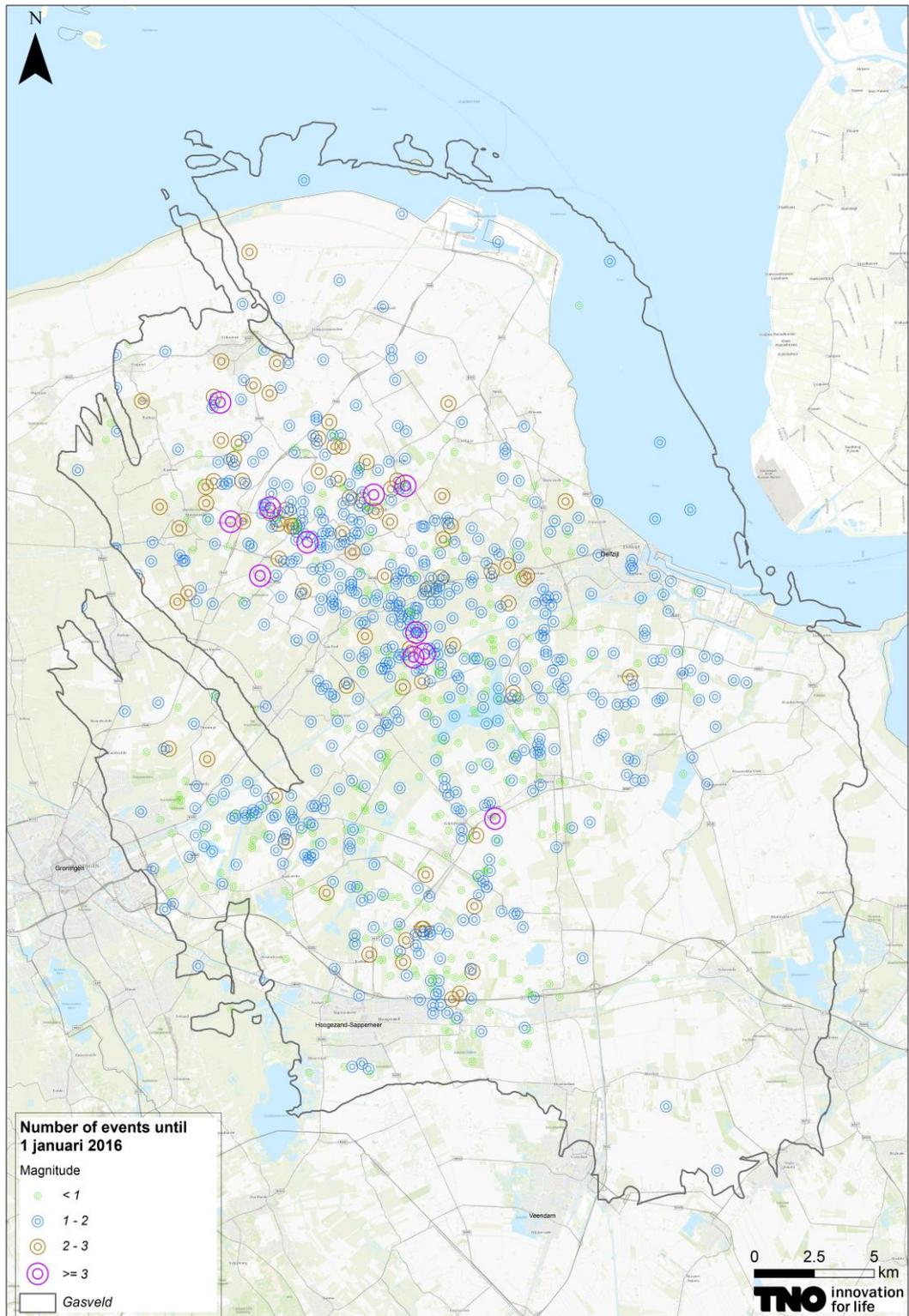
²¹⁷ Sources data: IEA and JODI. Data for Europe = European Union + Albania + Norway + Turkey + Switzerland

²¹⁸ The decline would be 45 bcm, but the range of possible decline goes from 29 bcm to 62 bcm between 2016 and 2020. Source: Author's estimates for Europe = European Union + Albania + Norway + Turkey + Switzerland

²¹⁹ The decline would be 111 bcm, but the range of possible decline goes from 91 bcm to 134 bcm between 2016 and 2030. Source: Author's estimates for Europe = European Union + Albania + Norway + Turkey + Switzerland

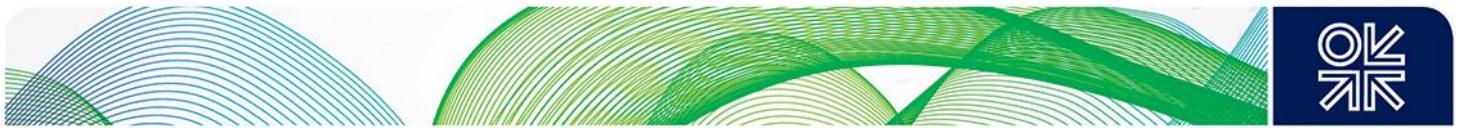
²²⁰ The frequency of earth tremors has increased since October 2016 and the Dutch state supervision of mines requested that NAM carry out further research into the possible causes. Argus, 31 March 2017, NAM sees no "obvious cause" for Loppersum tremors

Appendix 2: Map of induced earth tremors in the Groningen field



Note: Earth tremors $ML \geq 1,5$

Source: <http://www.nlog.nl/en/groningen-gasfield>



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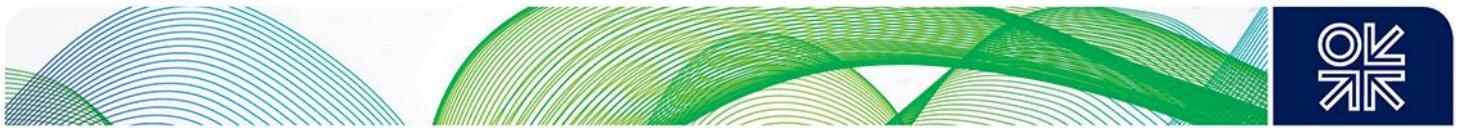
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