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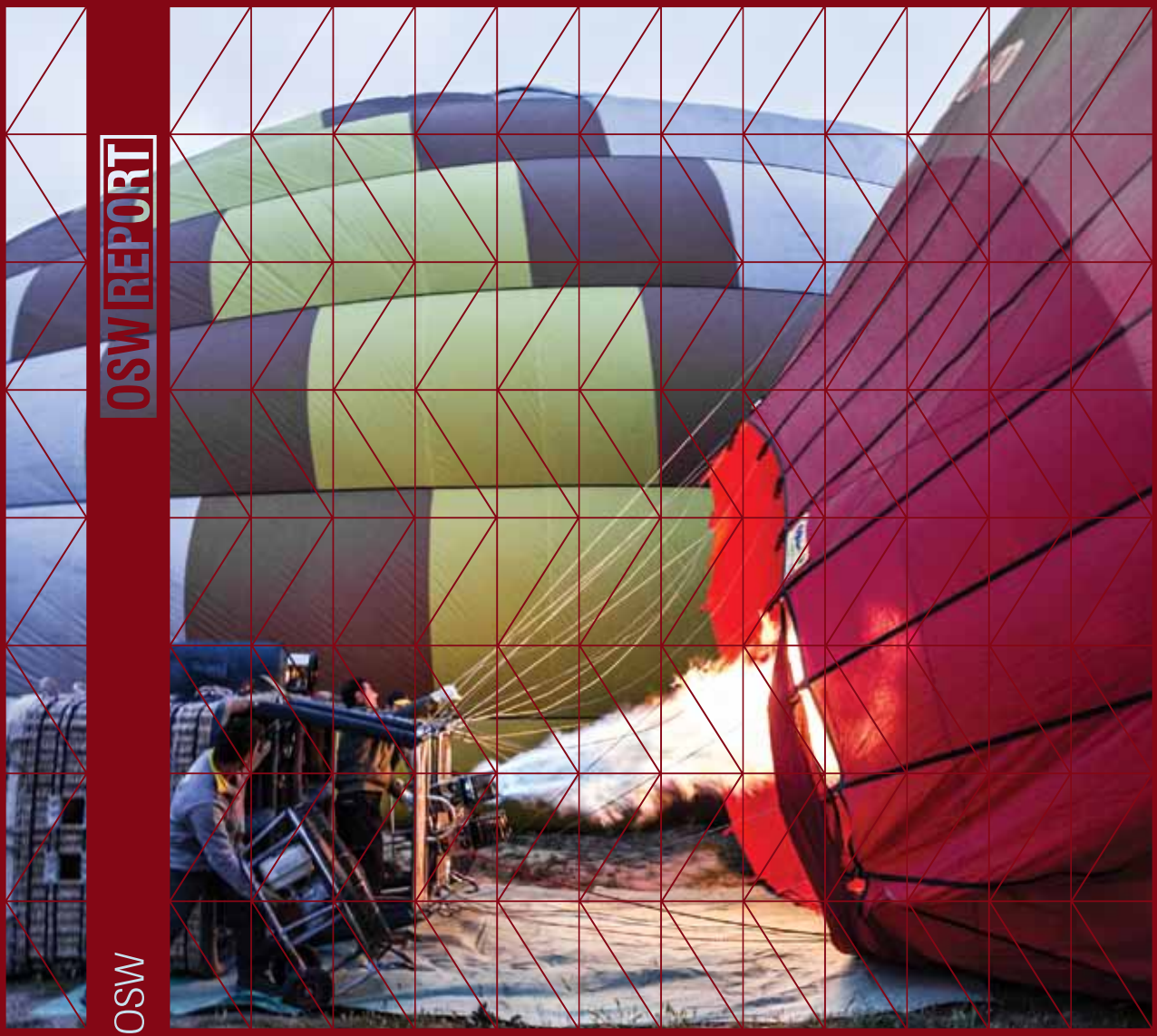

OSW

DEPENDENCE MANAGEMENT
THE BACKGROUND OF THE GERMAN GAS POLICY

Rafał Bajczuk

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DEPENDENCE MANAGEMENT
THE BACKGROUND OF THE GERMAN GAS POLICY

Rafał Bajczuk

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INTRODUCTION

Natural gas, after crude oil, is the most important energy carrier in the German economy. Over the past twenty years, natural gas has been the only conventional energy carrier to have increased its share in the German energy mix. Furthermore, according to consumption forecasts, its significance in Germany will grow. Since demand for natural gas has remained high while domestic production and imports from Holland have fallen, Germany needs to face the challenge of guaranteeing the security of its gas supplies. Given the lack of alternative supply routes, the most likely scenario in the medium term is increasing gas imports from Russia, which has been the largest supplier of gas to Germany since the 1980s.

This report discusses the issues of gas consumption in Germany and foreign supplies. The author has also examined the possibilities of replacing pipeline gas, which predominates at present, with imported liquefied natural gas (LNG) and domestic production of biogas and syngas. Most of the statistical data presented in this report originates from the Federal Ministry for Economic Affairs and Energy and from Arbeitsgemeinschaft Energiebilanzen, an association of representatives of the German energy sector tasked with analysing statistical data from the energy sector. The author has also used, among other materials, reports and information from the German government and industry organisations.

This report is divided into three parts. The first one discusses the internal conditions of gas consumption in connection with the implementation of the energy transformation strategy. It reveals the Germany industry's dependence on gas supplies. This is particularly true of the chemical industry, which consumes the largest amounts of gas as compared to other sectors and which has felt the consequences of the US shale revolution strongest of all. The second part discuses the external conditions of gas supply to Germany. This part includes a description of natural gas co-operation with Russia and development of gas infrastructure in which Russia's Gazprom has been strongly engaged over the past few years. The third and final chapter presents the opportunities for developing alternative sources of gas supplies to Germany. It also discusses the issue of liquefied natural gas imports to Germany and the construction of an LNG terminal, the use of rich shale gas resources in Germany and the opportunities of using biogas and the innovative technology known as 'power-to-gas'.

THESES

1. Natural gas plays a key role in the German economy. After crude oil, it is the most important energy carrier used in the country, satisfying around 20% of Germany's demand for primary energy. Natural gas is vital for the German industry, and is the most important source energy used for heating buildings. Germany is the largest consumer (84.7 billion m^3 in 2014) and importer of natural gas in the European Union (96.3 billion m^3 in 2014). It is also the world's second largest (after Japan) importer of natural gas.

2. Natural gas is the most important energy source for the German industry. Its share in final energy consumption in the industrial sector in 2014 was around 35%. Security of supplies and competitive gas prices are especially vital to energy-intensive industries which are competing on international markets, such as the metallurgical and chemical industries. From among all industries, the chemical industry is the largest consumer of natural gas (around 10% of domestic consumption). Over the past few years, this branch has experienced strong competitive pressure from North America, where gas prices have dropped by around 70% over the past ten years, while in Germany this has increased by around 30%. Relatively high gas prices in Germany have caused relocation of new investments in the chemical sector to the USA. This sector has been putting pressure on the market and the government to make gas prices as competitive as possible.

3. The role of natural gas in electricity production has been reduced dramatically over the past few years, although a complete marginalisation of gas power plants in Germany is unlikely. In 2010–2015, the output of gas power plants fell by 35%. This was an element of a broader trend existing on the German energy market labelled as the '*Energiewende* paradox': the increase in new output from renewable energy sources (RES) leads to more expensive low-emission gas power plants losing market share while cheap electricity production from coal grows. Given high production costs, the future of gas power plants on the German energy market is far from bright. Nevertheless, considering the climate policy and the need to maintain stable power production, the state will create instruments to enable them to continue operation on the market.

4. The energy transformation strategy (*Energiewende*) currently being implemented by Germany will strengthen the significance of natural gas in the energy sector, even though gas consumption volume will decrease. The

strategy envisages a 50% reduction of primary energy consumption by 2050, and an 80% reduction in the building heating sector, as well as decreasing greenhouse gas emissions by 80–95%. The share of energy from renewable sources in primary use is expected to increase from 11.3% in 2014 to 60% in 2050. Germany also wants nuclear power production to be eliminated by 2022. Given these goals, it will be necessary to lessen the consumption of fuels with the highest emission levels: coal and oil. This gap, along with renewable energy sources, will be filled by natural gas, which is the purest (causing lowest emissions) of the available fossil fuels. Therefore, the share of natural gas in the German energy basket will grow. However, considering the ever decreasing demand for energy, the volume of its consumption will fall. According to most forecasts, gas consumption will have fallen significantly by 2050.

5. Natural gas is Germany's most important heating fuel: 49.3% of households in Germany used individual gas heating in 2014. Building and water heating accounted for 33% of gas consumption. Natural gas will remain Germany's number one heating fuel until around 2050, by which time the currenti mplementation of building thermal insulation strategy will have had tangible effects. The energy transformation strategy is beeing implemented in the building heating area above all through reducing the demand for energy rather than replacing thermal energy sources with RES. In the long run, the issue of demand for thermal energy is expected to be resolved through thermal insulation of buildings and by equipping them with heat pumps or other renewable energy sources. Strategic documents stipulate that by around 2050 almost all building in Germany will be zero-energy buildings, and the primary consumption of energy in buildings is expected to fall by 80% as compared to 2008.

6. At present, 90% of natural gas consumed in Germany is imported. Three suppliers: Russia (36.4 billion m^3 in 2014), Norway (30.2 billion m^3 in 2014) and Holland (26 billion m^3 in 2014) account for over 95% of foreign supplies. Domestic production and imports from Holland will fall to zero in the coming fifteen years, while imports from Russia will grow. Even though the Federal Ministry for Economic Affairs and Energy has declared support for diversifying gas import sources, for example, by granting import guarantees to companies, it has no plans concerning new future sources of gas imports as yet. Consistent development of co-operation with the two key suppliers, Russia and Norway, is the basis for guaranteeing security of gas supplies.

7. In the medium term, Russia will strengthen its role as the largest supplier of natural gas to Germany. The share of Russian gas in German imports reached 39% in 2014. Russia has uninterruptedly been Germany's largest gas supplier since the mid 1980s. The construction of the first two branches of the Nord Stream gas pipeline in 2005-2012 was a milestone in enhancing co-operation between the two countries. The gas pipeline was used not only as an instrument to improve Germany's energy security but also as an element of the broader political concept of tightening Russian-German relations. The decision passed in 2015 to build Nord Stream 2 proves that co-operation with Russia in the area of gas supplies is being reinforced, and the German government politically supports the co-operation between German corporations and Gazprom. Officially, the government agrees with the European Commission that gas supply routes to the EU that are alternative to the Russian ones must be built, but Germany does not wish to relinquish its position of Russia's largest partner in oil and gas trade. Berlin hopes that gas supply security will be strengthened further, owing to the direct gas pipeline connection with Russia and to the benefit of being a gas hub in the EU.

Potential security risks linked to increasing dependence on a single source have not affected the government's political decisions and companies' investment strategies. Russia is treated by a majority of the German elite as a reliable supplier who supplied gas even when the USSR was collapsing. Besides, Germany is connected to the gas grids of the neighbouring countries so well that possible interruptions in supplies from Russia could be compensated with imports from other countries. Furthermore, energy co-operation with Russia is often viewed as a factor which improves Germany's security because it creates mutual dependence which offers Berlin an instrument to influence Moscow's moves.

8. Germany is among those few highly developed countries, and the only economy in the G20 group, not to have an LNG terminal. As a consequence, Germany imports only pipeline gas. As a matter of fact the German company E.ON buys liquefied gas to be supplied to foreign LNG terminals, but this gas is sold on foreign markets. Although projects for building LNG terminals in the German ports of Wilhelmshaven and Brunsbüttel have been prepared, investors have withheld the implementation of these projects as of yet. According to governmental analyses, developing gas storage facilities is a cheaper solution to ensure security of gas supplies than importing LNG or building a terminal in Germany. The large number of

gas interconnectors allows German customers to use the terminals in the neighbouring countries, above all the terminals in Rotterdam (Holland) and Zeebrugge (Belgium).

9. Theoretically, the utilisation of German shale gas resources offers the largest opportunity to reduce the country's dependence on imports. Extractable shale gas resources are estimated to range between 0.7 and 2.3 trillion m^3. Shale gas could successfully replace the shrinking imports from Holland and domestic conventional gas production. Business and industrial organisations have been lobbying for enabling shale gas extraction, but there is very strong political and public resistance to the use of shale gas extraction technology in Germany. The Bundestag is currently working on legislation amendments that will allow test drilling for shale gas. The bill provides for the possibility of using those drilling sites which will have been approved by an independent expert commission after 2018. However, large-scale shale gas extraction in Germany seems impossible due to strong public resistance to this technology.

10. Increasing domestic biogas production is one alternative to gas imports. Germany is already the European Union's largest biogas producer. Around 680 million m^3 of biomethane (around 0.8% of domestic gas consumption) was produced and pumped into the gas grid in 2014. Additionally, 32.6 TWh of electric power (around 5% of domestic consumption) and 14 TWh of thermal energy were produced from raw biogas. Back in mid 2014, the government's plans envisaged increasing biomethane production to around 10 billion m^3 annually by 2030, and electricity production at agricultural biogas plants were supported by the feed-in-tarrif. However, these plans were revised in the amended RES Act which came into force in August 2014. Due to pressure from environmentalist circles and high technology costs, the government reduced the forecasts concerning biomethane production and restricted investments in new biogas plants. In turn, hopes have been pinned on the development of the power-to-gas technology (P2G, i.e. transforming electric energy into gas fuel). Many German firms, including such giants as E.ON, RWE and EnBW, have been testing the possibilities of producing hydrogen from electric energy surpluses obtained from RES and transforming hydrogen into syngas which has the same properties as natural gas. At present, fourteen pilot installations for producing hydrogen from electricity surpluses operate in Germany, and six more are under construction. The German government hopes that the P2G technology will make it possible to build a zero-emission energy system. Widespread use of this technology

would mean that a way to effectively store electric energy has been found, the lack of which has been so far the greatest impediment to a rapid implementation of *Energiewende*.

I. THE ROLE OF NATURAL GAS IN THE GERMAN ECONOMY

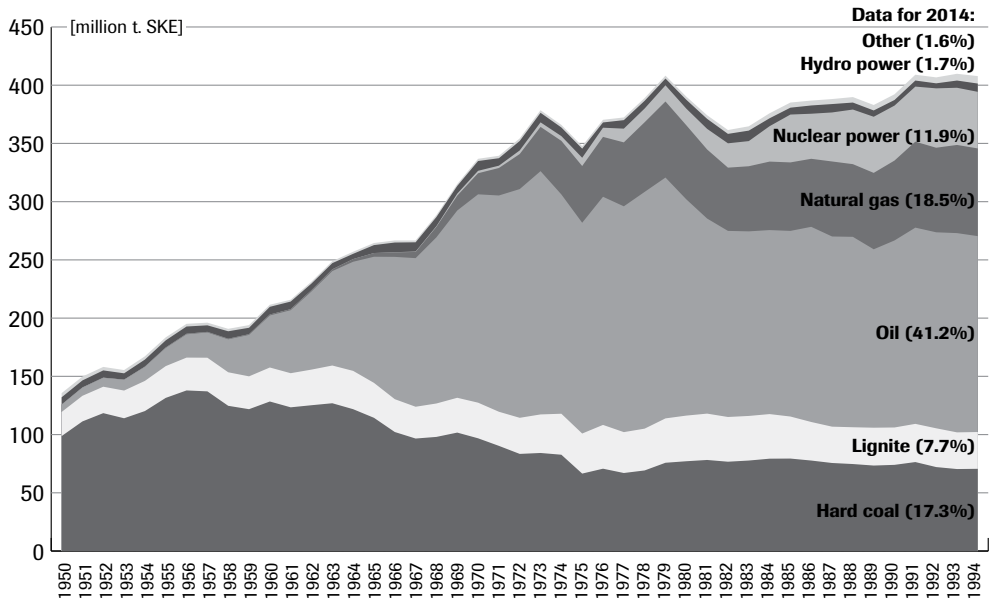
1. Internal conditions on the German gas market

Germany is the European Union's largest natural gas consumer, with an annual consumption level of 84.7 billion m^3 (data for 2014). Germany is followed by the United Kingdom (70.2 billion m^3), Italy (56.7 billion m^3) and France (46.1 billion m^3). Germany is also the largest recipient of Russian gas in the EU (around 36.4 billion m^3) and the second largest recipient of Norwegian gas after the United Kingdom (around 30 billion m^3)[1]. In 2014, Germany, after Japan, was the world's largest importer of natural gas, its imports volume reaching 96.3 billion m^3. However, if we take into account the share of natural gas in primary energy consumption, which is 23% in Germany, this country is close to the EU average, which is 23.1%. In this context, natural gas plays a greater role in eleven other EU member states, such as Holland (40%), Italy (38%), the United Kingdom (33%) and Hungary (35%).

Until the mid 1970s, natural gas, as with other countries, was of marginal significance for the German economy. Until 1964, the share of natural gas in primary energy consumption in Germany was not higher than 1%, but since the mid 1960s, the role of this fuel in Germany has been regularly growing above all at the expense of hard coal (see Chart 1). The increase in the significance of natural gas since the 1960s was a widespread trend in Western Europe. This resulted from the discovery of new gas fields and the search for new energy sources with the intention of lessening the dependence on oil imports from OPEC countries. In 1975, natural gas accounted for around 14% of primary energy consumption, and in 1990, the year of the reunification of Germany, for around 18%. Natural gas did not play such a sizeable role in the eastern part of Germany. Until the end of East Germany's existence, its energy security relied on domestic brown coal reserves (68% of primary energy consumption in 1990). However, natural gas also began playing a greater role in its economy between 1970 and 1990, and its share in primary energy consumption grew from around 1% to around 9%.

[1] *Energiestudie 2015*, BGR, Hanover 2015.

Chart 1. Primary energy consumption in Western Germany (the old federal states) in 1950–1994 in millions of tonnes of coal equivalent (SKE)

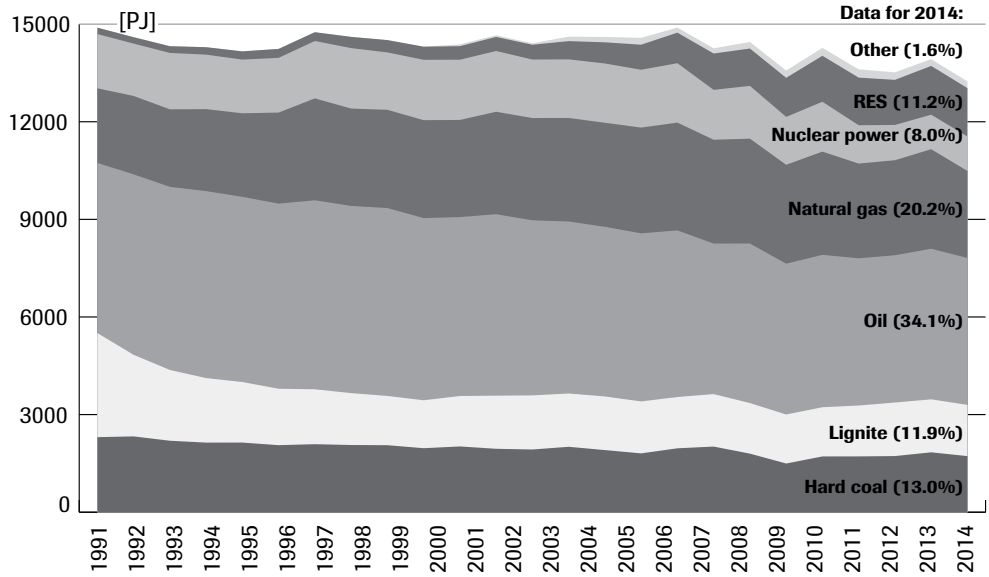


Source: AG Energiebilanzen, http://www.ag-energiebilanzen.de/10-0-Auswertungstabellen.html

Gas consumption increased from the reunification of Germany in 1990 to 2014 by around 16%, from approximately 72.6 billion m^3 (2293 PJ) to approximately 84.7 billion m^3 (2674 PJ). In the year of Germany's reunification, natural gas, with a share of 15.4%, was ranked fourth in terms of primary energy consumption after crude oil (35%), brown coal (21.5%) and hard coal (15.5%). In 2014, natural gas had already risen to second position (20.4%) after crude oil (34.4%). At present, hard coal (13.1%), brown coal (12%) and nuclear energy (8.1%) each have a smaller share than in previous years[2].

[2] Federal Ministry for Economic Affairs and Energy, *Zahlen Und Fakten Energiedaten*, 1 October 2015, http://bmwi.de/DE/Themen/Energie/Energiedaten-und analysen/Energiedaten/gesamtausgabe,did=476134.html

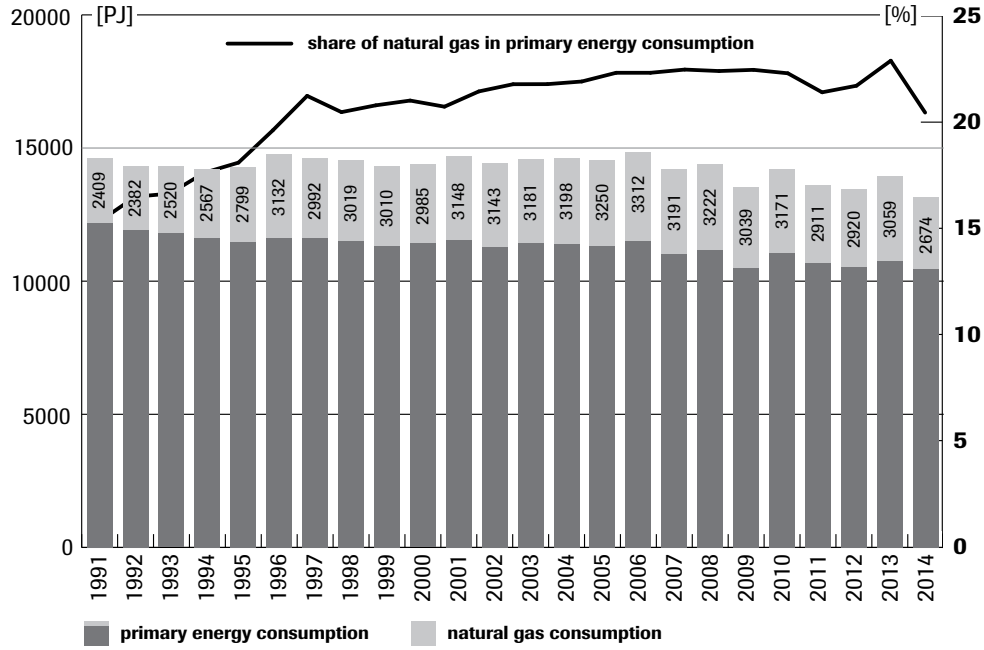
Chart 2. Primary energy consumption in Germany in 1990–2014 in PJ



Source: AG Energiebilanzen, http://www.ag-energiebilanzen.de/10-0-Auswertungstabellen.html

The share of natural gas in primary energy consumption increased from around 15.4% in 1990 to 20.2% in 2014. It is worth noting that while energy consumption has been gradually falling in general, natural gas consumption has remained at the same level (since the period of increase in the 1990s). Over the past 24 years, the decrease in energy consumption primarily concerned those fuels that are most polluting: petroleum products in road transport and heating (heating oil) and coal in the power sector. It is only over the past five years that natural gas consumption has fallen in the power sector: a decrease of 31% from 675 PJ in 2010 to 463 PJ in 2014. Total gas consumption fell by 14% from 2247 PJ to 1927 PJ during this period.

Chart 3. Natural gas consumption in Germany in 1990–2014 in PJ

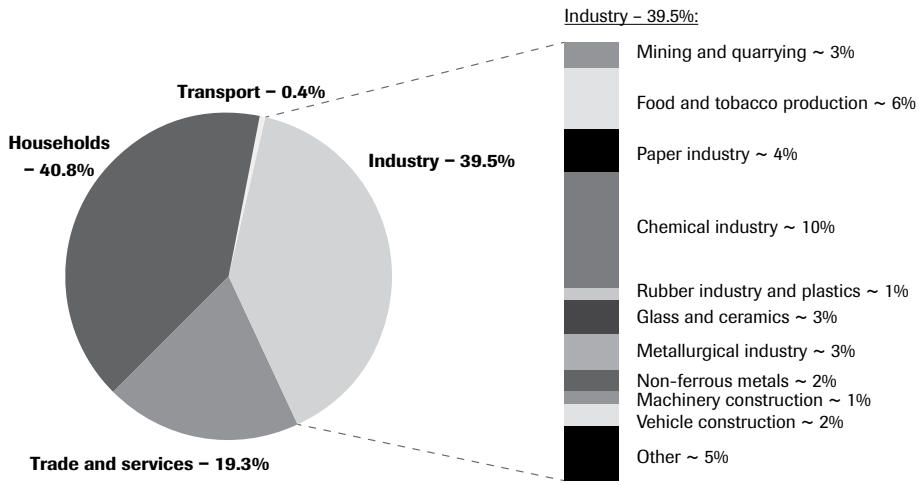


Source: Federal Ministry for Economic Affairs and Energy, *Zahlen Und Fakten Energiedaten*, 1 October 2015, http://bmwi.de/DE/Themen/Energie/Energiedaten-und-analysen/Energiedaten/gesamtausgabe-,did=476134.html

The household sector, which uses natural gas predominantly for heating, is the most important natural gas consumer in Germany (41% in 2014). The second largest group of gas consumers is industry (36%). The trade and services sector accounts for the remaining consumption (19%). Gas consumption in the transport sector is marginal, reaching around 0.5%[3], i.e. around 0.25 billion m³ in 2014.

[3] Federal Ministry for Economic Affairs and Energy, *Zahlen Und Fakten Energiedaten*, 16 March 2015, http://bmwi.de/DE/Themen/Energie/Energiedaten-und analysen/Energiedaten/gesamtausgabe,did=476134.html

Chart 4. Natural gas consumption in Germany in 2014 broken down into end users



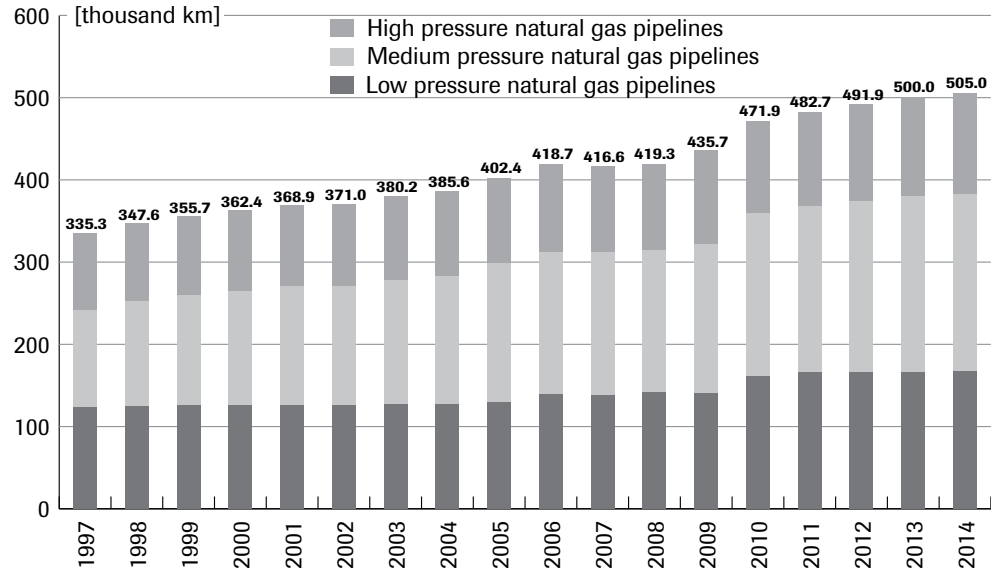
Source: Federal Ministry for Economic Affairs and Energy, *Zahlen Und Fakten Energiedaten*, 1 October 2015, http://bmwi.de/DE/Themen/Energie/Energiedaten-und analysen/Energiedaten/gesamtausgabe-,did=476134.html

At present, the German system of transport gas pipelines is approximately 40,000 km long, and the entire gas grid[4] has around 505,000 km. The German gas distribution market, unlike in many other countries, was not formed by the state but as a result of the operation of private gas companies. In effect, a relatively large number of actors operate on the German gas market, and there is no single national gas corporation. At present, around seventeen operators of distribution networks and around 700 distribution firms operate on the German gas distribution market, making it one of the most complex among the EU member states[5]. The gas trade market is diversified to a similar extent. Two market platforms operate in Germany: NCG (NetConnectGermany) in the southern part and Gaspool in the north of the country. The German gas transport infrastructure is well-developed, owing to which the country can act as a gas hub (gas distribution centre) in Central Europe.

[4] See data from the Association of Gas Transmission System Operators (German: Vereinigung der Fernleitungsnetzbetreiber Gas e. V. (FNB Gas), http://www.fnb-gas.de/de/fernleitungsnetze/gastransport/gastransport.html

[5] The website of the Association of Gas Transmission System Operators (FNG-Gas), http://www.fnb-gas.de/de/fernleitungsnetze/gastransport/gastransport.html

Chart 5. The development of the gas pipeline network in 1997–2014



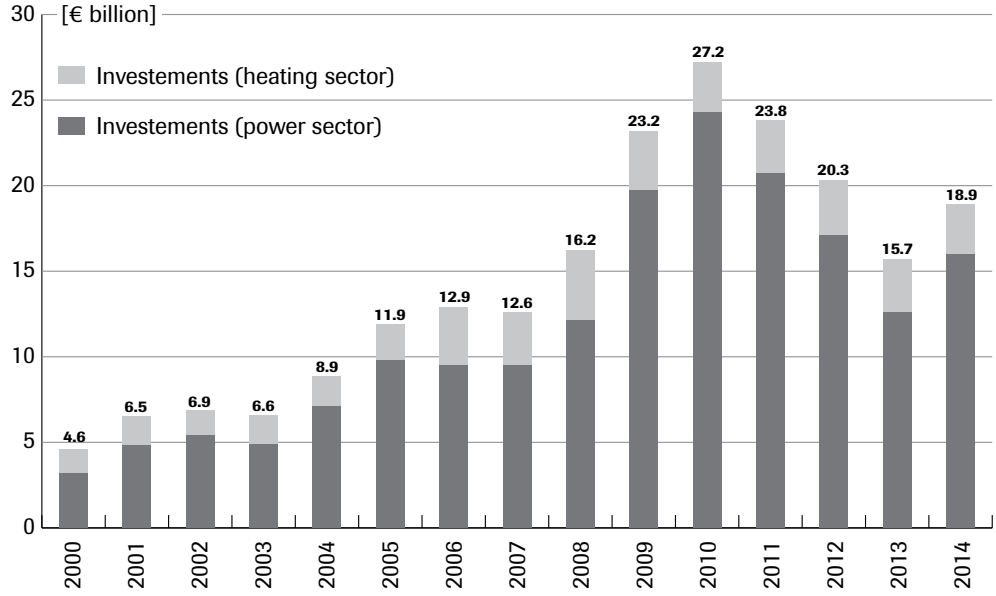
Source: *Monitoring-Bericht nach § 51 EnWG zur Versorgungssicherheit bei Erdgas*, Federal Ministry for Economic Affairs and Energy, page 9, July 2015.

2. *Energiewende* vs. natural gas

The goal of the German Energy Strategy 2050, the so-called energy transformation (known as *Energiewende* since 2011) launched in 2010, is to reduce the share of energy from fossil fuels in the energy mix and to reduce greenhouse gas emissions. By 2050, greenhouse gas emissions are expected to fall by 80–95% as compared to 1990, the share of RES in final energy consumption is expected to reach 60%, and primary energy consumption is to be reduced by 50% as compared to 2008. To achieve these goals, the government has made efforts to increase the share of RES in final energy consumption and to improve energy efficiency. Most funds allocated for RES are invested in systems producing electric and not thermal energy (see Chart 6). The consequences for the energy sector include increasing volumes of electricity production from RES which has been replacing electric energy produced by the gradually decommissioned nuclear power plants and has been pushing out of the market the most expensive electricity produced by gas power plants. The government has not taken any decisive steps in the heating and energy efficiency sectors. The heat production sector, where natural gas is the predominant fuel, has been affected by the energy revolution to a much lesser extent than the power sector. While the share of RES in the power sector is expected to rise to

40–45% by 2025[6], the share of RES in the heating sector is only expected to reach 14% in 2020[7]. In 2014, renewable energy sources were used to produce 27.4% of electric energy and 12.2% of thermal energy[8].

Chart 6. Investments in the construction of renewable energy facilities in Germany between 2000–2014



Source: Entwicklung der erneuerbaren Energien in Deutschland im Jahr 2015 Grafiken und Diagramme unter Verwendung aktueller Daten der Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat), Stand Februar 2016, http://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/entwicklung_der_erneuerbaren_energien_in_deutschland_im_jahr_2015.pdf?__blob=publicationFile&v=12

It can be expected that natural gas consumption will still decline slower than that of coal and oil, and gas's share in the energy basket will remain relatively high.

Firstly, there is no political pressure to rapidly reduce natural gas consumption because it is the cleanest of the fossil fuels available – with low emission levels of both greenhouse gases and air-polluting dust. The goals of the German Energy Strategy to 2050 include an 80–95% reduction in emissions of greenhouse

6 Renewable Energy Sources Act (German: *Gesetz für den Ausbau erneuerbarer Energien*, Article 1, clause 2.

7 Renewable Energy Sources in the Heating Sector Act (German: *Gesetz zur Förderung Erneuerbarer Energien im Wärmebereich*, Article 1, clause 2.

8 The Federal Environment Agency, https://www.umweltbundesamt.de/daten/energiebereitstellung-verbrauch/anteil-erneuerbarer-energien-am-energieverbrauch

gases by 2050 as compared to 1990 and a 50% reduction of primary energy consumption by 2050. Given these goals, it is necessary in the first order to stop using the most polluting fuels: brown coal, hard coal and crude oil.

Secondly, the highest priority is currently given to investments in RES in the electricity production sector, where coal is the predominant energy carrier and natural gas plays a marginal role. This strategy has been adopted for a number of reasons. The most important being public support for decommissioning nuclear and coal power plants and replacing them with RES. Furthermore, the German government, by supporting RES, wants to support German manufacturers from the electric power engineering sector. Germany aspires to becoming a powerful player in the area of using renewable energy sources for electricity production, which offers the greatest opportunities for expansion to foreign markets. This is one of the reasons why renewable energy sources receive greater support in the electric energy sector than in the thermal energy sector.

Thirdly, modernisation of the heating sector takes much more time and causes more problems of an administrative nature than modernisation of the electric energy sector. The heating sector will be modernised above all through thermal insulation of buildings and by reducing the demand for energy. The National Action Plan on Energy Efficiency[9] specifies that by 2050 almost all buildings in Germany will have energy consumption levels close to zero[10], i.e. they will use as much energy as they produce themselves. Primary energy consumption by buildings is to be cut by 80% by 2050 as compared to 2008. The government announced in December 2014 that one billion euros would be allocated for supporting thermal insulation of buildings from the federal budget in 2015–2019, and the pool of cheap loans would be increased to two billion euros annually[11].

It is assumed in most available energy consumption forecasts that, if *Energiewende* goals are achieved by 2050, gas consumption will be reduced by at

[9] Energieeffizienzstrategie Gebäude Wege zu einem nahezu klimaneutralen Gebäudebestand 2015, Federal Ministry for Economic Affairs and Energy, http://www.bmwi.de/BMWi/Redaktion/PDF/E/energieeffizienzstrategie-gebaeude,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

[10] According to Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings.

[11] Federal Ministry for Economic Affairs and Energy, Gabriel: Wir systematisieren die Energiewende und machen Energieeffizienz zur zweiten Säule, 3 December 2014, http://www.bmwi.de/DE/Themen/Energie/energiewende,did=672914.html

least half or will be eliminated entirely[12]. According to alternative forecasts, gas consumption levels will remain relatively high, ranging from 1300 to 2000 PJ in 2050 (analyses of research institutes Prognos AG, GWS and Köln University[13]), and will even rise to 3300 PJ in 2040 (ExxonMobil[14]). However, taking into account the way in which energy transformation has been implemented and the pace of technological progress in the area of RES, it should be assumed that gas consumption in Germany will fall in the longer term.

3. Natural gas in the heating and power sectors

Natural gas is Germany's main heating fuel. In 2014, 49.3% of German households used individual gas heating, while heating oil was the second most popular heating energy carrier (26.8%). 13.5% of households bought energy from heating networks (42% of the network heat was generated by natural gas, 25% by hard coal and 15% by waste[15]). Natural gas is used so widely because it is a practical, clean and widespread way of heating buildings. Heating oil is poorly regarded in Germany and is not a preferred choice in newly constructed buildings, which is proven by statistics concerning the heating of new buildings – heating oil systems were installed in less than 0.5% of new houses in 2014. Gas heating systems are still the most popular in newly built houses – in 2014, 49.8% of new buildings had gas heating systems, 21.5% were connected to the heating network, 19.9% used electric heat pumps, and 6.1% used solid biomass furnaces[16].

[12] Geschäftsmodell Energiewende Eine Antwort auf das „Die-Kosten-derEnergiewende"-Argument, Fraunhofer-Institut für Windenergie und Energiesystemtechnik, IWES, Kassel, January 2014, page 21, https://www.energie.fraunhofer.de/de/bildmaterial/news-pdf/studie-geschaeftsmodell-energiewende.pdf (accessed on 15 Januar 2016), see page 21.

[13] Entwicklung der Energiemärkte – Energiereferenzprognose Projekt Nr. 57/12, Studie im Auftrag des Bundesministeriums für Wirtschaft und Technologie, Prognos AG, EWI – Energiewirtschaftliches Institut an der Universität zu Köln, GWS – Gesellschaft für wirtschaftliche Strukturforschung, June 2014, pages 529-530, http://www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/entwicklung-der-energiemaerkte-energiereferenzprognose-endbericht,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf (accessed on 15 January 2016).

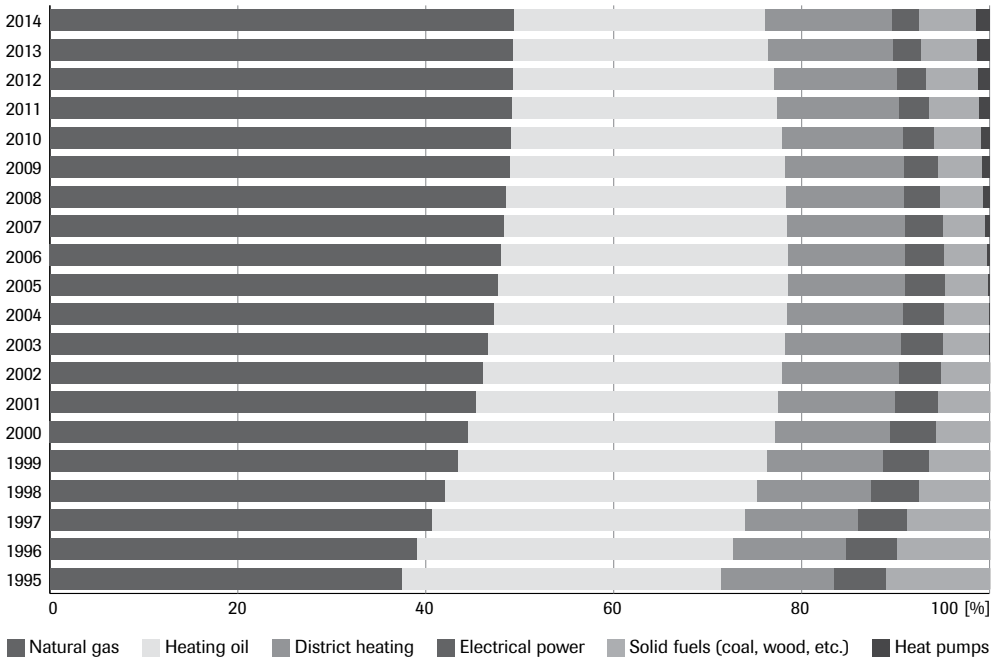
[14] ExxonMobil's Energy Forecast, http://www.exxonmobil-energieportal.de/energieprognose/primaerenergieverbrauch/ (accessed on 15 January 2016).

[15] The Federal Statistical Office, Wärmeversorgung 2014: Abgegebene Wärmemenge um 11,3% gesunken, 4 December 2015, https://www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2015/12/PD15_447_434.html;jsessionid=199E7E513EAD043571D2D9723AE2375F.cae1

[16] AG Energiebilanzen e.V., Energieverbrauch in Deutschland Daten für das 1. – 4. Quartal 2015, http://www.ag-energiebilanzen.de/

Natural gas will remain the key heating fuel in Germany in the long term. Water and building heating accounts for around 33% of final energy consumption in Germany. Differences in gas consumption resulting from the temperature outside are significant. In the winter season, gas consumption in Germany exceeds 100 billion kWh monthly (around 10.2 billion m³), and in summer, it reaches around 50 billion kWh monthly (around 5.1 billion m³). This consumption profile causes development of storage facilities, whose capacity is growing on a regular basis – it increased from 14.1 billion m³ in 1998 to 24.6 billion m³ in 2015[17].

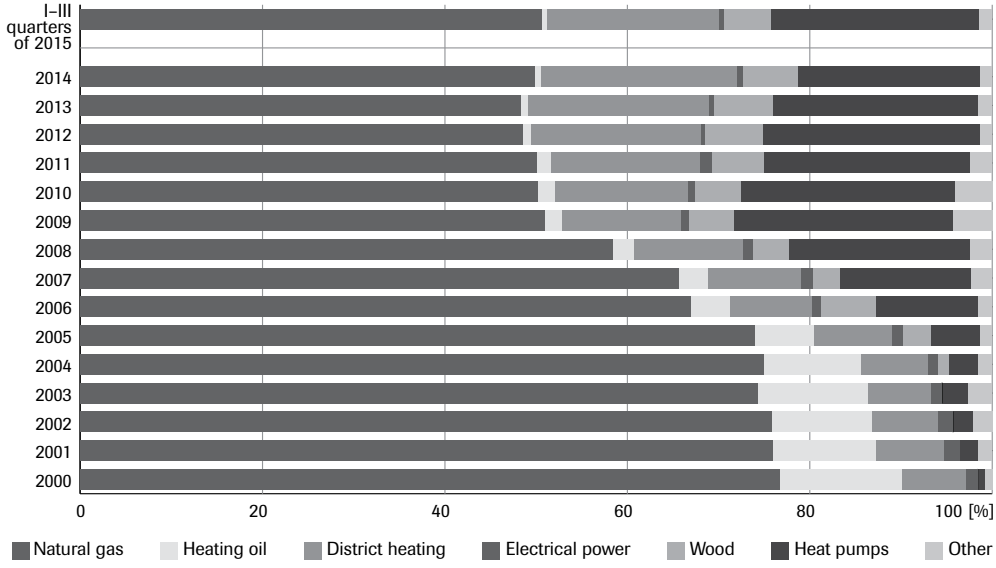
Chart 7. German household heating structure in 1995–2014



Source: Energieverbrauch in Deutschland Daten für das 1.- 4. Quartal 2015, AG Energiebilanzen, http://www.ag-energiebilanzen.de/

[17] The German Association of Energy and Water Industries BDEW, Entwicklungen in der deutschen Erdgaswirtschaft 1. Halbjahr 2015, Berlin, June 2015, http://www.ag-energiebilanzen.de/index.php?article_id=29&fileName=erdgas_hj_2015.pdf (accessed on 15 January 2016).

Chart 8. New houses' heating structure



Source: Energieverbrauch in Deutschland Daten für das 1.- 4. Quartal 2015, AG Energiebilanzen, http://www.ag-energiebilanzen.de/

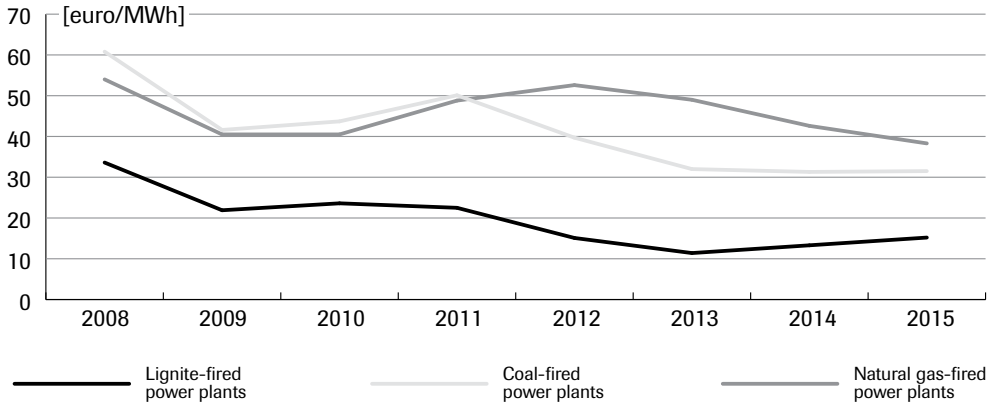
Gas consumption reached around 10.3 billion m³ in the electric energy sector in 2015. However, gas power plants have become less and less profitable over the past few years, and therefore gas consumption has been rapidly falling in electricity production. This has been one of the unplanned consequences of the government's energy policy aimed at supporting RES. This trend is a result of the so-called 'energy transformation paradox'[18]. This phenomenon means that as production of electric energy from RES grows, more electricity is produced by coal power plants, and carbon dioxide emissions grow instead of falling. In 2010–2015, production of electric energy from RES increased by around 85%, from 105 billion kWh to 194 billion kWh, and at the same time the output of gas power plants dropped by 37% and that of nuclear power plants by 35%. At the same time, brown coal power plants increased their output by around 6% and hard coal power plants by around 1%. The German government views this as a disturbing phenomenon because one of the main goals of the energy policy branded as energy transformation was to reduce greenhouse gas emissions by increasing the output of wind and solar power plants and using gas power plants to supplement electricity production from

[18] German: *Energiewende-Paradox*; see: Das deutsche Energiewende Paradox: Ursachen und Herausforderungen, *Agora Energiewende*, Berlin 2014, http://www.agora-energiewende.de/fileadmin/downloads/publikationen/Analysen/Trends_im_deutschen_Stromsektor/Analyse_Energiewende_Paradox_web.pdf

renewable sources, which are characterised by fluctuations in the output, depending on weather conditions.

To counteract this trend and reach the greenhouse gas emission goals, the government has decided to intervene and withdraw from the market the oldest brown coal power plants with a capacity of 2.7 GW (13% of the capacity of German brown coal power plants) and to shift them to the so-called power reserve. This means that these power plants will be put into operation only in case of power shortages in the system, and they will be decommissioned and liquidated after four years. The costs of this operation will reach around 0.5–1 billion euros annually in 2015–2020, and they will be paid by electricity consumers[19]. However, it is uncertain whether and when gas power plants will be competitive again on the German market. At present, the low price of coal coupled with relatively low prices of CO_2 emission permits makes coal power plants the most profitable. According to data from Agora *Energiewende* think tank in 2015, production costs at gas power plants (38.8 euro/kWh) were around 20% higher than those of hard coal power plants (31.5 euro/kWh) and around 60% higher than at brown coal power plants (15.2 euro/kWh)[20].

Chart 9. Marginal costs of electric energy production



Source: Die Energiewende im Stromsektor: Stand der Dinge 2015, Agora Energiewende, Berlin 2016, page 27, http://www.agora-energiewende.de/fileadmin/Projekte/2016/Jahresauswertung_2016/Agora_Jahresauswertung_2015_web.pdf

[19] Rafał Bajczuk, The uncertain future of the coal energy industry in Germany, *OSW Commentary*, 20 October 2015, http://www.osw.waw.pl/en/publikacje/osw-commentary/2015-10-20/uncertain-future-coal-energy-industry-germany

[20] 'Die Energiewende im Stromsektor: Stand der Dinge 2015', *Agora Energiewende*, Berlin 2016, page 27, http://www.agora-energiewende.de/fileadmin/Projekte/2016/Jahresauswertung_2016/Agora_Jahresauswertung_2015_web.pdf (accessed on 15 January 2016).

The gas power plant Irsching 5 in Bavaria has become a symbol of the problems German gas power plants are experiencing. Its construction was completed in 2010, and it is Germany's most modern gas power plant so far, its efficiency being 59.7%. However, given the competition from RES, which receive preferential treatment, and cheap coal power plants, it did not produce any electricity to be sold on the market in 2014 and 2015, and its output was only used to stabilise the network. For this reason, its operator, E.ON, has announced that the power plant will be withdrawn from use in 2016[21].

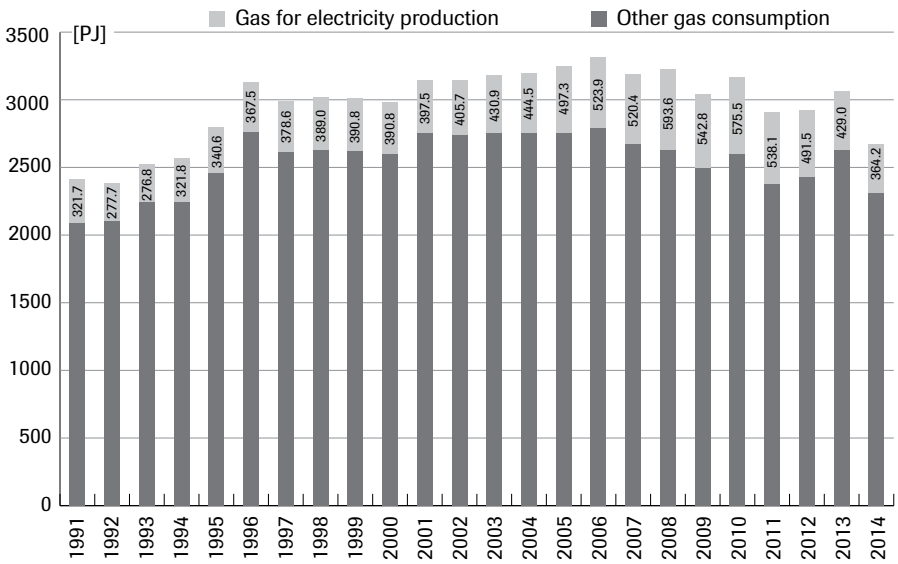
Considering the current trends, it seems that gas power plants have no chance of development on the German energy market. Electricity from natural gas will remain uncompetitive in the coming years, and power plant operators will make efforts to keep them on the threshold of profitability. To counteract this, the government amended the Combined Heat and Power Plant Act in December 2015 which provides for increasing subsidies for gas powered systems. In the medium term, the increase in emission permit prices and falling gas prices will help gas power plants continue operation on the German market.

The authors of the forecast for the Federal Ministry for Economic Affairs and Energy concerning the development of energy markets compared a dozen or so of various analyses concerning the future of the German energy market. Depending on the analysis, it is predicted that between 38% (ExxonMobil's forecast) and 5% of electric energy (forecast from the government's representative for the environment) will be produced by gas power plants in 2040[22].

[21] E.ON's press information, Keine wirtschaftliche Perspektive: Eigentümer der Gaskraftwerke Irsching 4 und 5 zeigen Stilllegung an, 30 March 2015, http://www.eon.com/de/presse/pressemitteilungen/pressemitteilungen/2015/3/30/no-economic-prospects-owners-of-the-irsching-4-and-5-gas-fired-power-stations-announce-their-closure.html

[22] Entwicklung der Energiemärkte – Energiereferenzprognose Projekt Nr. 57/12, Studie im Auftrag des Bundesministeriums für Wirtschaft und Technologie, Prognos AG, EWI – Energiewirtschaftliches Institut an der Universität zu Köln, GWS – Gesellschaft für wirtschaftliche Strukturforschung, June 2014, pages 529–530, http://www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/entwicklung-der-energiemaerkte-energiereferenzprognose-endbericht,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

Chart 10. Gas consumption in electricity production in PJ



Source: Federal Ministry for Economic Affairs and Energy, Zahlen Und Fakten Energiedaten, 1 October 2015, http://bmwi.de/DE/Themen/Energie/Energiedaten-und%20analysen/Energiedaten/gesamtausgabe,did=476134.html

4. The importance of natural gas for industry

The German industrial sector treats natural gas as the most important source of electric and thermal energy and feedstock in chemical processes. Its primary advantages include the ability to be used flexibly and the low level of pollution and greenhouse gas emissions. In 2014, the German industrial sector accounted for around 40% of final gas consumption (760.3 PJ). The key consumers were: the chemical (10% of domestic consumption), food (6%) and paper (4%) industries.

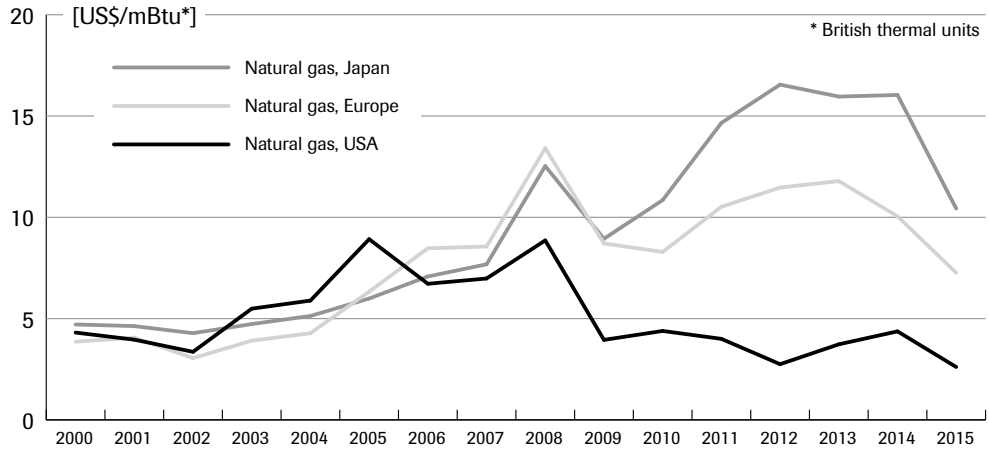
The price and availability of natural gas are most important to the chemical, pharmaceutical and metallurgical industries, where raw material prices affect the final product price to the greatest extent. The risk of relocating German chemical plants to the USA due to competitive gas prices there has been given a lot of publicity over the past few years. Germany is the world's largest exporter of chemical products. In 2013, natural gas, after crude oil, was the second most important production raw material in the chemical industry (crude oil 74%, natural gas 11%) and the most important energy source (36% of demand for energy from natural gas)[23]. Representatives of the chemical industry say that if

[23] In 2013, the chemical industry consumed 20 million tonnes of raw materials for the needs of organic chemistry: 74% are petroleum products, 11% natural gas, 13% renewable raw materi-

oil prices increased permanently, natural gas could replace crude oil as a production raw material and increase its share in the raw material basket of the German chemical industry[24]. However, given the falling oil prices, a reverse trend has been observed over the past few years.

The imbalance of the gas prices between the USA and Europe is currently the largest problem for the German chemical industry. Gas prices in the European Union and the USA were very similar (the price was slightly lower in Europe) until as recently as 2005, but since then gas prices in the USA have fallen significantly. An unprecedented increase in shale gas extraction has caused gas prices in the USA to be among the lowest in the world, and are around 65% lower than in Europe. According to BP's data, in 2014, the natural gas averaged price in Germany was higher (US$9.11/million Btu) than the averaged price in the United Kingdom (US$8.22/million Btu), the USA (US$4.35/million Btu) and Canada (US$3.87/million Btu)[25].

Chart 11. Global natural gas prices in 2000–2015



Source: World Bank, Commodity Markets, http://www.worldbank.org/en/research/commodity-markets

als (including cellulose, sugar, starch, vegetable and animal fats), 2% coal. Energy needs were satisfied in 36% by natural gas, 33% by electricity and 12% by network heat. Source : H. Bardt, Fossile Rohstoffe der Chemischen Industrie, Institut der deutschen Wirtschaft Köln, Köln, 2 September 2013, http://www.iwkoeln.de/studien/gutachten/beitrag/hubertus-bardt-fossile-rohstoffe-der-chemischen-industrie-128289; Verband der Chemischen Industrie e.V., Rohstoffbasis der chemischen Industrie, 30 November 2015, https://www.vci.de/vci/downloads-vci/top-thema/daten-fakten-rohstoffbasis-der-chemischen-industrie-de.pdf

24 S. Hofmann, Chemiebranche such nach Ölersatz, *Handelsblatt,* 14 January 2010.

25 www.bp.com, http://tools.bp.com/energy-charting-tool.aspx#/ep/natural_gas_prices/unit2/$-mBtu/view/line/

This imbalance in gas prices affects German companies' investment decisions. In 2015, German chemical companies' foreign investments grew six times faster than their domestic investments. Furthermore, considering low oil and gas prices, chemical production in the USA is currently four times more profitable than in Europe[26]. Whereas as recently as in 2011, German companies' domestic investments were almost equal to foreign ones. Analysts from Euler Hermes predict that this trend will strengthen in 2016 – German chemical sectors' domestic investments are expected to increase by 1% and foreign investments by 9%. The United States benefits most from these investments. In 2015, Germany's largest chemical corporation, BASF, informed of the launch of an investment in an ammonia factory worth around US$600 million in Freeport, Texas. It is also considering an investment worth double the value in a propylene factory[27].

One solution to resolve the issue of the chemical industry's dependence on natural gas would be, on the one hand, introducing cheaper substitutes of this fuel and diversifying supply sources, and on the other, moving production to North America, where gas prices are currently the lowest in the world. Given this situation, the German Chemical Industry Association is lobbying for the launch of shale gas extraction in Germany even though the vast majority of the German public oppose this[28]. In the opinion of representatives of the chemical industry, increasing the share of renewable resources might only partly solve the problem. Considering the limited surfaces of cultivated areas and competition from the energy sector (biogas and biofuels), neither Germany nor the European Union are capable of satisfying the chemical industry's demand for renewable raw materials relying solely on their own production. Therefore, under hypothetical conditions of an economy based on renewable raw materials, the raw materials would be supplied to the chemical industry from South America and Asia.

[26] Euler Hermes Studie: Konkurrenz Wächst – Deutsche Chemiebranche Investiert im Ausland, 30 June 2015, http://www.eulerhermes.de/mediacenter/neuigkeiten/Pages/euler-hermes-studie-deutsche-chemiebranche.aspx

[27] BASF, https://www.basf.com/de/company/news-and-media/news-releases/2015/03/p-15-176.html, https://www.basf.com/documents/corp/de/news-and-media/news-releases/2015/07/P300_BASF_Yara_Ammoniakanlage.pdf

[28] The German Chemical Industry Association (German: *Verband Chemischer Industrie*), https://www.vci.de/themen/energie-klima-rohstoffe/energiepolitik/vci-positionspapier-zur-erdgasfoerderung-in-deutschland-chancen-von-schiefergas-nutzen.jsp

II. GUARANTEEING GAS SUPPLIES TO GERMANY

1. Foreign gas supplies vs. domestic production

In 2014, the share of imported natural gas in domestic consumption reached 87.1%. The largest suppliers were: Russia (34.2%), Norway (28.4%) and Holland (24.5%). The remaining suppliers, i.e. Denmark and the United Kingdom, were of marginal significance (3.5%). Domestic production reached 10.7 billion m^3 and satisfied 9.5% of consumption. In 2014, domestic users consumed 84.7 billion m^3, and 21.4 billion m^3 was re-exported out of 106.4 billion m^3 of natural gas used in Germany. Dependence on imports from the two main suppliers, Russia and Norway, will strengthen in the future. This is due to the fact that imports from Holland and domestic gas production – the sources which have so far balanced out the supplies from Russia and Norway – will have been exhausted in the coming years. According to forecasts published in 2015, at the present level of output conventional gas fields in Germany can continue production for eight more years. It needs to be noted that Germany imports only gas supplied via pipelines. The country has no LNG terminal and is not planning to build any at present.

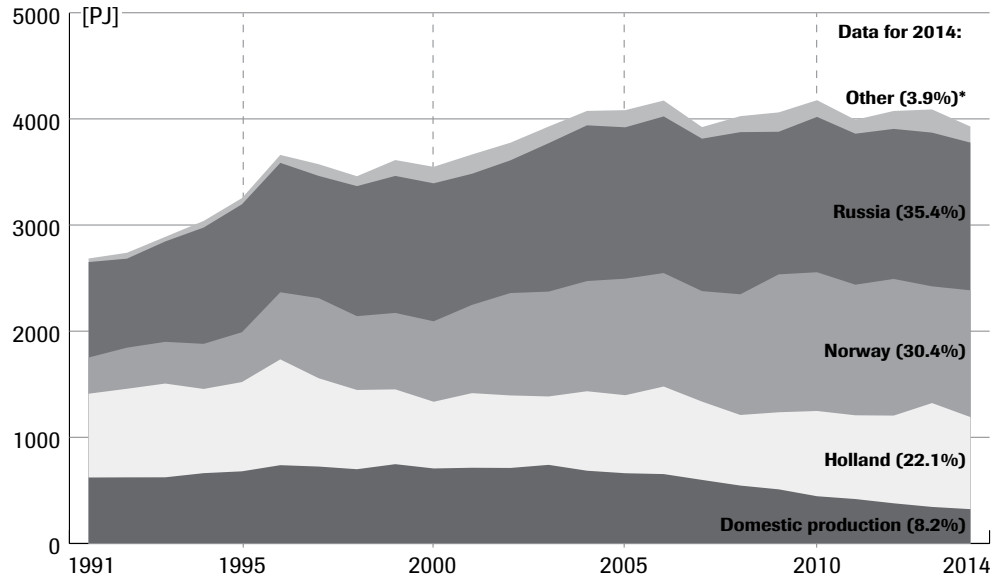
Table 1. Origin of natural gas in Germany in 2012–2013

Origin	2012 (billion m^3)	%	2013 (billion m^3)	%	2014 (billion m^3)	%
Russia	37.0	34.0	37.9	34.1	36.4	34.2
Holland	24.8	22.8	29.4	26.4	26	24.5
Norway	32.5	29.8	27.7	25.0	30.2	28.4
Other	2.9	2.7	5.4	4.8	3.7	3.5
Domestic production	11.7	10.8	10.7	9.6	10.1	9.5
Gross consumption	108.8	100	111.0	100	106.4	100
Re-export	19.7	18.1	20.9	18.8	21.4	20.1
Gas in storage facilities	0.2	0.2	0.9	0.8	-0.3	-0.3
Consumption	89.3	82.0	91.0	82	84.7	79.6

Source: Energiestudie 2015 – Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen, Hanover 2015, http://www.bgr.bund.de/DE/Themen/Energie/Produkte/energiestudie2014_Zusammenfassung.html?nn=1542230

Russia has been the largest natural gas supplier to Germany since as far back as the mid 1980s (see Appendix). Norway is the second most important supplier. In 1994, it outpaced Holland, which is now the third most important supplier. Apart from these three major sources, natural gas is also imported to Germany from the United Kingdom and Denmark.

Chart 12. Germany's natural gas supply broken down into sources of origin in 1991–2014 in PJ



Source: Federal Ministry for Economic Affairs and Energy, Zahlen Und Fakten Energiedaten, 1 October 2015, http://bmwi.de/DE/Themen/Energie/Energiedaten-und analysen/Energiedaten/gesamtausgabe-,did=476134.html

Domestic production plays a decreasing role in gas consumption structure. Both the share of natural gas from domestic production and the production volume are several times lower than in the 1990s. Domestic production of natural gas reached its peak in 1999, the output being 747.1 PJ (around 24.7 billion m^3). In 2014, the output fell to 323.3 PJ (around 10.7 billion m^3), reaching the lowest level in reunited Germany's history. At present, 90% of domestically produced gas originates from Lower Saxony. In addition to this, rich gas fields are also located in Schleswig-Holstein. 99% of natural gas in Germany is produced by five firms[29]: BEB Erdgas und Erdöl GmbH & Co. KG (3.474 billion m^3), Mobil Erdgas-Erdöl GmbH (2.778 billion m^3), DEA Detusche Erdöl GmbH (1.504 billion m^3),

[29] Energiestudie 2015, Federal Institute for Geosciences and Natural Resources, Hanover 2015, page 21.

Wintershall Holding AG (0.622 billion m^3) and GDF Suez E&P Deutschland GmbH (0.620 billion m^3).

German gas producers attach much more significance to production abroad (in Russia, North-Western Europe, North Africa and South America) than to domestic production. In 2014, production abroad reached around 24.4 billion m^3 and was 4.6% higher than a year before. The largest gas producers were Wintershall AG and E.ON[30]. Wintershall AG is Germany's largest producer of natural gas and crude oil. The company operates worldwide: it is the largest gas producer in Holland, and also extracts gas in the North Sea, Argentina and Russia. In 2014, the company's foreign natural gas output reached around 15.13 billion m^3. Germany's second most important natural gas producer abroad was E.ON. In 2014, its foreign output reached 7.82 billion m^3, including around 75% from the Russian Yuzhno-Russkoye field in which the company holds a stake[31].

It is worth emphasising that German firms have been withdrawing from natural gas production abroad. Germany's largest energy companies, E.ON and RWE, operating in oil, gas and electric energy sectors in 2015 sold a major part of their portfolio in the area of oil and gas production. In March 2015, the investment fund Letter One bought Dea, a company which extracts oil and gas in the North Sea and in Germany, from RWE for 5.1 billion euros. The same investor bought gas fields in Norway from E.ON in October 2015. The fund is controlled by Mikhail Fridman, the owner of one of Russia's largest investment funds, Alfa Group[32]. In January 2015, E.ON also sold its subsidiary producing oil and gas in the United Kingdom to the British company Premier Oil. The main reason why German investors sell oil and gas production companies are their financial problems caused by sudden changes on the German energy market resulting from the implementation of the energy transformation strategy and falling demand for energy due to the economic crisis in the EU.

Another source of foreign gas supplies is purchasing directly from the producer. Long-term contracts where gas prices are indexed to oil prices have been the predominant form of gas purchase in Germany throughout history. Such contracts are increasingly rare and are mainly used in contacts with Russia's

30 Energiestudie 2015, *op. cit.*, page 22.

31 Energiestudie 2015, Federal Institute for Geosciences and Natural Resources, Hanover 2015, page 22

32 Konrad Popławski, E.ON sprzeda swoje udziały w norweskich złożach, *OSW Analyses*, 14 October 2015.

Gazprom, although price formulas can be renegotiated more and more often[33]. Gazprom has concluded the most important long-term contracts covering gas supplies to Germany with the following German companies: E.ON (four contracts until 2035), Wingas (one contract until 2030) and VNG (one contract until 2030).

Since the late 1990s, medium-term contracts where the price is set on the basis of gas prices on the largest energy exchanges (so-called hub-indexation) have been ever more frequently used since the late 1990s. Norway's Statoil applies partial or complete hub-indexation to all its German clients. The latest way of buying foreign gas is through futures and spot contracts on gas exchanges. This form is becoming increasingly popular among German gas firms; for example, the German company VNG in 2013 acquired around 70% of gas under futures and spot contracts, and only 30% under long-term contracts[34].

2. History of co-operation with Holland and Norway

Historically, Holland was the first supplier of natural gas to Germany. It took only four years from locating Groningen, Europe's largest gas field in northern Holland, in 1959, for Holland's Gasunie to launch its first supplies in 1963. Holland was the sole supplier of natural gas to Germany for the next ten years. The Trans-Europa-Naturgas-Pipeline (TENP), a gas pipeline connecting the Dutch gas network with Switzerland and Italy via western Germany was put into operation in 1974. At present, the pipeline, with an annual transport capacity of 15.5 billion m^3, is used to transport Norwegian and British natural gas from the gasfields in the North Sea. In 1977, Holland exported to Germany 24.36 billion m^3 of natural gas, and this was the largest volume of gas this country has ever supplied to its western neighbour. Later on, Holland lost the position of Germany's largest supplier of natural gas, first to Russia (1984) and then to Norway (1999)[35]. At present, exports to Germany are

[33] In July 2012, E.ON and Gazprom signed a retrospective contract valid from 2010 amending the conditions of the gas purchase contract. The new contract provides for withdrawal from 100% indexation of gas prices to oil prices, Source: E.ON's press release of 3 July 2012 titled *E.ON erzielt Einigung bei langfristigen Gaslieferverträgen mit Gazprom und hebt Konzernausblick für das Jahr 2012 an*, https://www.eon.com/de/presse/pressemitteilungen/pressemitteilungen/2012/7/3/e-on-erzielt-einigung-bei-langfristigen-gasliefervertraegen-mit-0.html

[34] VNG, Annual report 2013, page 16.

[35] Source: Federal Office for Economic Affairs and Export Control (BAFA), Entwicklung der Erdgaseinfuhr in die Bundesrepublik Deutschland Bilanzen 1998–2014 Grafik, http://www.bafa.de/bafa/de/energie/erdgas/ausgewaehlte_statistiken/egashist.pdf

in the final phase because Dutch gas fields will soon be exhausted. The Federal Network Agency (*Bundesnetzagentur*) is planning that Dutch gas supplies to Germany will end in 2029[36]. It should be noted that Dutch gas has a lower energy value than Russian and Norwegian gas, and therefore it cannot be mixed in a single gas network. L-gas (low calorific gas) produced in Germany and Holland has a methane content ranging from 80% to 87% and is available to recipients in north-western Germany, while H-gas (high calorific gas), with methane content ranging from 87% to 99%, is distributed in the rest of Germany. Since Dutch and German gas fields are running dry, Germany launched the process of switching from L-gas to H-gas in 2015. At present, around 4.3 million consumers are connected to L-gas in north-western Germany. This change means above all the need to rebuild network equipment and simultaneous replacement or reconstruction of the devices using gas so that they can operate on high calorific gas. For Germany this means the need to increase gas imports from its two largest suppliers, Russia and Norway, or to look for other sources of natural gas.

Gas from Norway began to be supplied in 1977. Initially, it was transported from the Norwegian field Ekofisk to the collection point in Emden via the Norpipe gas pipeline. Since then, Norway has regularly launched production on subsequent fields (Statfjord, Heimdal, Gullfaks, Troll), which has been accompanied by the development of new gas pipelines. Towards the end of the 1980's, the chemical corporation BASF negotiated building a gas pipeline running from Emden to its chemical production site in Ludwigshafen in central Germany. However, due to pressure from Ruhrgas, the main recipient of Norwegian gas in Germany, the Norwegian partners chose not to begin this co-operation. This was an element of the so-called 'gas war' between BASF and Ruhrgas, which ended up with BASF's engagement in building gas pipelines running eastwards and co-operation with Russia's Gazprom after the Iron Curtain fell[37]. The Europipe I and Europipe II pipelines which run to Dornum, 40 km to the north-east from Emden were put into operation in 1995 and 1999, respectively. Norway's Statoil invested in these pipelines. At present, Norwegian and British gas from the North Sea is also transported to Germany via Dutch and Belgian gas pipelines. It is estimated that Norwegian natural gas reserves will run out

[36] Federal Network Agency, Umstellung von L- auf H-Gas (Marktraumumstellung), http://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Verbraucher/NetzanschlussUndMessung/UmstellungGasbeschaffenheit/UmstellungGasqualitaet-node.html

[37] U. Leuschner, Die deutsche Gasversorgung von den Anfangen bis 1998, 2008, page 34, http://www.udo-leuschner.de/pdf/gasversorgung.pdf

around 2030[38]. Co-operation with Norway covering natural gas, crude oil and, in the near future, electric energy[39] is very important to Berlin. The two countries co-operate as part of Energy Partnership, i.e. a deep and comprehensive co-operation formula in the area of energy[40]. Oil and gas account for 80% of the value of Norwegian exports to Germany. This dependence is mutual as regards gas: around 30% of gas supplies to Germany originate from Norway, and the share of German gas in Norwegian gas imports also reaches around 30%. Work on building an electricity link between the two countries is underway. It is planned to be put into operation in 2020.

3. History of gas co-operation with Russia

At present, Russia is Germany's most important energy partner. In 1973, the USSR became the second (after Holland) largest supplier of natural gas to Germany. Major reasons for beginning co-operation with Moscow included the need to diversify supplies and subsequently the search for alternative sources of energy following the oil crises in 1973 and 1979. On the one hand, the then SPD–FDP coalition government led by Chancellor Willy Brandt treated the 'pipes for gas' deal of 1970 as a response to the need to diversify energy sources in Germany, and on the other hand treated it as an instrument for further normalisation of relations with the Soviet Union. Thus, gas co-operation between Germany and Russia has carried a political overtone since the very beginning, and this tradition of dual-track co-operation (trade and politics) is an essential element of German foreign policy.

Germany and the USSR signed the first three contracts in 1970: the first one signed by Ruhrgas AG (the predecessor of E.ON) provided for supplying 3 billion m^3 of natural gas annually for twenty years, the second contract signed by Mannesmann Export GmbH concerned the sale of pipes for gas pipeline

[38] In 2009, the estimated volume of Norwegian natural gas reserves was 2046 billion m^3, see: *Norway 2011*, International Energy Agency, http://www.iea.org/publications/freepublications/publication/Norway2011_web.pdf

[39] Rafał Bajczuk, Nowe połączenie energetyczne Niemiec z Norwegią, *OSW Analyses*, 18 February 2015, http://www.osw.waw.pl/pl/publikacje/analizy/2015-02-18/nowe-polaczenie-energetyczne-niemiec-z-norwegia

[40] The energy partnership is intended at maintaining market-oriented conditions of co-operation in the area of energy and promoting German RES technologies and energy efficiency. At present, Germany co-operates as part of energy partnership with Norway, Russia, Brazil, China, India, Morocco, Nigeria, South Africa, Tunisia and Turkey. Source: Ministry of Foreign Affairs, http://www.auswaertiges-amt.de/DE/Aussenpolitik/GlobaleFragen/Energie/Energiepartnerschaften_node.html

construction (the USSR did not have the necessary technology at that time), and the third one concerned financing. Gas supplies were launched in 1973. The co-operation turned out to be so effective that two more gas supply contracts were signed in the next four years. Another contract, signed in 1980, provided for increasing supplies to 20 billion m^3 annually for 25 years. The only export route to Western Europe available at that time was the Bratstvo gas pipeline running through the Ukrainian SSR and Czechoslovakia. In 1975, Germany's Ruhrgas and France's GDF commenced the construction of the MEGAL (German: Mittel-Europäische-Gasleitung) transit gas pipeline connecting France with the Soviet gas pipeline system. The connection, which had an annual capacity of 22 billion m^3, was put into operation in 1980. The development of co-operation with the USSR was disrupted for a while due to the embargo imposed by Western countries on trade in components for gas production and transport in 1981. The embargo was lifted in 1982 following diplomatic efforts from France, Germany and the United Kingdom. By 1989, the Soviet Union's share in gas supplies to Germany grew to 30%.

In the Cold War period, gas imports from the USSR were of major economic significance to Germany. Firstly, Eastern gas was cheaper than alternative supplies from Norway, Libya or Algeria, and secondly, it strengthened the market position of the German company Ruhrgas[41]. Markus Wörz, a German expert, claims that gas supplies from the Soviet Union to Germany during the Cold War period strengthened bilateral relations, and gas co-operation served as a foundation for developing political relations[42]. Experience in contacts with the USSR during the Cold War period has had a major impact on the development of relations between reunited Germany and Russia. The German political and economic elites supported enhancing economic and political co-operation with Russia from the turn of the century[43], arguing that it positively affected the oil and gas sector at the time of the Cold War. This point of view gradually changed as a consequence of the Russian-Ukrainian gas conflicts in 2005–2006 and 2007–2009 and the Russian-Georgian conflict in 2008. Arguments concering threats posed by

41 P. Högselius, Red Gas, New York, 2013, page 225.

42 M. Wörz, 10 Minuten Energieaußenpolitik: Zentrale Herausforderungen, in T. Kästner, A. Kießling, G. Riemer, energie in 60 Minuten, Wiesbaden 2011, page 106.

43 A. Kwiatkowska-Drożdż, Germany on Russia. Yes to links, no to rapprochement, *OSW Point of View*, Warsaw 2013, pages 10-25, http://www.osw.waw.pl/sites/default/files/pw_39_germany_on_russia_net_0.pdf

Germany's dependence on gas imports from Russia began to be raised in debate more and more frequently[44].

The state-controlled company Gazprom was created in Russia in 1989. Its main objectives included expansion to Western markets and co-operation with Western companies. Russia treated Germany as a bridgehead during its expansion to Western Europe. Gazprom's strategic goal was to acquire shares at each level of gas trade: transport, storage and direct sale. In 1990, Gazprom signed a co-operation agreement with Germany's Wintershall, a subsidiary of the chemical corporation BASF, tasked with oil and gas production and trade. As part of their co-operation, the two corporations established two joint ventures: Wingas (gas transport and distribution) and WIEH (gas trade) in 1993. Wintershall became the majority shareholder (65% stake). Wingas financed most investments in German gas transport and storage infrastructure in the 1990s, including the JAGAL gas pipeline, being a section of the Yamal-Europe gas pipeline and the first alternative to the Ukrainian route for Russian gas transport to Europe and Germany. Then, at the onset of gas market liberalisation, Gazprom's activity in Germany was perceived positively. The German Federal Ministry for Economic Affairs and Energy supported Gazprom's co-operation with Wintershall, since competition to the then monopoly, Ruhrgas, was thus created, and cheap gas was offered to clients in Germany[45]. In 1993, Wingas put into operation three projects of key significance for the security of gas supplies:

- the STEGAL (German: Sachsen-Thüringen-Erdgas-Anbindungsleitung) gas pipeline connecting the Czech gas pipeline system with the MIDAL gas pipeline in central Germany;
- the MIDAL (German: Mitte-Deutschland-Anbindungsleitung) gas pipeline connecting the Dutch gas pipeline system with central Germany and the gas storage facility in Rehden;
- the gas storage facility in Rehden, its capacity being 4 billion m^3; the largest gas storage facility in Western Europe.

[44] S. Kaufmann, Es gibt noch keine Alternative zu russischem Gas, *Handelsblatt*, 12 March 2014, http://www.handelsblatt.com/politik/international/deutschlands-abhaengigkeit-es-gibt-noch-keine-alternative-zu-russischem-gas/9605486.html (accessed on 20 January 2015).

[45] J. Grätz, Ziemlich beste Freunde. Das Auf und Ab der Partner Wintershall – Gazprom, in: *Osteuropa* no. 63/7, July 2013, page 83.

Another of Wingas's important projects was putting into operation the WEDAL (German: Westdeutschland Anbindungsleitung) gas pipeline connecting the Belgian transport system with the MIDAL gas pipeline in central Germany in 1998. The simultaneous launch of the Interconnector gas pipeline connecting Bacton in the United Kingdom with Zeebruge in Belgium made it possible for the first time to import British gas from the North Sea fields to Germany. In the eastern direction, Wingas put into operation in 1999 the JAGAL (German: Jamal-Gas-Anbindungsleitung) gas pipeline connecting the Yamal gas pipeline running through Poland with the STEGAL gas pipeline in Thuringia. The annual capacity of this connection stands at 24 billion m^3.

The decision to build Nord Stream was a milestone in German-Russian gas co-operation. This gas pipeline connecting the two countries has reinforced their mutual links and co-dependence. The development of gas pipeline connections with Russia had been planned from the mid 1990s, since it was then concluded that it was necessary to develop the transport infrastructure due to increasing demand for natural gas. Three variants were considered: building a gas pipeline running along the Baltic Sea bed (the most expensive variant), developing the connection running through Belarus and Poland (Yamal II) and building a gas pipeline running through the Baltic states and Poland (Amber). What led to the choice of the most expensive variant bypassing transit states was Russia's successful strategy aimed at winning support for this project, first from the German government and then from the European Commission (in 2000, the European Commission granted TEN-E status to this gas pipeline)[46]. The key role in the implementation of this project was played by the "unprecedented, strong political support from Gerhard Schröder"[47], who became the CEO of Nord Stream AG weeks after his term in office as chancellor had ended[48].

The construction of the gas pipeline was commenced in 2005 as a Russian-German project since, along with Gazprom (51% stake), Germany's E.ON and

[46] K. Pronińska, Bezpieczeństwo energetyczne w stosunkach UE–Rosja, Warsaw 2012, page 313.

[47] *Ibidem*.

[48] Employing former prominent German politicians so that they represent Russians in contacts with the West is a strategy frequently used by Russian firms. In 2009, Wolfgang Clement (SPD), the former minister in North Rhine-Westphalia, was elected member of the supervisory board of the Russian consulting company named Energy Consulting. In 2012, the former mayor of Hamburg, Henning Voscherau (SPD), was elected chairman of the supervisory board of South Stream AG; Source: S. Brauns, P. Heller, Die Genossen und das Gas, *Zeit online*, 8 May 2013.

Wintershall (initially 24.5% each, at present 15.5% each) were engaged in it. Holland's Gasunie joined the project in 2008, and France's GDF Suez (now Engie) in 2010 – the two companies bought shares from the German companies (9% each). The Nord Stream gas pipeline, including accompanying infrastructure, was put into operation in 2011–2012. Its annual capacity is 55 billion m^3. Promptly after Nord Stream – connecting Vyborg in Russia and Greifswald in north-eastern Germany – was put into operation, two gas pipelines were launched to enable gas transport to Western and Southern Europe. The OPAL (German: Ostsee-Pipeline Anbindungsleitung) gas pipeline, with a capacity of 35 billion m^3, linking the entry point of Nord Stream in Greifswald with the STEGAL gas pipeline and the Czech system of transport gas pipelines, was put into operation in 2011. Then the NEL (German Nordeuropäische Erdgasleitung) gas pipeline was launched in 2012, with an annual capacity of 20 billion m^3 that connected Greifswald with the gas storage facility in Rehden and the MIDAL gas pipeline,. These two gas pipelines are managed by separate companies owned by WIGA (WIGA Transport Beteiligungs-GmbH & Co. KG), a joint venture of Gazprom and Wintershall. Thus, at the turn of the second decade of the 21st century, Germany gained a direct link to the Russian gas pipeline network and opened up its way to reach the position of the key country in Russian gas transit to the European Union.

4. German-Russian gas relations at present

Four years after the inauguration of the first section of the Nord Stream gas pipeline, on 4 September 2015 during the Economic Forum in Vladivostok, Gazprom signed an agreement on building two additional branches of Nord Stream. Developing Nord Stream is beneficial from the German point of view, first of all, because a gas pipeline with an annual capacity of 110 billion m^3 (at present it is 55 billion m^3) will improve the security of gas supplies to Germany (for example, in the case of Russia's conflict with transit countries and resulting interruptions in gas supply). The agreement on developing Nord Stream was signed despite the economic sanctions imposed by the European Union on Russia due to Russian aggression against Ukraine and the annexation of Crimea. Along with Gazprom, the agreement was signed by Germany's BASF and E.ON (now Uniper), Austria's OMV, Dutch-British Shell and France's Engie (former GDF Suez). The preliminary draft agreement provides for building a gas pipeline that will run in parallel to the existing connection. The shareholding structure in New European Pipeline AG, which, like Nord Stream AG, was incorporated in Zug, Switzerland, is as follows: Gazprom 51%, BASF, OMV, E.ON and Shell 10% each, and Engie 9%. The gas pipeline is expected to be put

into operation by the end of 2019 and its construction cost will reach around 9.9 billion euros[49].

Even though German politicians deny that the decision to develop Nord Stream has any political context, giving assurances that this is a purely commercial project, the pipeline's development will contribute to a strengthening of German-Russian relations and will weaken the position of Central European countries. Over the past few years, Germany has taken action to enhance bilateral co-operation with Russia, especially in the area of the economy. In 2008, Germany initiated the so-called 'Partnership for Modernisation' project, which envisaged enhancing economic and political co-operation and providing German companies with access to the Russian market[50]. The Partnership for Modernisation concept turned out to be a failure. Neither Germany nor Russia have achieved the goals linked to it: Germany has been unable to convince Russia to adopt democratic standards in state administration or ensure access for German small and medium-sized businesses to the Russian market, and Russia has not been given access to the EU market and Western technology to the expected extent. The energy and gas sectors are the areas in which bilateral co-operation is developing best of all. Berlin's intention was above all to provide German companies with access to oil and gas production and to create a market for German energy efficiency and renewable energy source technologies in Russia. The Russian-German Energy Agency (Russisch-Deutsche Energie-Agentur (rudea) was established for this purpose in 2009, but it was closed in 2013 – the official reason being the needlessness of maintaining a joint institution, and current co-operation was to be continued through direct collaboration of the two national energy agencies[51].

In addition to the previously discussed construction of the Nord Stream gas pipeline, Germany's E.ON (renamed Uniper since 1 January 2016) has been investing in Russian gas fields and the energy sector. At present, the company

[49] Szymon Kardaś, Agata Łoskot-Strachota, Konrad Popławski, Gas business as usual? The new agreements between Gazprom and EU energy companies, *OSW Analyses*, 9 September 2015, http://www.osw.waw.pl/en/publikacje/analyses/2015-09-09/gas-business-usual-new-agreements-between-gazprom-and-eu-energy

[50] In 2010, PfM also became a Russia-EU project. See: J. Ćwiek-Karpowicz, R. Formuszewicz, „Partnerstwo dla modernizacji" – nowa inicjatywa UE wobec Rosji, BIULETYN PISM No. 44 (652), 18 March 2010.

[51] Press release by the German Energy Agency (dena), dena stellt Kooperation mit Russland auf neue Basis, 27 June 2013, http://www.dena.de/presse-medien/pressemitteilungen/dena-stellt-kooperation-mit-russland-auf-neue-basis.html

has a 25% shares minus one share in the Yuzhno-Russkoye gas field (Wintershall owns 25% of the shares minus one share, and Gazprom 51%) and owns five power plants in Russia, with a total capacity of 9.9 GW (6% of the Russian power grid capacity)[52]. At the same time, Gazprom has been increasing its presence on the German market. In September 2015, BASF and Gazprom carried out an asset swap that had been announced in 2012. BASF's subsidiary, Wintershall, received a 25% stake in two blocks in the Akhimov deposit in the Yuzhno-Russkoye gas field in western Siberia, the estimated deposits of which are 274 billion m^3 of gas; the production is expected to begin in 2018 and will reach 8 billion m^3 annually. In exchange, Gazprom received the second half of the shares in the companies it had so far controlled jointly with BASF: Wingas, WIEH (Wintershall Erdgashandelshaus Berlin), WIEE (Wintershall Erdgashandelshaus Zug) and in the gas storage facilities in Rehden and Jemgum and their operator, Astora. Additionally, Gazprom received a 50% stake in the production company Wintershall Nordzee. As a result of this transaction, Gazprom gained control of around 6 billion out of 25 billion m^3 (approximately 25%) of the potential capacity from German gas storage facilities. The increase in Gazprom's share of the German gas market is not perceived as a threat to Germany's energy security, since the German gas market is well-developed and in case of disruption, natural gas can be supplied from other directions.

Close German-Russian relations in the area of energy are becoming increasingly problematic, considering the Russian-Ukrainian conflict and the implementation of one of the energy union's goals by the European Commission, i.e. diversification of gas supplies. Berlin has been lobbying, for example, so that the European Union in its official stance did not express clear objection to the construction of the Nord Stream 2 gas pipeline. When the agreement to develop Nord Stream was signed, the project began to be criticised by seven Central European countries (including Poland)[53] and also by other states concerned about their economic interests, such as Italy, for example[54]. As a result of pressure from countries opposing Nord Stream 2, the German chancellor,

[52] E.ON's website, http://www.eon.com/de/nachhaltigkeit/regionale-aktivitaeten/russland.html (accessed on 20 January 2015).

[53] *Wspólny front przeciwko Nord Stream 2?*, Euractiv.pl, 2 December 2015, http://www.euractiv.pl/energia-srodowisko/wywiad/wspolny-front-przeciwko-nord-stream-2-007664 (accessed on 20 January 2015).

[54] Italy's prime minister, Matteo Renzi, spoke against Nord Stream 2 during the European Council's summit on 18–19 December 2015.

Angela Merkel, gave assurances during the summit of the European Council on 17–18 December 2015 that despite the development of the gas pipeline, Ukraine will still play the role of a transit country in gas supplies to Europe[55]. However, such a declaration needs to be viewed as rather unrealistic, because Gazprom's strategy envisages withdrawing from gas transit via Ukraine. On the other hand, the German side openly supports the implementation of the project in contacts with Russia. During the meeting of the German Minister for Economic Affairs and Energy, Sigmar Gabriel (SPD), and the Russian president Vladimir Putin in Moscow in October 2015, the deputy chancellor assured Putin of German support for the project and the desire to enhance and improve bilateral relations[56]. This stance represented by Germany adversely affects relations with those countries for which the development of the gas pipeline will have negative effects (Central-Eastern European countries). Countries in this region are concerned above all that gas can be used by Russia as a political weapon, that pricing conditions will worsen and that they will lose profits generated so far by gas transit. On the European scale, the development of this connection will increase Russia's share in gas supplies to the EU, which is already high, reaching 40%.

At present, Russia is the most important supplier of oil and gas to Germany (around 33.6% and 34% of imports in 2014)[57]. Since gas consumption in Germany will remain stable in the medium term, and Dutch and German gas will no longer be present in the energy basket by 2029, Germany's dependence on Russian gas imports is likely to increase. It is also worth remembering that, while the share of Russian gas in imports to Germany has remained at the same level since 1990, the volume of imported gas has increased by almost a half. German elites are divided as to the evaluation of the impact of energy dependence on Russia. On the one hand, politicians and experts emphasise the need to diversify the sources of gas supplies and to develop renewable energy sources and investments in energy efficiency in order to become less dependent on

55 ‚Nord Stream ist privates Projekt – Rechtsgrundlagen klären', *Frankfurter Allgemeine Zeitung*, 18 December 2015, http://www.faz.net/agenturmeldungen/unternehmensnachrichten/merkel-nord-stream-ist-privates-projekt-rechtsgrundlagen-klaeren-13973432.html (accessed on 20 January 2015).

56 Gabriel spielt in Moskau den Gerhard Schröder, *Die Welt*, 29 October 2015, http://www.welt.de/politik/ausland/article148156440/Gabriel-spielt-in-Moskau-den-Gerhard-Schroeder.html (accessed on 20 January 2015).

57 Federal Ministry for Economic Affairs and Energy, Zahlen Und Fakten Energiedaten, 16 March 2015, http://bmwi.de/DE/Themen/Energie/Energiedaten-und analysen/Energiedaten/gesamtausgabe,did=476134.html

imports from Russia[58]. On the other hand, the government supports the development of Nord Stream 2 contrary to the European Commission's official stance. A large proportion of German decision-makers and experts support the idea of strengthening energy co-operation between the EU and Russia[59]. Above all, Russia is treated as a reliable partner as regards oil and gas supplies, and the argument that Russian oil and gas continued to be supplied to Germany even when the USSR was falling apart is still raised in the debate. In case of a disruption in Russian gas supplies, Germany has a guarantee of gas supply security owing to a well-developed infrastructure which enables gas imports from other countries. According to calculations of experts from the German Institute for Economic Research (DIW), if gas supplies from Russia were cut, the price of natural gas in Germany would rise by around 20%, while gas prices in other Western European countries, such as the United Kingdom, Holland or Belgium, may rise by a similar extent[60]. Furthermore, energy co-operation with Russia is often viewed as a factor contributing to Germany's security because it creates co-dependence, offering Berlin an instrument for influencing Moscow's moves. The debate reveals conflicts of interest between representatives of business circles who want to maintain close links with Russia and politicians who perceive potential threats to the region's security[61]. It needs to be emphasised that even though energy policy is a very popular topic in the German media, public opinion and the media focus above all on such areas as development of renewable energy sources and climate policy. Gas imports from Russia is a niche issue, reserved for debate among a narrow circle of experts. German public opinion does not view Russian gas imports as a major threat to energy security, unlike in Central and Eastern Europe.

58 The government's response to a parliamentary question of 2 November 2015: response 18/6526, Geplanter Asset-Tausch zwischen BASF bzw. Wintershall und Gazprom, page 4, http://dip21.bundestag.de/dip21/btd/18/065/1806526.pdf (accessed on 20 January 2015).

59 The publication by the German think-tank SWP, whose authors argue for the need to enhance EU-Russia relations in the area of energy: A. Gusev, K. Westphal, Russian Energy Policies Revisited, SWP Research Paper 2015/RP 08, December 2015, page 52, http://www.swp-berlin.org/en/publications/swp-research-papers/swp-research-paper-detail/article/russian_energy_policies_revisited.html

60 Europäische Erdgasversorgung Trotz politischer Krisen sicher, *DIW Wochenbericht* no. 22, 2014, pages 490-492, http://www.diw.de/documents/publikationen/73/diw_01.c.465398.de/14-22.pdf

61 A. Libman, S. Stewart, K. Westphal, Mit Unterschieden umgehen: Die Rolle von Interdependenz in der Beziehung zu Russland in: Ausblick 2016: Begriffe und Realitäten internationaler Politik, V. Perthes (ed.), page 20, http://www.swp-berlin.org/fileadmin/contents/products/sonstiges/Ausblick2016.pdf#page=18

III. POSSIBLE ALTERNATIVE SOURCES OF SUPPLIES

1. Liquefied natural gas

At present, Germany imports natural gas solely via pipelines, and its dependence on imports from the two largest suppliers, Russia and Norway, is increasing. Officially, the government supports the European Union's stance as regards the need to diversify gas import routes, but it does not pursue any active policy to this effect. In the German government's opinion, it will only be possible to diversify gas import routes in the medium and long term, because this requires adequate infrastructure to be built[62]. Germany is one of those few highly-developed countries and the only economy in G-20 not to have an LNG terminal. At present, German firms can import liquefied natural gas via LNG terminals located abroad. Considering location and inter-system connections, the LNG terminals in Zeebrugge, Belgium and the Gate terminal in Rotterdam, Holland are the best adapted to this. Germany can also indirectly use the terminals in the United Kingdom (Isle of Grain), Italy (Porto Levante), France (Dunkirk) and Poland (Świnoujście). According to an analysis by the Federal Ministry for Economic Affairs and Energy concerning security of gas supplies, the spare regasification capacity of European LNG terminals is sufficient to import additional quantities of natural gas to Germany[63]. However, the authors of this analysis suggest that developing domestic gas storage facilities and storing pipeline gas in them is a cheaper solution for ensuring security of gas supplies than importing LNG or building a terminal in Germany.

Plans to build an LNG terminal in Germany date back to the 1970s. DFTG (German liquefied natural gas terminal company, German: Deutsche Flüssigerdgas Terminal Gesellschaft mbH)[64] was established in 1972 and was tasked with building an LNG terminal at Wilhelmshaven Port, with an annual capacity of around 10.8 billion m^3. The terminal has not been built as of yet because

[62] The government's response to the parliamentary question of 17 April 2014; response 18/1210, Position der Bundesregierung zu Energierohstoffimporten aus Russland, page 5.

[63] Möglichkeiten zur Verbesserung der Gasversorgungsicherheit und der Krisenvorsorge durch Regelungen der Speicher (strategische Reserve, Speicherverpflichtungen), einschließlich der Kosten sowie der wirtschaftlichen Auswirkungen auf den Markt, an analyses ordered by the Federal Ministry for Economic Affairs and Energy, Berlin, June 2015, pages 251-254 source: http://bmwi.de/BMWi/Redaktion/PDF/Publikationen/Studien/moeglichkeiten-zur-verbesserung-der-gasversorgungsicherheit-und-der-krisenvorsorge-durch-regelungen-der-speicher,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

[64] http://www.dftg.de/

it would not be cost-effective according to economic analyses. In 2008, E.ON, which holds a 90% stake in DFTG (10% is owned by the German gas company VNG) withdrew from this project, and in exchange bought shares in the gas port in Rotterdam. At present, E.ON, which is experiencing the worst financial problems in its history, is not planning to invest in the LNG terminal in Wilhelmshaven, even though DFTG has a design and a site for building the terminal. According to analyses from the Federal Ministry for Economic Affairs and Energy, the cost of building the terminal would reach around 800 million euros, without taking into account the costs of transport infrastructure to send gas to the south of the country, which it would be necessary to incur if the project was implemented. A new LNG terminal project emerged in 2015. It was developed by the administration of Brunsbüttel Port and the logistics firm VTG[65]. No details of the investment have been revealed so far. The investors point out that the terminal's operation would be based on bunkering (refueling) ships with liquefied natural gas and supplying the gas to the nearby chemical complex, and transporting LNG using specialist railway carriages.

Even though Germany has no terminal of its own, German companies are active on the LNG market. E.ON, which is present in the electricity and gas markets in most member states of the European Union, has been actively searching for LNG supply sources over the past few years. In 2013, the company signed a contract with Canada's Pieridae Energy under which it will buy 6.5 billion m^3 of natural gas annually for twenty years, starting from 2020. In October 2013, it signed a contract with Qatargas, a gas supplier from Qatar, envisaging supplies of 10 billion m^3 of gas in 2014–2019. In February 2015, E.ON signed two agreements enabling LNG imports from the USA to Europe starting from 2018. The first one concerns transport and liquefaction of gas at Freeport terminal in Texas. The second one, signed with the Japanese ship owner, Mitsui O.S.K. Lines Ltd., concerns transporting around 800,000 tonnes of LNG (approximately 1.1 billion m^3) annually for twenty years. E.ON holds stakes in terminals across Europe, including in the United Kingdom (Isle of Grain), Holland (Gate Terminal in Rotterdam), Spain (Barcelona and Huelva) and Italy (OLT in Livorno), and the US gas will be sent to these terminals. The company is still considering such LNG supply directions as: Mozambique, Israel and Peru. During the debate on the diversification of gas supplies in 2014, the German government declared that it backed German companies' efforts to diversify the sources of

[65] The official website of Brunsbüttel Port, http://www.brunsbuettel-ports.de/artikel/schienen-und-hafenlogistiker-setzen-auf-lng.html

gas imports, including LNG, through political support for signing the contracts and their current activity[66].

2. Shale gas

Gas production in Germany has been declining since 1999. In 2014 alone, domestic output shrunk by 0.6 billion m^3 as compared to the preceding year – to 10.1 billion m^3. In 2014, the Federal Institute for Geosciences and Natural Resources (BGR) estimated that German natural gas reserves were 88.5 billion m^3 (82.6 billion m^3 of pure gas)[67], which means that conventional gas reserves will be depleted by around 2023[68]. In additional to small conventional gas reserves, Germany has huge reserves of unconventional gas. German reserves of unconventional gas in use:

- shale gas: 0.7–2.3 trillion m^3
- coal bed gas: 0.45 trillion m^3
- tight gas: 90 billion m^3 [69]

Shale gas reserves deserve special attention. According to a report prepared by BGR in 2012, German shale gas reserves range between 6.8 and 22.6 trillion m^3 (reserves which cannot be fully extracted for technical reasons, known as GIP, Gas-in-Place)[70]. While coal bed gas and tight gas have been extracted in small quantities since the 1950s, shale gas has not been extracted at all. This is caused by the very restrictive laws regulating shale gas extraction, disapproval from the public and the lack of convenient environmental conditions to enable shale gas extraction – Germany is a densely populated country, and shale gas deposits are predominantly located in the urbanised north-western part of the country.

66 The government's response to a parliamentary question concerning the role played by liquefied natural gas in diversifying gas supply sources, source: http://dip21.bundestag.de/dip21/btd/18/012/1801299.pdf

67 *Energiestudie 2015*, Federal Institute for Geosciences and Natural Resources, Hanover 2015, page 20.

68 Office for Mining, Energy and Geology of the State of Lower Saxony, Erdöl- und Erdgasreserven in der Bundesrepublik Deutschland am 1. *Januar 2015*, http://www.lbeg.niedersachsen.de/portal/live.php?navigation_id=656&article_id=786&_psmand=4

69 *Energiestudie 2015*, Federal Institute for Geosciences and Natural Resources, Hanover 2015, page 21.

70 Federal Institute for Geosciences and Natural Resources, Abschätzung des Erdgaspotenzials aus dichten Tongesteinen (Schiefergas) in Deutschland, Hanover 2012, http://www.bgr.bund.de/DE/Themen/Energie/Downloads/BGR_Schiefergaspotenzial_in_Deutschland_2012.pdf?__blob=publicationFile

German public opinion is critical of shale gas extraction. The debate on this issue began around 2011 and has been focused on threats to the natural environment since the very beginning (purity of potable water, pollution with chemicals and earthquake risk) rather than on the positive aspects, such as, for example, improving energy security. At the same time, hundreds of local initiatives bringing together local opponents of shale gas exploration and extraction have emerged. The most important organisations representing shale gas opponents are: Bundesverband Bürgerinitiativen Umweltschutz e.V. (BBU) and No Moor Fracking. The opponents include the Evangelical Church in Germany and the German Brewers' Federation. Production companies used to make test drills until recently, but they have discontinued operation in Germany due to protests from local communities and an unfavourable legal environment, as was the case for ExxonMobil in 2012.

The critical approach to shale gas represented by public opinion and non-governmental organisations is not shared by national research institutions. It can be concluded from the joint opinion presented by the State Geological Surveys (SGD) and the Federal Institute for Geosciences and Natural Resources (BGR) that it is possible to extract shale gas and at the same time protect the water resources and the natural environment[71]. In August 2013, three German research institutes dealing with geology and protection of the natural environment: BGR, GFZ (German Research Centre for Biosciences) and UFZ (Helmholtz Centre for Environmental Research) issued a statement claiming that shale gas can be extracted in Germany, but it is necessary to create a legal framework to protect water resources and the natural environment[72].

In 2012, the Christian Democrat-Liberal (CDU/CSU-FDP) coalition government commenced work on legislation regulating shale gas extraction in Germany. At that time the FDP openly supported the use of these gas resources, while the CDU and the CSU were divided. During work on the legislation, the mood against shale gas extraction in Germany became overwhelming. The then minister for the natural environment, Peter Altmaier (CDU), speculated that a moratorium

[71] Stellungnahme zu den geowissenschaftlichen Aussagen des UBA-Gutachtens, der Studie NRW und der Risikostudie des ExxonMobil InfoDialogprozesses zum Thema Fracking, Hanover, 2013, http://www.bgr.bund.de/DE/Themen/Energie/Downloads/SGD-Stellungnahme-Fracking-Studien.pdf?__blob=publicationFile&v=2

[72] Hanover-Erklärung zum Kongress Umweltverträgliches Fracking?, June 2013, http://www.bgr.bund.de/DE/Gemeinsames/Nachrichten/Veranstaltungen/2013/GZH-Veranst/Fracking/Downloads/Hanover-Erklaerung-Finalfassung.pdf?__blob=publicationFile&v=3

on shale gas extraction could be imposed[73], and the Bundesrat passed a resolution appealing for adopting the strictest possible standards for shale gas extraction. The bill was presented in June 2013 but it was only in April 2015 that the Christian Democrat (CDU/CSU) and Social Democrat (SPD) coalition government presented a legislation package regulating shale gas extraction. Since the package was submitted to the Bundestag, work on it has stalled in parliament.

The governmental proposal of 1 April 2015 for a legislative package regulating shale gas extraction in fact equates to a moratorium on its extraction. The law imposes a ban on shale gas extraction in areas which contain potable water reservoirs and in protected areas. Extraction from layers shallower than 3000 metres will be prohibited across Germany. Furthermore, federal states may ban shale gas extraction in areas where mineral waters are present. It is only admissible to make test drills for scientific and research purposes. Following a motion from the economic faction among Christian Democrats (CDU/CSU), a provision enabling shale gas extraction after 2018 from the wells was approved by an independent expert commission. The package contains the following legal acts:

- An act amending regulations of the water law and the natural environment law;
- An act extending the liability for damages caused by mining to drill mining and caverns;
- Regulation introducing assessment of the environmental impact of shale gas extraction.

The legislation package proposed by the government was criticised by non-governmental organisations engaged in protecting the natural environment. Their criticism concerned both the possibility of water contamination and the onus on creating opportunities for extracting new fossil energy sources in general instead of focusing on efforts to invest in renewable energy sources. In turn, economic organisations expressed satisfaction with the fact that Germany had not given up on shale gas entirely. Representatives of business circles emphasise that the government has proposed the strictest conditions for shale gas exploration as compared to other countries and that over 300 hydraulic fracturing operations have been carried out in Germany over the past 50 years without adversely affecting ground waters. According to calculations

[73] Altmaier plant Fracking-Verbot, 17 February 2013, *Die Welt*, http://www.welt.de/print/wams/article113687849/Altmaier-plant-Fracking-Verbot.html

from the German Industrial Association of Oil and Gas Producers, unless Germany passes a law regulating shale gas extraction, the country will lose possible investments worth 2 billion euros in the next ten years[74]. Politicians representing those German regions where oil and gas are produced also support enabling shale gas extraction[75]. Regardless of this, it seems unlikely that shale gas could be extracted on a large scale in Germany.

3. Gas from renewable energy sources

3.1. Biogas and biomethane

Biogas production is a realistic alternative to natural gas imports. This technology has no major opponents among the German public. While Germans categorically oppose shale gas extraction, their support for renewable energy sources, including biogas plants, is widespread and ranges, depending on the poll, from 60% to 85%. Furthermore, biogas is a renewable fuel and has a neutral impact on the climate because no additional carbon dioxide is created in the process of biomass processing and combustion to the coal cycle. Biogas is generated in the process of decomposition of organic waste or energy crops grown specially for this purpose – in Germany, this is predominantly maize[76]. When biogas is purified to biomethane, its properties become identical to those of natural gas – it can be used in industrial processes and as fuel for home furnaces, combustion engines and gas power plants. Germany is the European leader in terms of both biogas production and research and know-how in this area.

The production volume of biomethane, which is injected into the gas network, is definitely smaller than that of raw biogas, which is combusted directly at

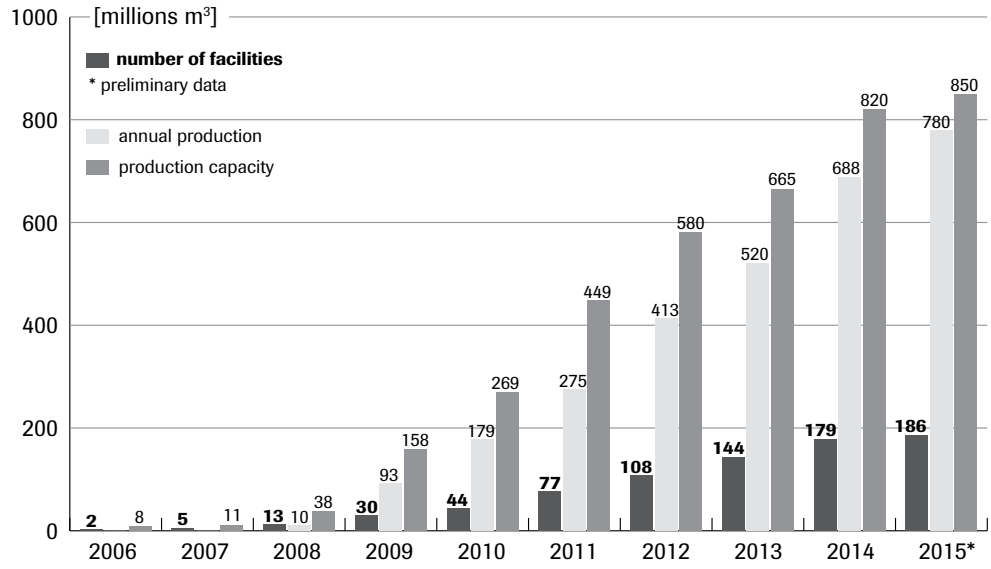
74 German Industrial Association of Oil and Gas Producers (WEG), Deutsche Erdgasförderer: 2 Milliarden Euro in 10 Jahren stehen auf dem Spiel, 1 October 2015, http://www.erdoel-erdgas.de/Medien/Pressecenter/Presseinformationen/2015/2-Milliarden-Euro-in-10-Jahren-stehen-auf-dem-Spiel

75 The mayor of Celle, Dirk-Ulrich Mende (SPD), Germany will lose its future without hydraulic fracturing (Ohne Fracking verspielt Deutschland seine Zukunft), *Die Zeit*, 6 November 2015, http://www.zeit.de/wirtschaft/unternehmen/2015-11/fracking-deutschland-erdoel-dirk-ulrich-mende/komplettansicht

76 In 2014, 53% of substrate (primary material) at German biogas plants originated from energy crops, 43% from manure, 3% from municipal waste and 2% from industrial and agricultural production waste. Maize accounts for 73%, haylage for 12% and corn for 7% of energy crops. Source: Fachagenutr Nachwachsende Rohostoffe e.V. (Agency for Renewable Resources), https://mediathek.fnr.de/massebezogener-substrateinsatz-nachwachsender-rohstoffe-in-biogasanlagen.html

biogas plants to produce electricity or heat. 178 installations injecting biomethane into the gas network were in operation in 2014. With an annual output of 9 TWh, biomethane satisfied around 1% of Germany's demand for natural gas. What impedes widespread use of this technology is the gas price – imported natural gas is in most cases cheaper than biomethane. Initial plans concerning development of biogas plants were very ambitious. In 2007, the Integrated Energy and Climate Programme (IEKP) strategy set the goal of increasing biomethane production to 6 billion m^3 by 2020 and to 10 billion m^3 by 2030. Biogas production has been supported with legal regulations: the Act on Renewable Energy Sources financed the production of electricity and heat from biogas plants, and the Biofuels Act supported biomethane production for transport purposes. A regulation supporting production of biomethane and its introduction into the network was adopted in 2008.

Chart 13. Biomethane production in Germany in 2006–2015



Source: Erneuerbare Energien und das EEG: Zahlen, Fakten, Grafiken (2015), BDEW, Berlin 2015, page 13

Earlier forecasts concerning development of the sector turned out to be overly optimistic. In 2014, the government withdrew from the goal of increasing biomethane production to 10 billion m^3 annually by 2030. Around 0.63 billion m^3 of biomethane was introduced to the gas network in 2014. Given the high costs and negative environmental impact of biofuel cultivation, the government has also scaled back the plans concerning electricity production by biogas plants. Biogas plants producing raw biogas for power plants in 2014 generated 32.6 TWh of electric energy, i.e. around 5.5% of total consumption.

Biogas power plants, like other RES, are given preferential treatment on the market in Germany. In 2014, the government decided to cut the guaranteed energy purchase tariff for this technology. At present, 8928 biogas power plants operate in Germany: the largest number in Bavaria (2360) and Lower Saxony (1562). While in the period 2004–2013 the installed capacity of biogas power plants increased from 390 MW to 3637 MW, the growth rate was significantly lower in the subsequent years. Biogas power plants with a capacity of 268 MW were built in 2014, while the forecast for 2015 is 202 new installations with a capacity of 272 MW. This growth rate is low, especially if we compare the increase in capacity of photovoltaic and wind power plants in 2014, respectively: 1899 MW and 4750 MW. In 2014, biogas was used to produce around 14 TWh of thermal energy and 0.55 TWh of energy for cars fuelled by gas. In total, biogas satisfied around 5% of Germany's demand for electricity (natural gas 9.7%) and 3% of primary energy consumption (natural gas 20.4%) in 2014[77]. Even though expectations concerning the development of biomethane sector have been tempered, the German government still declares its intention to develop this sector.

3.2. Power-to-gas or gas from renewable energy sources

Gas production from electricity originating from RES is a necessary element of the German energy transformation. This technology is known in Germany as power-to-gas. Transforming power surpluses from solar and wind power plants into hydrogen or methane is a way of storing energy. Stored hydrogen or methane can be used as a fuel in the heating and transport sectors. Gas from RES is generated through electrolysis of water. This process generates hydrogen (H_2). Hydrogen can be directly injected to the gas network (the admissible hydrogen concentration limit is 5%), used as a raw material in the chemical industry or as a fuel, for example, for car engines (at present, 29 hydrogen filling stations operate in Germany, including 17 available to all road users[78]). Reaction with carbon dioxide, so-called methanisation, enables the production of synthetic methane (syngas), i.e. gas which has identical properties to natural gas. In around 30 years, power-to-gas may be a means of managing electricity

[77] Data quoted from the Biogas Association (*Fachverband Biogas e.V.*), http://www.biogas.org/edcom/webfvb.nsf/id/DE_Branchenzahlen/$file/15-11-19_Biogas%20Branchenzahlen-2014_Prognose-2015_final.pdf

[78] In 2014, 29 hydrogen filling stations operated in Germany, 82 in Europe as a whole, 63 in North America and 38 in Asia. Source: http://www.tuev-sued.de/tuev-sued-konzern/presse/pressearchiv/weltweit-17-neue-wasserstoff-tankstellen-im-jahr-2014

production in a system based on renewable wind and solar energy – in the periods of low sun exposure and during windless weather it will be possible to generate electricity through the combustion of previously stored gas from RES.

The power-to-gas technology has not reached the research and development phase – at present, fourteen pilot installations operate in Germany, and six more are under construction. Even though electrolysis of water has been known since the early 19th century, it is still an excessively expensive energy storage method. According to information from the Federal Ministry for Economic Affairs and Energy, power-to-gas may be a decisive factor in the construction of a zero-emission energy system in the medium term. However, at present, the government is concentrating on supporting research and building demo installations[79]. According to research conducted by the German Renewable Energies Agency (*Agentur für Erneuerbare Energien e.V.*), power-to-gas technology will have to be applied in managing electricity production when the share of RES in total electricity output reaches 60%-80%, i.e. around 2040 (in 2015, the share of RES in electricity production stood at 30%). Before this, pumped-storage power plants and battery-based energy storage facilities will be used to adjust output fluctuations[80]. Forecasts concerning the future development of power-to-gas differ radically. The most optimistic scenarios suggest that the installed capacity of power-to-gas installations will reach between 50 and 90 GW by 2050, while the pessimistic ones range between 10 and 20 GW[81] (for comparison, in 2015, the installed capacity of German power plants was 199.2 GW, where RES accounted for 93.9 GW)[82]. This discrepancy results from the differences in assumptions made – if the European energy market develops and transmission networks are expanded, energy storage on such a large scale will be unnecessary, since electricity can be traded and thus output surpluses and shortages can be adjusted, otherwise large-scale storage will be necessary.

Another noteworthy fact is that the German industry supports the idea of developing hydrogen-powered cars. In 2015, six leading companies from the

79 Information from the website of the Federal Ministry for Economic Affairs and Energy, http://bmwi.de/DE/Themen/Energie/Konventionelle-Energietraeger/gas,did=540466.html

80 Renewable Energies Agency, Netzausbau und internationaler Stromaustausch verringern Speicherbedarf, 16 January 2015, source: http://www.unendlich-viel-energie.de/netzausbau-und-internationaler-stromaustausch-verringern-speicherbedarf

81 *Ibidem.*

82 Federal Network Agency, https://www.bundesnetzagentur.de/cln_1411/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Versorgungssicherheit/Erzeugungskapazitaeten/Kraftwerksliste/kraftwerksliste-node.html

fuel and automotive industries established a company named H2 Mobility Deutschland tasked with building by 2023 a network of around 400 hydrogen filling stations in Germany. Its shareholders are Germany's Daimler and Linde, Austria's OMV, Dutch-British Shell and France's Total and Air Liquide. BMW and Volkswagen co-operate with H2 Mobility. The companies have become engaged in the project because they believe that the future solutions for alternative fuel vehicles are not limited to electric or hybrid cars, but that there is also a place for hydrogen-powered vehicles. The construction of 400 filling stations will cost around 400 million euros[83]. At the same time, the federal government has increased funding for research and development of the hydrogen technology – in 2015, the government allocated 161 million euros to the research programme for the development of hydrogen and fuel cell technologies. This decision might have been a result of lobbying from German car manufacturers, the prices of whose electric cars are far from competitive. The German government announced back in 2007 that one million electric cars would be registered in Germany by 2020. Although each subsequent cabinet has declared their intention to achieve this goal, this is already impossible – only 24000 electric cars and only around 100 hydrogen-powered cars were registered in Germany up until May 2015. In April 2015, the government agreed to support the automotive industry as regards the sale of electric cars. The sum of 300 million euros is to be allocated to building car charging stations, and 600 million euros to subsidies to promote the buying of electric cars. Between 300,000 and 400,000 electric cars are expected to be on the roads in Germany by 2019 thanks to this move[84].

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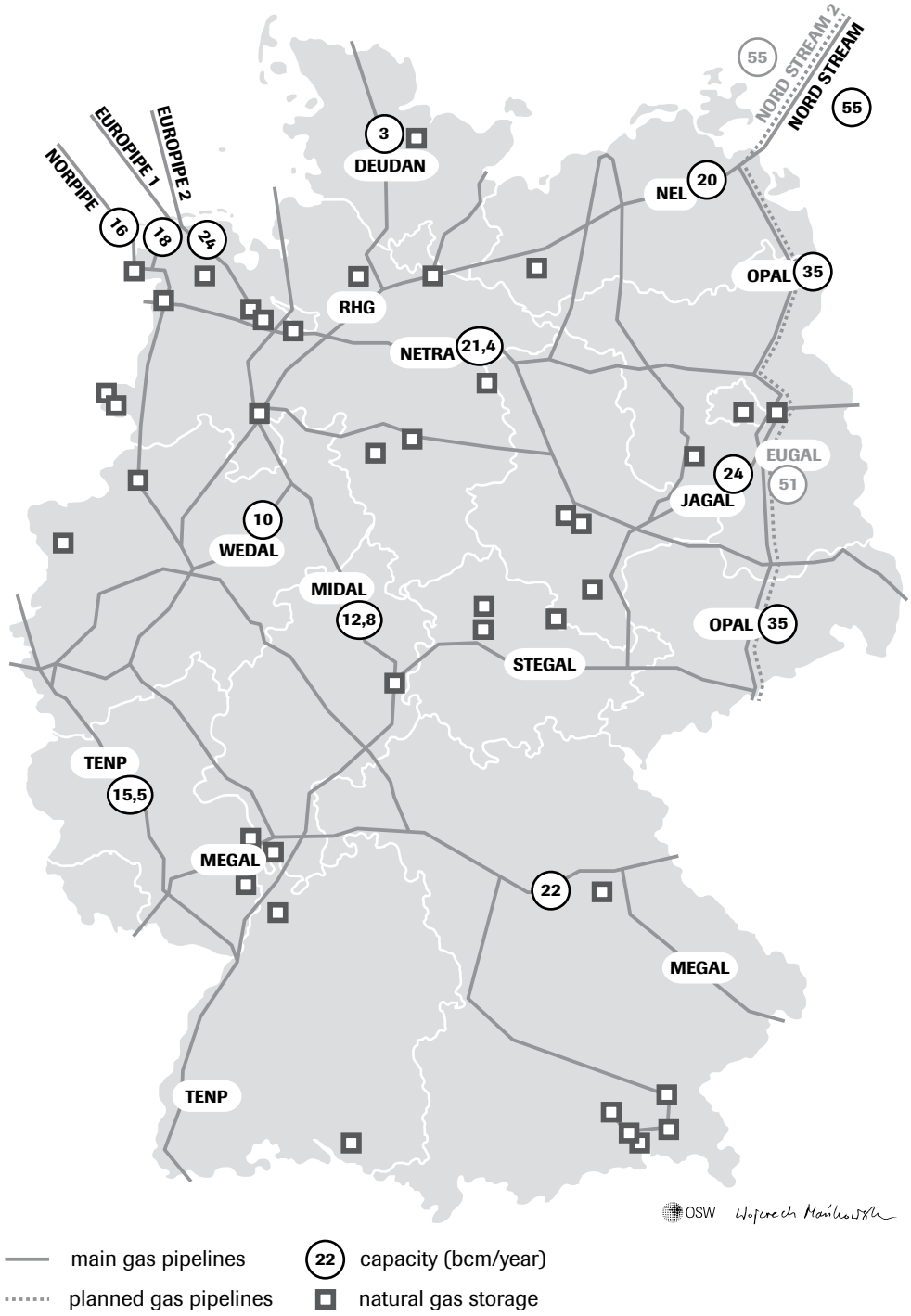
[83] Official website of H2 Mobility Deutschland, http://h2-mobility.de/wp-content/uploads/2015/10/Wasserstoff-tanken-in-Deutschland-zuk%C3%BCnftig-fl%C3%A4chendeckend-m%C3%B6glich_13.10.2015.pdf

[84] Konrad Popławski, Niemcy: rząd wprowadzi dotacje dla samochodów elektrycznych, *OSW Analyses*, 11 May 2016, http://www.osw.waw.pl/pl/publikacje/analizy/2016-05-11/niemcy-rzad-wprowadzi-dotacje-dla-samochodow-elektrycznych

APPENDIX:

Map 1. The German natural gas transmission system



Source: Federal Ministry for Economic Affairs and Energy, BMWi

Table 1. Natural gas imports to Germany in 1960–2014 in TJ

	Denmark	France	Holland	Norway	United Kingdom	USSR / Russia	Other countries	Total
1960	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	109	109
1964	0	0	0	0	0	0	373	373
1965	0	0	0	0	0	0	1 256	1 256
1966	0	0	0	0	0	0	1 642	1 642
1967	0	0	0	0	0	0	12 010	12 010
1968	0	0	0	0	0	0	54 095	54 095
1969	0	0	0	0	0	0	93 744	93 744
1970	0	0	135 472	0	0	0	0	135 472
1971	0	0	224 940	0	0	0	0	224 940
1972	0	0	354 362	0	0	0	0	354 362
1973	0	0	546 913	0	0	29 860	0	576 773
1974	0	0	779 666	0	0	110 258	0	889 924
1975	0	0	945 945	0	0	128 202	0	1 074 147
1976	0	0	1 014 244	0	0	126 554	0	1 140 798
1977	0	0	884 053	29 438	0	135 113	200 349	1 248 953
1978	0	0	714 314	252 908	0	390 297	0	1 357 519
1979	0	0	816 802	304 590	0	465 741	0	1 587 133
1980	0	0	793 453	358 855	0	583 688	0	1 735 996
1981	0	0	649 364	369 075	0	606 283	0	1 624 722
1982	0	0	614 183	298 975	0	531 677	69 191	1 514 026
1983	0	0	627 492	277 744	0	510 855	102 870	1 518 961
1984	0	0	562 530	280 825	0	699 404	1 863	1 544 622
1985	0	0	680 275	248 294	0	699 193	14 211	1 641 973
1986	15 730	0	584 544	258 920	0	823 496	11 175	1 693 865
1987	18 229	0	627 326	303 731	0	898 025	0	1 847 311
1988	18 146	0	551 522	322 488	0	907 229	0	1 799 385
1989	16 670	0	630 253	346 168	0	969 641	0	1 962 732

	Denmark	France	Holland	Norway	United Kingdom	USSR / Russia	Other countries	Total
1990	16 245	0	652 396	336 170	0	981 006	0	1 985 817
1991	29 486	0	789 635	340 911	0	899 264	4 361	2 063 657
1992	31 318	23 999	834 641	387 390	0	838 330	121	2 115 799
1993	31 282	6 048	883 342	393 148	5 163	945 645	615	2 265 243
1994	34 314	4 032	793 608	424 842	22 875	1 095 350	940	2 375 961
1995	34 800	516	840 951	469 546	21 646	1 205 187	1 197	2 573 843
1996	44 577	2 634	996 760	632 264	18 660	1 218 947	8 955	2 922 797
1997	95 421	0	831 931	754 943	13 261	1 151 339	1 494	2 848 389
1998	80 603	0	749 117	712 951	12 842	1 190 980	1 557	2 748 050
1999*	0	0	704 733	720 273	0	1 290 507	149 721	2 865 234
2000*	0	0	628 513	757 969	0	1 299 906	155 309	2 841 697
2001*	0	0	703 016	831 264	0	1 235 431	181 712	2 951 423
2002*	0	0	683 059	964 662	0	1 249 659	166 329	3 063 709
2003*	0	0	644 370	987 800	0	1 398 271	156 887	3 187 328
2004*	0	0	748 779	1 038 277	0	1 466 679	136 122	3 389 857
2005*	0	0	735 193	1 097 831	0	1 425 938	161 701	3 420 663
2006*	0	0	824 753	1 069 246	0	1 475 505	149 637	3 519 141
2007*	0	0	737 589	1 040 911	0	1 436 060	109 134	3 323 694
2008*	0	0	665 071	1 137 048	0	1 527 566	150 786	3 480 471
2009*	0	0	726 248	1 299 062	0	1 343 539	182 429	3 551 278
2010*	0	0	803 226	1 307 119	0	1 463 304	157 499	3 731 148
2011*	0	0	802 514	1 246 754	0	1 422 373	165 861	3 637 502
2012*	0	0	826 450	1 287 263	0	1 413 482	117 602	3 644 797
2013*	0	0	978 637	1 099 523	0	1 448 087	218 503	3 744 750
2014*	0	0	867 522	1 194 227	0	1 391 163	151 655	3 604 567

*Imports from Denmark and the United Kingdom are specified in the table as "other countries"

Source: Federal Office for Economic Affairs and Export Control (BAFA), *Entwicklung der Erdgaseinfuhr in die Bundesrepublik Deutschland Bilanzen 1998–2014 Grafik*, http://www.bafa.de/bafa/de/energie/erdgas/ausgewaehlte_statistiken/egashist.pdf

Table 2. Gas consumption by domestic recipients in 2004–2014 in Germany (final energy consumption in PJ)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total final consumption in Germany	2 216.7	2 098.6	2 189.1	2 103.7	2 176.9	2 034.0	2 247.3	2 038.2	2 122.7	2 184.3	1 926.5
Trade & services	377.8	368.6	461.2	393.2	416.7	392.8	425.4	390.4	363.7	411.1	372.6
Households	1 017.5	985.0	959.6	893.5	940.5	928.3	1 016.6	845.3	916.5	966.0	786.2
Transport	0.0	3.1	4.4	5.8	7.1	8.4	8.8	8.8	8.9	7.4	7.5
Industry	821.4	741.9	763.9	811.1	812.5	704.4	796.6	793.7	792.4	799.8	760.3
including:											
Aggregate mining	54.8	31.8	56.2	56.0	52.2	44.0	47.6	47.7	47.0	47.5	46.5
Food and tobacco production	99.2	98.3	94.5	98.9	96.7	96.0	105.4	107.8	109.6	112.1	104.9
Paper industry	65.0	83.6	75.9	94.1	86.5	78.5	86.7	80.1	78.2	79.5	74.4
Chemical industry	207.6	169.4	166.4	187.8	202.1	182.3	203.6	208.9	216.7	216.8	200.5
Rubber and plastics industry	20.8	20.1	21.5	20.0	20.5	17.8	20.6	20.1	20.0	21.2	20.1
Glass and ceramics	64.0	59.7	51.3	55.5	61.2	56.5	60.5	61.1	60.1	61.6	60.1
Metallurgical industry	92.8	68.8	84.7	90.0	92.5	56.6	77.8	78.2	70.9	64.0	61.6
Non-ferrous metals	39.5	36.2	40.4	38.6	38.4	32.9	38.7	37.5	37.0	36.6	36.0
Machinery construction	29.2	29.2	29.8	29.4	26.8	22.6	25.4	22.7	24.5	25.0	23.9
Vehicle construction	43.7	42.7	38.5	39.1	37.8	31.6	37.8	37.1	36.1	39.8	38.7

Source: Federal Ministry for Economic Affairs and Energy, *Zahlen Und Fakten Energiedaten*, 1 October 2015, http://bmwi.de/DE/Themen/Energie/Energiedaten-und analysen/Energiedaten/gesamtausgabe-,did=476134.html

Chart 1. Primary energy consumption in Germany in 2014

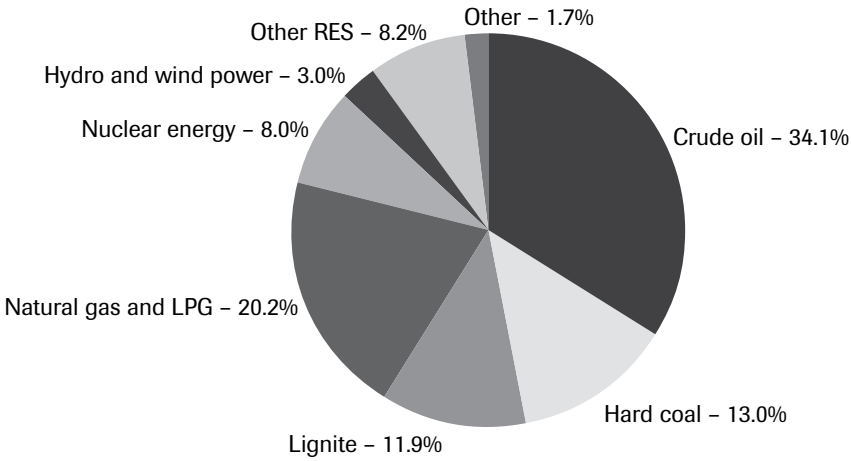
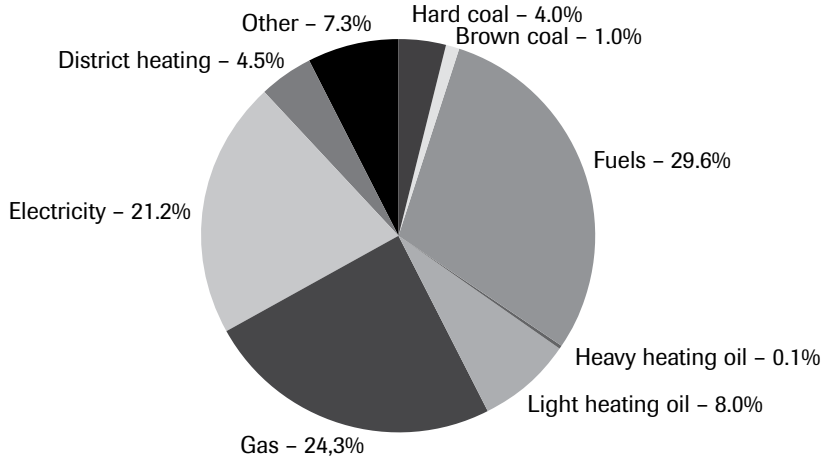


Chart 2. Final energy consumption in Germany in 2014



Source: Federal Ministry for Economic Affairs and Energy, *Zahlen Und Fakten Energiedaten*, 1 October 2015, http://bmwi.de/DE/Themen/Energie/Energiedaten-und analysen/Energiedaten/gesamtausgabe-,did=476134.html