UNIVERSITY OF PIRAEUS

DEPARTMENT OF EUROPEAN AND INTERNATIONAL STUDIES,

MSc in Energy: STRATEGY, LAW AND ECONOMICS

ASPASIA ZEMA

The global liquefied natural gas market: Challenges and Prospects.

Table of contents

Abstract

Purpose of the present study is to analyze challenges and prospects of the global liquefied natural gas market. To achieve the purpose of this research, primary qualitative research was conducted. Selecting the deliberate sampling, the researcher selected from the entire population 3 experts on the subject, from whom she asked their permission to participate in the research. Through qualitative research the researcher collected the data through conducting semi-structured interviews. From all the work it is concluded that the global gas market is in a phase of transformation changing in turn the energy map. Currently fragmented by region and mode of transport (via pipelines or liquefaction) the gas market will gradually become unified globally. The main connecting link between the three major regional markets in North America, Europe and Asia will be liquefied natural gas (LNG), which is transported by special tankers. The exploitation of gas has shown tremendous growth over the last decade, but the way it is priced remains almost entirely dependent on the oil market.

Key words: global liquefied natural gas market, transported, special tankers oil market

Chapter 1 Introduction

In the last fifteen years the gas market in Europe has grown more than in the period up to the mid-1990s. During the decade 2000 - 2010 the demand for natural gas in Europe increased significantly in various sectors of use. , given the increasingly important role of natural gas as a fuel in the energy system due to the lower greenhouse gas emissions resulting from its combustion (Kumar, 2019). In addition, due to the uneven distribution of natural gas reserves worldwide and the long-standing need for significant investments in gas production and transmission infrastructure, countries with excess stockpiles for export may in some cases exploit their position and influence its selling prices. gas and market conditions to the detriment of customers - consumers in other countries. Since mid-2000, the European Commission has been working to coordinate between EU Member States on the development of gas infrastructure (pipelines, LNG terminals, storage facilities), and on the other hand to liberalize individual gas markets, and for their unification (Mohajan, 2018). At the same time several developments at local and global level such as technological - economic developments in the transport of liquefied natural gas (LNG), the supply crises of Europe with Russian gas through Ukraine in 2006 and 2009, the international economic The 2008 crisis, the "shale gas revolution" in the US in 2009 and the Fukushima nuclear accident in Japan in 2011 have significantly affected the European market (Basias&Pollalis, 2018).

Purpose of the present study is to analyze challenges and prospects of the global liquefied natural gas market. To achieve the purpose of this research, primary qualitative research was conducted. The reason for choosing qualitative research is due to the fact that qualitative research enables the researcher to thoroughly investigate the researched object. Through qualitative research the researcher collected the data through conducting semi-structured interviews. The semi-structured interviews consist of open-ended questions, which are predetermined by the researcher and formulated in such a way that they are understandable, but also relevant to the topic. In semi-structured interviews the researcher has the ability not to formulate the questions to the respondents in the same order, but there is flexibility, such as the possibility of explanations, the possibility of removing or adding questions (Athanassiou, 2000).

The study population consists of all those familiar with the subject in the area of Athens. Selecting the deliberate sampling, the researcher selected from the entire population 3 experts on the subject, from whom she asked their permission to participate in the research. Deliberate sampling can include in the study experts who have an opinion on the investigated issue and in this way the researcher can gather a wealth of information (Creswell, 2016).

Initially and in order for the researcher to start her research, she received written consent from all respondents that they wish to participate in the research. This document is called a consent form and was prepared by the researcher. This form mentioned the purpose of the study and what is expected from the participants. In this publication, the researcher stressed that the participants wish to participate in the research voluntarily and anonymously. It is important that respondents do not expect any benefit from participating in the survey. He also stressed that their lives are not in danger (Paraskevopoulou-Kollia, 2008; Isari&Pourkos, 2015).

The second step was to make an appointment to conduct the interview. In the consent document, respondents noted either a telephone or an e-mail where the researcher was able to contact them. Through this information, the researcher asked the respondents what day, what time and where they want the interview to take place. The freedom of choice of the respondents lies in the fact that it is very important to have time when they will give an interview and to feel familiar, in order to give as much and reliable information as possible.

During the interview, the researcher noted what she considers very important, under each question, as she had taken care to leave enough space under each question. At the same time, in each question he noted sub-questions with the prospect of extracting as much data as possible (Athanassiou, 2000; Paraskevopoulou-Kollia, 2008; Creswell, 2016).

The contribution of the study lies in the conclusion that in recent years, natural gas has shown increasing growth and spread worldwide. It is the most important source of energy, since the pollutants emitted during combustion and use in the environment are negligible, and its cost is relatively lower. As a result, many shipping companies have entered the LNG market, with its shipping vessels growing rapidly. One of these companies, which is studied in the present study, is the company of Peter Libanos with the name GasLog which is based in Monaco. In particular, for this company is presented its business plan for the construction of a new ship for the transport of LNG. It can be transported either by land or by sea with suitable tankers. Of course, its demand is on the rise and the shift of people towards this form of energy could not leave shipping unattended, as liquefied natural gas transports dominate the world. The need to transport large quantities of LNG over long distances via the sea has led in recent years to the growth of shipping companies operating in this sector, and of course the market for LNG carriers and the fleet has been significantly strengthened worldwide.

According to research, it turned out that there is a large number of orders for the construction of new ships for the transport of LNG, with the Greeks and the Chinese dominating the world market. Regarding the business plan for the investment for the construction of a new LNG carrier by GasLog, based on the previous analysis, it is concluded that the above business plan is characterized by stability and sustainability in the long run. It is obvious that the studied company presents results which are much more than satisfactory especially in terms of liquidity, sales and in general its financial data are characterized as very satisfactory. The company in the last years at least (based on the balance sheets for the years 2015-2018 and the financial analysis) presents significant elements of maturity. The trend of progress and development of the company is described as upward and optimistic for the next years of use. The strengths of the company are the quality of the services provided, the security, the efficiency, the competitive prices and the timely execution of the agreements. However, there are significant weaknesses, such as heightened uncertainty, financial instability and difficulty in financing due to high investment costs.

Chapter 2 Analysis of the energy market and the Liquefied natural gas market

2.1 Introduction

This chapter presents an analysis of the energy market and the Liquefied natural gas market. Specifically, it presents analysis of industries worldwide, analysis of the external environment, energy in general, competition analysis, the economic analysis of the industries and SWOT analysis of the industries.

2.2 Analysis of industries worldwide

Natural gas is a mixture of gaseous hydrocarbons consisting mainly of methane (CH_4) in a percentage of 70-90%, while it may contain other hydrocarbons in smaller percentages (e.g. ethane, propane). It is found in underground fields either on land or underwater. Within the fields, the gas is kept "trapped" between layers of porous sedimentary rocks while an upper layer of denser and impermeable rock prevents it from escaping. In order to mine it, drillings are carried out, and as the gas is under pressure inside the field, it escapes to the atmosphere, while its commercial exploitation requires treatment plants and piping systems that will transport it to the place of consumption (Noor, 2008).

The higher calorific value of commercial quality natural gas (IEA, 2014) ranges from 42 MJ/kg (Dutch gas) to approximately 52 MJ/kg (Norwegian, Algerian and Russian gas). In comparison, the higher calorific value of other liquid fuels (crude oil, petrol, diesel) is about 45 MJ/kg, while for coal (lignite or anthracite) it is about 23 MJ/kg. Of course, because the density of natural gas is about 0.7 kg/m^3, if the calorific value is expressed in MJ/m^3, for natural gas it will be about 40 MJ/m^3 while for liquid fuels the density of which is much higher (for gasoline about 0.7 kg/L i.e. 700 kg/m^3), the calorific value is about 35 GJ/m^3. Natural gas is therefore a competitive fuel, but its gaseous form requires a completely different management of liquid fuels in terms of production, transportation, storage and use processes, and the required transportation and distribution infrastructure has a higher cost than the corresponding liquefied fuel infrastructure (Ulvestad& Overland, 2012).

An additional reason that gas is in many cases preferred to other fuels is the lower carbon dioxide emissions, a factor which has become particularly important given the European and global policy of reducing greenhouse gas emissions in the context of tackling greenhouse gas emissions and climate change. Typically, the emission factor of the most important greenhouse gas, carbon dioxide (CO_2) is about 56 t CO_2/TJ for natural gas, while compared to liquid fuels (crude oil, gasoline, diesel) it is about 70 t CO_2, for carbon is about 100 t CO_2/TJ (Herold, 2003, Hrastar, 2014).

Natural gas is used as fuel in the electricity sector, in the industrial sector (also used as raw material for petrochemical industrial processes), in the domestic and tertiary (commercial) sector, and in the transport sector.

In the electricity sector, especially from the mid-1990s onwards, gas retains a significant share of other alternatives. The share of fuels in total electricity generation in Europe for 2010 was: coal 24.7%, oil 2.6%, natural gas 23.6%, nuclear fuel 27.4%, renewable sources 20.9%, other fuels 0.7% (EEA, 2013). The use of natural gas increased especially after 2000, when combined cycle power plants became widely used in Europe, using natural gas as fuel and generating energy through a gas turbine that performs the Brayton - Joule thermodynamic cycle and through a steam turbine that performs a closed Rankine cycle in a closed steam - water circuit recovering heat from hot exhaust gases. Such plants achieve a thermal efficiency of up to 50% - 60%, which is higher than the corresponding efficiency of coal-fired steam or oil-fired power plants (Poling et al., 2003).

In the industrial sector, the applications of the thermal use of natural gas vary: waste treatment and charring, preheating of metals (mainly iron and steel), drying and dehumidification systems widely used in the recycling industries and plastic and pharmaceutical products, processing of glass and supply of industrial burners. At the same time, it is used as a raw material in many processes of the chemical industry, such as: production of fertilizers, ammonia and methanol as well as in petrochemical processes.

In the domestic and tertiary sectors, the main use concerns the heating of spaces through burners and closed circuit water and radiators (this use is mainly due to the intense seasonality of the annual demand, with high levels in the winter months and lower in the summer), water heating, but also the operation of gas cookers (they offer faster and better temperature control and have lower variable operating costs compared to electric cookers) and other home heating appliances. Along with heating, space cooling can also be achieved with gas cooling systems (Corbeau, 2016).

In the transport sector, although petrol and diesel are the predominant fuels, gas can be a credible alternative. In its compressed form (CNG, with a compression ratio of about 1:300), natural gas is stored in the vehicle and introduced into it in the same way as gasoline, although modifications are required on some components for the vehicle engine to use gas. At the same time there is the possibility of moving with liquefied natural gas (LNG, with a compression ratio of about 1:600), but such applications are possible only for large trucks and cargo ships. In terms of consumer adoption, the technology is still at a very early stage in Europe, with few commercial gas stations and vehicles (mainly on public transport), while it is at a relatively more advanced stage in countries with sufficient domestic production (Hughes, 2011).

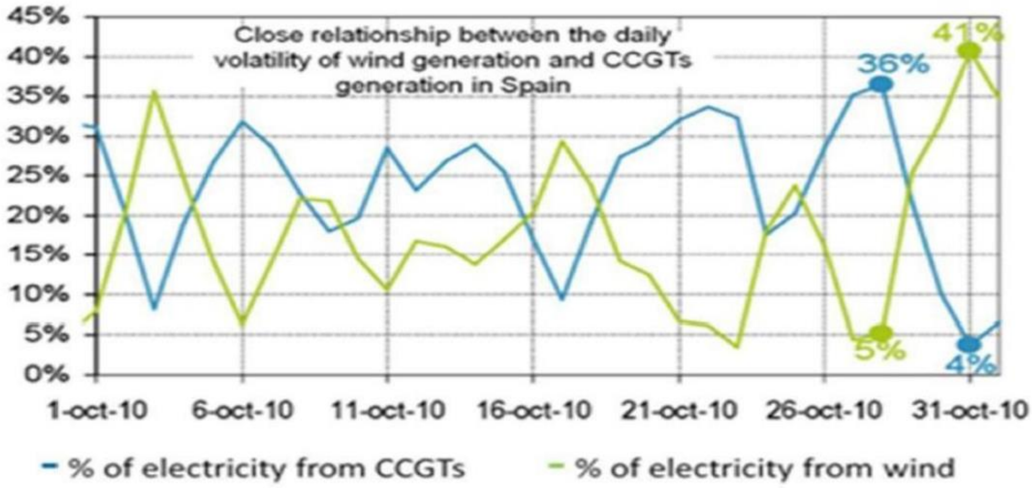
2.3 Analysis of the external environment

In Western Europe, as early as the 19th century, some countries produced coal gas (brand name: town gas) with the main use of lighting, and from the early 20th century its use was displaced by electricity, oil and gas (Stevens, 2010). The first discoveries of gas fields were made in Italy and France in the late 1930s and in Germany and the Netherlands around 1950. Around 1960-1970, demand in the aforementioned countries (with the exception of the Netherlands) began to exceed production capacity and there was a need for gas imports, initially from the Netherlands in 1960 with the parallel development of the pipeline network. The first oil crisis in 1973 pushed the countries of Western Europe to reduce their share of oil in their energy mix, while the second oil crisis in 1979 made this need even more urgent. The result was agreements for gas imports from Norway (1973), the Soviet Union (1978), and Algeria (in 1985 exports began by submarine pipeline from Algeria to Italy, while Algeria had been exporting LNG to various countries since 1964), and intensifying efforts to develop domestic deposits throughout Europe (significant gas production began in the United Kingdom in the early 1970s) (Mokhatab et al., 2013).

The importance of natural gas for the energy system lies in its competitive advantages over other fuels and energy forms, which it replaces in several cases. First of all, with regard to the lower CO_2 emissions compared to other fossil fuels (as already mentioned), makes it a possible substitute for them in many applications in the framework of the European carbon reduction policy. In the transport sector as well as in the domestic and tertiary sectors, the use of oil and gasoline is extensive, but given the right incentives, natural gas can significantly replace them, thus reducing CO_2 emissions, while in the electricity sector (European Gas Advocacy Forum, 2011) combined cycle units are superior to carbon or lignite units in terms of CO_2 emissions (twice the emissions per kWh generated compared to modern coal units and up to 80% less emissions than older coal units). Given that older carbon plants have a lifespan of about 10 more years, there is a significant opportunity to increase the utilization rate of existing combined cycle plants (60% on average in Europe in 2012), and to build new combined cycle plants (Lin et al., 2010).

Also an important factor is the flexibility of combined cycle power plants with natural gas, as we see in figure 2.1, giving them a significant comparative advantage over coal and nuclear fuel plants in terms of the role of rotating reserve, due to the increasing penetration of renewable energy sources of intermittent power into the power generation mix. Specifically (Papaefthymiou et al., 2014), the possibility of changing the load per minute (in% of the nominal produced power), and the cold start time for existing and new production stations are presented. The charge changeability for old coal plants is 1%/min - 1.5%/min and 6%/min for new stations, while for combined cycle gas plants it is respectively 2%/min for existing plants and 8%/min for new plants. Cold start time is 10 hours and 4 hours for old and new coal stations respectively, and 4 hours and 2 hours for old and new combined cycle plants. It is worth noting that the simple natural gas plants have even better characteristics (gas turbine supplied with compressed gas-fuel mixture without exploiting the heat of the exhaust gases for steam generation), but their efficiency is much worse (even lower than coal plants) with a potential negative impact on cost per kWh produced. Also, nuclear power plants have the ability to change the load 3.8%/min - 10%/min (depending on the charge level) but the cold start time can reach up to two days (Ghorbani et al., 2020).

Figure 2.1-Complementarity between wind farms and combined cycle power plants (CCGTs) in the Spanish system

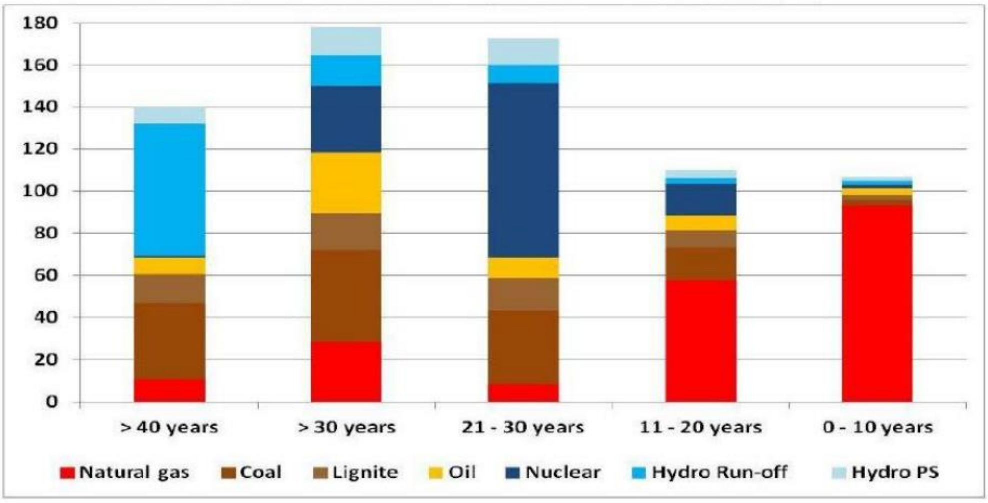


Source: Ghorbani et al., 2020

One of the main factors influencing the demand for gas is the course of the economy. Thus, since 2000, a continuous increase in demand (mainly due to the increase in the share of natural gas in electricity generation) was projected for the next 20 years, and around 2005 there was talk of the "golden age of natural gas". However, the economic crisis of 2008 and the recession in which Europe entered (2008-2009 and 2011-2013), caused, among others, a decline in industrial activity and efforts to increase energy efficiency and reduce energy consumption in industrial and in the domestic and tertiary sectors, with a consequent reduction in demand for gas both primary and secondary through the reduction of demand for electricity. As a result (Honore, 2014), the levels of gas demand (as well as for energy in general) followed a downward trend, with significant reductions in 2009 (5.67% for gas and 5.35% for energy as a whole). In 2012, gas demand in Europe was 8.1% lower than in 2008 (586 bcm in 2008, 528 bcm in 2012), while even in 2015 it did not return to the levels of 2008. Typically, according to the IEA (IEA Medium Term Gas Market Report, 2014) the total demand in the European members of the OECD for 2012 was 507 bcm, while it is estimated at 504 bcm for 2013. It is noted that in the winter of 2013 there were particularly low temperatures and for a much higher period than usual, and it is therefore estimated that the climate-adjusted demand would be around 490 bcm (Bridge & Bradshaw, 2017).

In the field of electricity generation sector in particular, developments such as the fall in the international coal price in 2008, the parallel increase in gas import prices and the increasing penetration of Renewable Energy Sources, combined with the collapse of the European Emissions Trading Scheme (ETS) caused significant displacement of natural gas from the electricity generation mix and at the same time further increased production from coal and renewable sources, and caused economic viability (or even shutdown) problems at several combined cycle plants. Electricity generation may recover in the future, given the policy of reducing CO_2 emissions (both due to lower carbon emissions and the complementary role of RES, although in many cases other solutions are used to address intermittent and variable power of RES), but also because most combined cycle plants in Europe were built around 2000 and thus have a much longer lifespan than older carbon plants, and based on the CO_2 emission reduction policy it will be difficult to build new carbon plants in the future, as we see from figure 2.2.

Figure 2.2- Age of power plants in 2011 (GW of installed capacity



Source: Bridge & Bradshaw, 2017

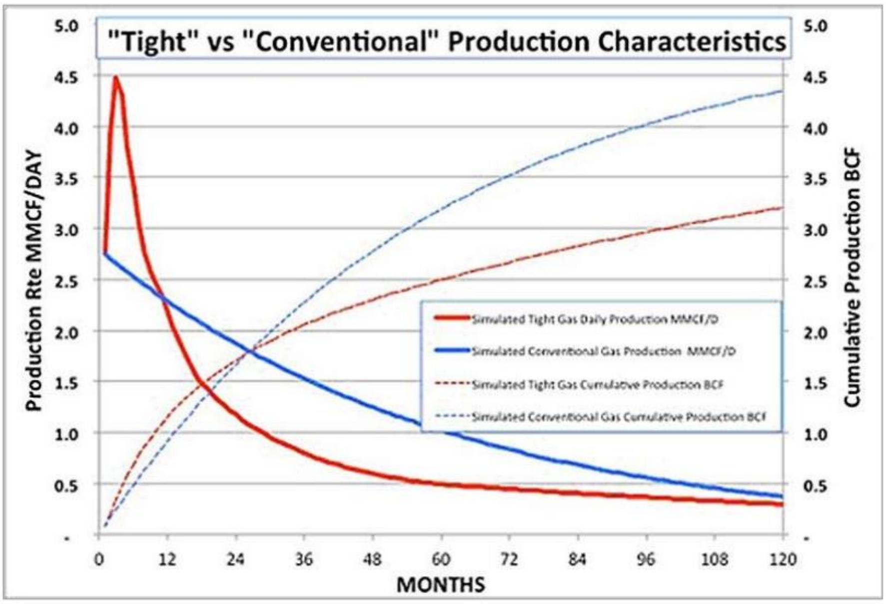
In the long run, IEA estimates (IEA, 2014) that demand for natural gas in Europe will return to 2010 levels around 2035, and will gradually increase by 2040. However, there is a degree of uncertainty, as European policies to reduce emissions and partial dependence on Russian gas imports may be fully implemented and therefore demand will remain stable during the 2030s - 2040s.

2.3.1 Energy in general

The process of discovering hydrocarbons involves the artificial induction of low-intensity seismic vibrations at potential points of existence (which are determined based on the geological composition of the subsoil) and exploratory drilling with the aim of two-dimensional and three-dimensional mapping of the subsoil and finally, the most accurate possible determination of the amount of hydrocarbons possibly contained in the field.

If it is decided that the field is economically exploitable (which depends directly on the cost of the mining, processing and possibly even transport processes, and on the price at which the gas is expected to be sold), controlled mining of natural gas is carried out from the field through drilling, as we see fron figure 2.3 and 2.4 and 2.5. In the case of unconventional shale deposits, where the gas is trapped between layers of shale gas, the mining is based on hydraulic fracturing and horizontal drilling techniques, which are widely used in US production, while other unconventional deposits such as coal bed methane and tight gas are still quite limited. This is followed by the processing of the gas, which includes the removal of other complex hydrocarbons that may be present in the mixture in lower concentrations, as well as possibly crude oil, water vapor, hydrogen sulfide, carbon dioxide, helium and nitrogen, so that the natural gas specifications are met to be injected into the transport system, which includes piping, compression stations that control gas flow, and the control and metering system.

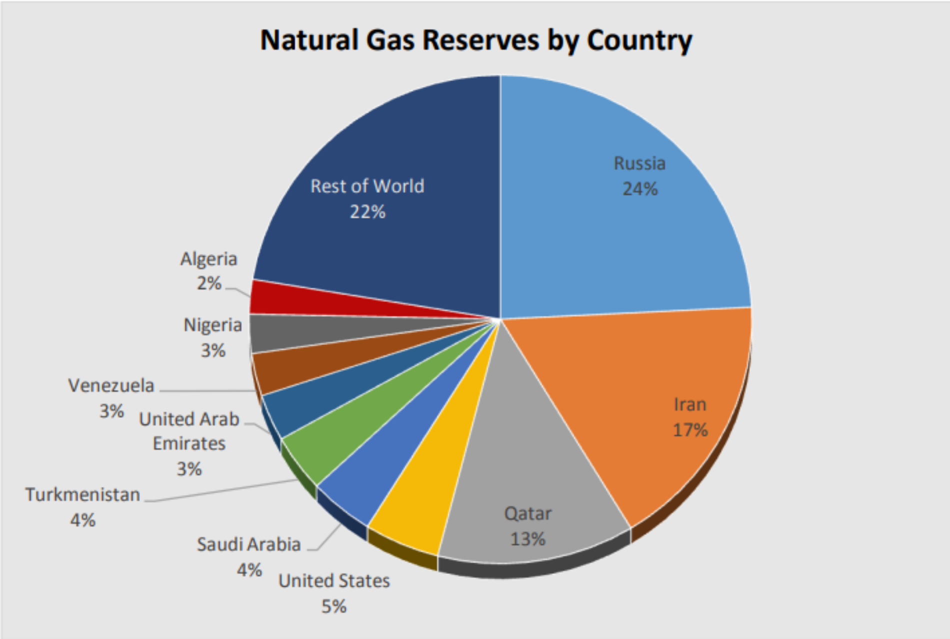
Figure 2.3-Daily (continuous line) and cumulative (dashed line) production curves of conventional (blue) and non-conventional (red) gas fields.



Source: Bridge & Bradshaw, 2017

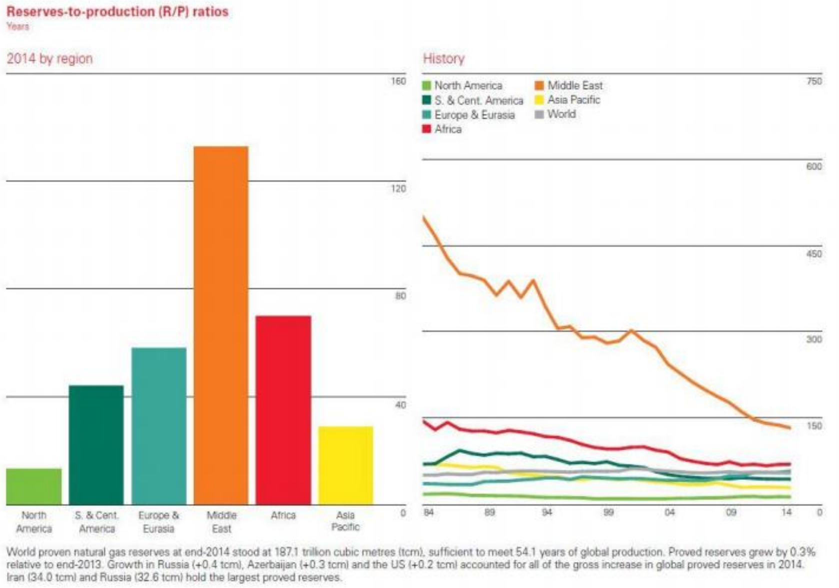
According to EIA data, the global certified natural gas reserves (defined as reserves that are technically recoverable with a probability of 90%) were about 200 tcm in 2014. The main reserves are located in the following countries: Russia has 47.8 tcm, Iran 33.8 tcm, Qatar 25.1 tcm, USA 9.6 tcm and Saudi Arabia 8.2 tcm.

Figure 2.4- Confirmed reserves of each country as a percentage of total world reserves



Source: Bridge & Bradshaw, 2017

Figure 2.5- Ratio of reserves to Annual Production - R/P ratio per region



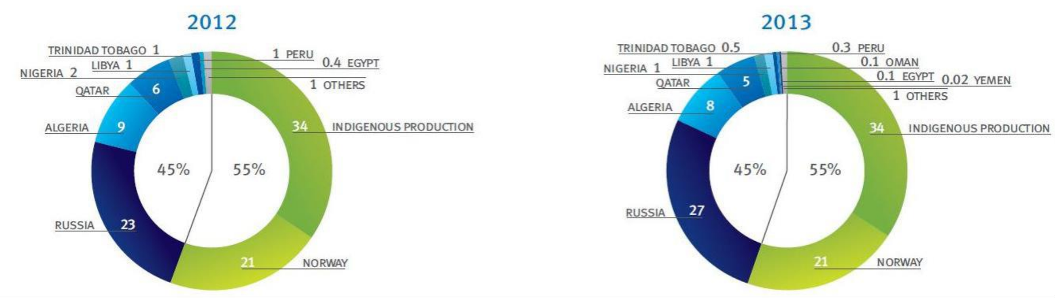
Source: Bridge & Bradshaw, 2017

2.3.2 Liquefied natural gas

For the European market, the main pipeline gas supplier is the Russian state-owned Gazprom, which owns fields in Western Siberia and the Barents Sea, and supplies gas through pipelines to Ukraine, Belarus and Germany, and the rest Western and Southern European countries, while the Baltic countries and Finland are supplied by direct pipelines from Russia. Russia’s total exports to Europe (the 28 Member States of the European Union and Switzerland) via pipeline for 2013 (Eurogas, 2014) amounted to 120 bcm (about 40% of total European gas imports, 23% of total European demand).

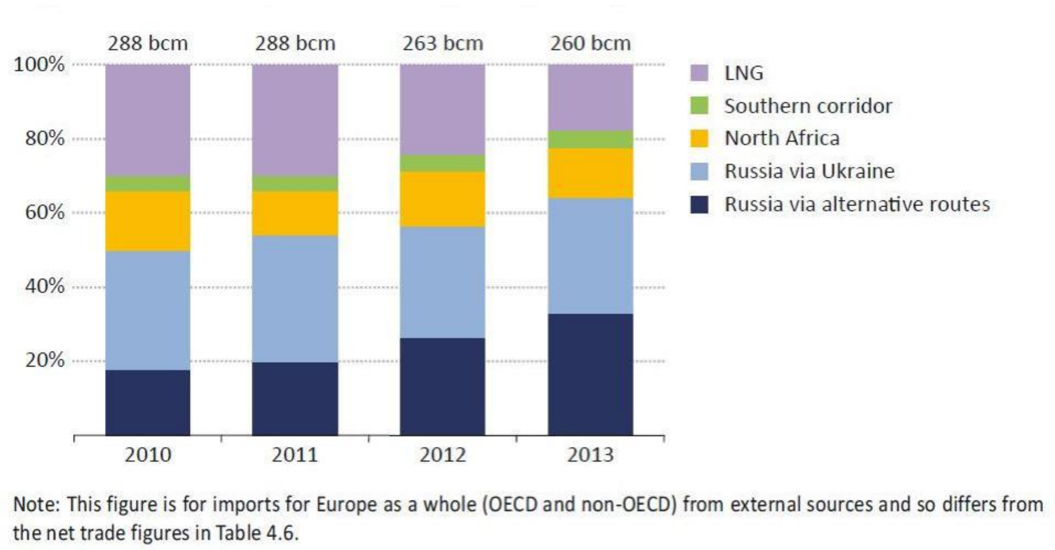
Europe’s second largest supplier is Norway’s state-owned hydrocarbon company Statoil, which owns fields in the North Sea at the border between the Norwegian and British EEZs, as well as further northeast in Norwegian territorial waters. Gas from the fields is piped underwater to the United Kingdom, Belgium, the Netherlands, France, Germany and Denmark, and from there to the rest of Europe. In 2013, Norway exported 92 bcm of natural gas to Europe (38% of total European pipeline imports, about 21% of total European demand). Another major gas supplier is the Algerian state-owned company, Sonatrach, which has gas fields in the south of the country, and through pipelines to Italy and Spain supplied Europe in 2013 with 31 bcm, 15% of the total gas imports via pipeline, as we see from 2.6 and 2.7 .

Figure 2.6- Shares of gas suppliers to the EU



Source: Eurogas, 2014

Figure 2.7- Gas imports from suppliers outside Europe



Source: Eurogas, 2014

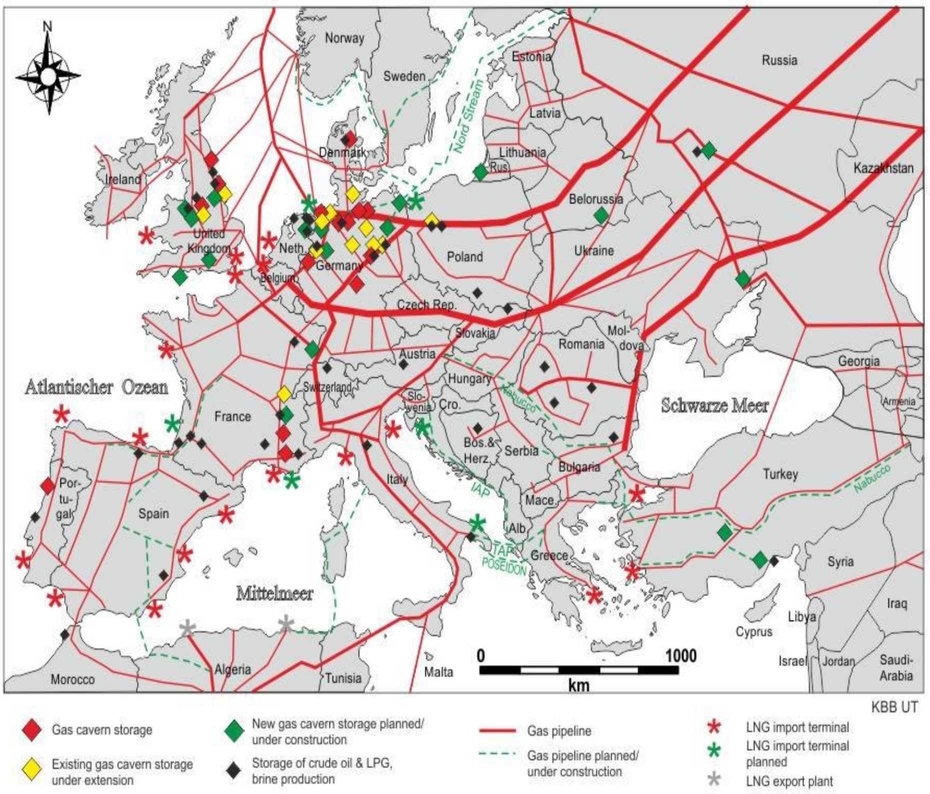
2.4 Competition analysis

2.4.1 Energy in general

In terms of new suppliers, for several decades several competing pipelines (e.g. Nabucco, Nabucco-West, White Stream, TAP) have been in the design process for the implementation of the “Southern Corridor” (IEA 2014 Medium Term Gas Market Report), with the aim of diversifying Europe’s import sources, with Azerbaijan as the main possible supplier (although several other suppliers such as Iran, Turkmenistan and Egypt were also considered). The TAP pipeline was finally selected and is expected to be fully operational around 2021 (construction was expected to begin in 2015) with an initial capacity of 10 bcm/y and a possible future increase to 20 bcm/y. Gas will be transported from the Shah Deniz field of the Azerbaijani state-owned company SOCAR to the Caspian Sea, through the TANAP pipeline under construction, which will cross Turkey and through the TAP from the Greek-Turkish border to Albania and from there to Italy and secondarily to the Balkans, as we see from 2.8

.

Figure 2.8- The European gas pipeline network



Source: IEA 2014

There are also plans for new pipelines on the part of Russia, as part of Gazprom’s strategy to eliminate Ukraine as a transit country as much as possible.

This strategy emerged as a solution to the ongoing disputes, mainly of a political and economic nature, between the two countries (Henderson &Mitrova, 2015). Prior to 1990, the Soviet Union owned the production infrastructure and the transmission network and fully controlled exports to Europe. Since 1990, the final stage of the transmission network to Europe has been within Ukraine, which has created conflicts with Russia over transit charges.

Around the middle of 2000, annual negotiations began at the end of each year, sometimes literally until the last minute. Russia threatened to cut off gas supplies to Ukraine, while Ukraine threatened to cut off its transit activities and therefore Russian gas supplies to Europe (as it did in 2006 and 2009). This strategy of Gazprom was realized in part with the construction of the Yamal pipelines to Germany (via Belarus and Poland and fully operational in 2006) and the Nord Stream (via the Baltic Sea directly to Germany in 2012). With the same perspective, the construction of the Nord Stream 2 was proposed, and of the South Stream, the evolution of which is the proposal for the Turkish Stream. The South Stream pipeline was designed with a capacity of 63 bcm/y (possibly competing the "Southern Corridor"), would cross the Black Sea, and through Bulgaria and Serbia would supply the Balkan countries, Hungary, Austria and Italy (Clardy, 1997).

The European Commission reacted by changing the regulatory framework of the European gas market (Henderson &Mitrova 2015), in order to prevent full control of transmission infrastructure and certain markets by major gas producers (such as Gazprom). The 3rd Community Directive on Gas requires every new gas infrastructure within the EU to commit a significant part of its capacity to be available for outsourcing whenever requested. Of course, there is a possibility of exempting an infrastructure from this rule (as was the case for the TAP pipeline), but it seems that infrastructure such as the Nord Stream pipeline on German soil and the land section of the previously planned South Stream pipeline will not be excluded.

With the main argument for the financial viability of the infrastructure, Gazprom submitted an objection in the case of the Nord Stream and abandoned the construction of the South Stream at the end of 2014, replacing it with the planned Turkish Stream pipeline, which will cross the Black Sea ending near Istanbul and will initially supply Turkey while expanding its capacity to serve part of the demand of the Balkan countries and possibly Central Europe. Therefore, with the Turkish Stream, Gazprom has effectively reduced the planned South Stream to its non-EU segment.

Based on the above, the implementation of these plans is uncertain, although not unlikely. The European strategy is generally in favor of diversification of import sources and partial dependence on Russian gas. However, given that the new pipelines will replace the flows through Ukraine, the share of Russian imports from this development alone is not expected to increase significantly. On the contrary, several European companies support these plans (e.g. the current shareholding of the planned Nord Stream 2 pipeline: the Russian Gazprom owns 50%, the German BASF 10%, EON Ruhrgas 10%, the French Engie - former GDF Suez - 10%, the Austrian OMV 10% and Shell 10%). In addition, based on the latest geopolitical developments in the Middle East, energy cooperation between Russia and Turkey has been called into question and therefore the construction of the Turkish Stream is highly uncertain.

Another potential alternative route is the possible construction of the East-Med pipeline from Cyprus (supplied by the recently discovered Cypriot field Aphrodite with a possible alliance of the Israeli Leviathan and Tamar fields) to Greece, as proposed by DEPA.

The possibility of supplying Europe from important fields in the Caspian region in Central Asia (e.g. Turkmenistan or Uzbekistan) is relatively small, both for cost reasons (hypothetically, a pipeline of about 3600 km should be built by e.g. the CEGH sales hub, in Baumgarten, Austria, since the capacity of the TANAP pipeline is, by way of exception to the European Regulation, fully committed to the transit of production from the Shah Deniz field in Azerbaijan), as well as due to political difficulties (e.g. crossing the Caspian Sea or the Russian hinterland) and competition from nearby producer countries (e.g. Azerbaijan, Russia or even Iran and Kazakhstan).

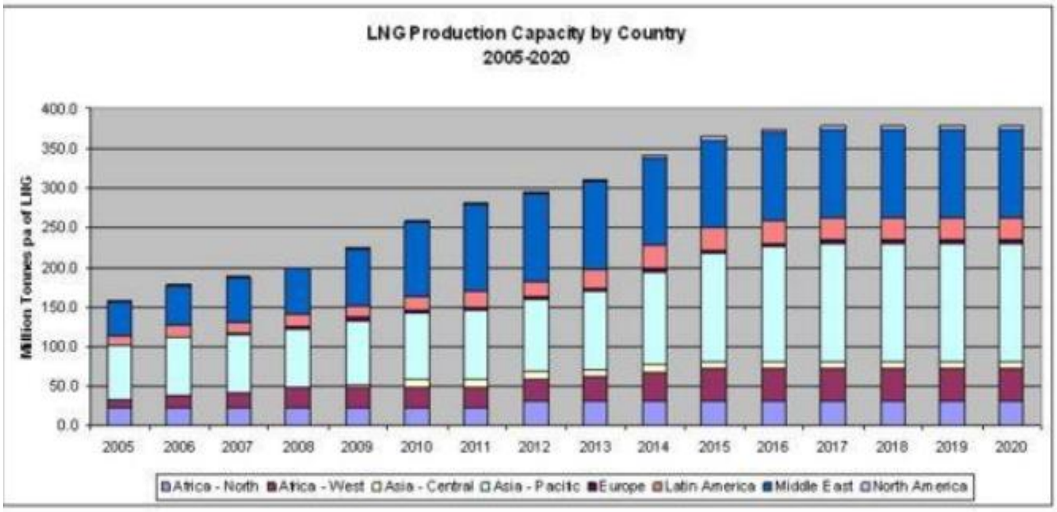
2.4.2 Liquefied natural gas

Instead of being transported through a pipeline network, natural gas can be transported in liquefied form and introduced into the transmission system after being re-gasified. The liquefaction process includes cooling the gas to very low temperatures (approximately -160o C) and compressing it (at a rate of approximately 1: 600), transporting it by specially designed tankers, and regasifying it (heating the LNG to return to gaseous form) takes place on land or floating installations.

2.5 Economic analysis of the industries

According to IEA (IEA, 2014) data, the largest LNG exporters worldwide in 2013 were: the Gulf states (Qatar, Oman, Yemen, and the United Arab Emirates) with 41% of global sales , the countries of Southeast Asia (Malaysia, Indonesia, Brunei) with 20%, Australia with 10%, the countries of Central Africa (Nigeria and Equatorial Guinea) with 8%, followed by Algeria, Russia, Trinidad with 5% each , and Norway, Egypt, Peru with 1% each. In 2013, a total of almost 320 bcm of natural gas was exported in the form of LNG, while the total global liquefaction capacity (and therefore the ability to supply LNG worldwide) was 414 bcm of gas per year, as we see from 2.9.

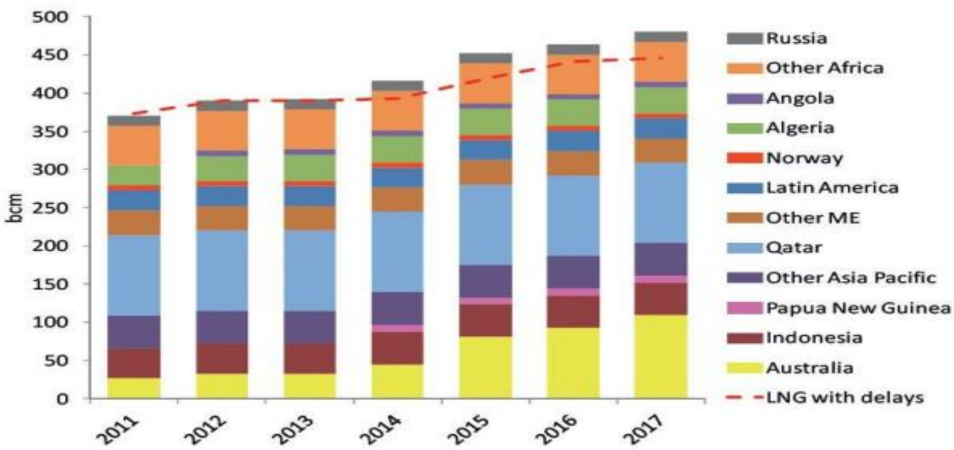
Figure 2.9- LNG production capacity by geographical area



Source: IEA World Energy Outlook 2014

As we see from figure 2.10 the landscape is expected to change in the next five years, but also in the long run until 2035-2040 (Energy Economist Issue 400, Feb 2015), (IEA, 2014). The most important changes are analyzed below.

Figure 2.10- Under construction liquefaction infrastructure in 2012



Source: IEA World Energy Outlook 2014

2.6 SWOT analysis of the industries

In Australia, seven liquefaction plants are under construction and the country's LNG production capacity is expected to double by 2020 from 56 bcm / y in 2014 to 130 bcm / y, and is expected to reach 170 bcm / y by 2040. A similar picture is presented and in the US, where gas production is also projected to increase in the medium term. Due to the particularly growing shale gas production from 2009 onwards, the US is gradually becoming a gas exporting country, with four liquefaction plants up and running by 2020, with a total export potential of around 70 bcm of gas per year. In the long run, however, a downturn in export growth is expected in the US until 2040, as the production of shale deposits is declining faster than conventional ones, and the prices required for non-conventional stocks to be exploited are estimated in the region of 3 - $ 7 / mmbtu (compared to the last five years the Henry Hub index is in the range of 2-4 $ / mmbtu), and therefore higher prices in the domestic market will reduce the incentive to export (Henderson & Mitrova, 2015). In addition, the regulatory framework for hydrocarbon exports is relatively rigid and complex, and at the political level there are reactions even to the prospect of exports. Considering that the price of the Henry Hub will be around $ 5 / mmbtu, the cost of producing and transporting LNG from America to Europe is approximately equal to the price at which Gazprom exported to Europe on average in 2013, and therefore There may be competition for Europe's supply, as shown in Figure 2-9. Nevertheless, Gazprom's break-even cost is much lower than the total cost of producing and transporting LNG from the US, and therefore Russia has the potential to maintain its market share while reducing its profit margin. We list in the table below the comparisons of the different areas. As it is obvious year per year and especially two years there is an increase in annual growth rate.

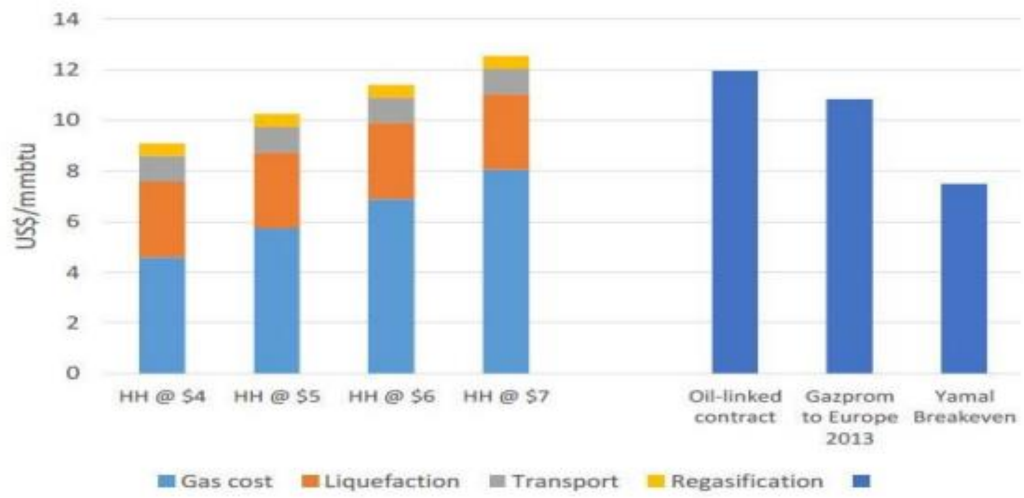
Table 1 : Comparisons of the different areas OECD-
COMPOUNT AVARAGE ANNUAL GROWTH RATE

Region	2016	2018	2020	2022	CAAGR+2016-22	Contribution to global growth

OECD Armenias	958	1000	1060	1099	2.3%	38%
OECD Europe	254	239	228	215	-2.5%	-10%
OECD Asia Oceania	107	134	142	144	5.1%	10%
China	137	159	181	200	5.5%	17%
Non – OECD Asia	336	323	308	312	-1.2%	-6%
FSU Non – OECD Europe	865	889	916	948	1.5%	22%
Middle East	583	596	623	651	1.8%	18%
Africa	202	223	232	237	2.7%	10%
Latin America	173	176	175	177	0.3%	1%
Total	3615	3740	3856	3936	1.6%	

CAAGR: COMPOUNT AVARAGE ANNUAL GROWTH RATE

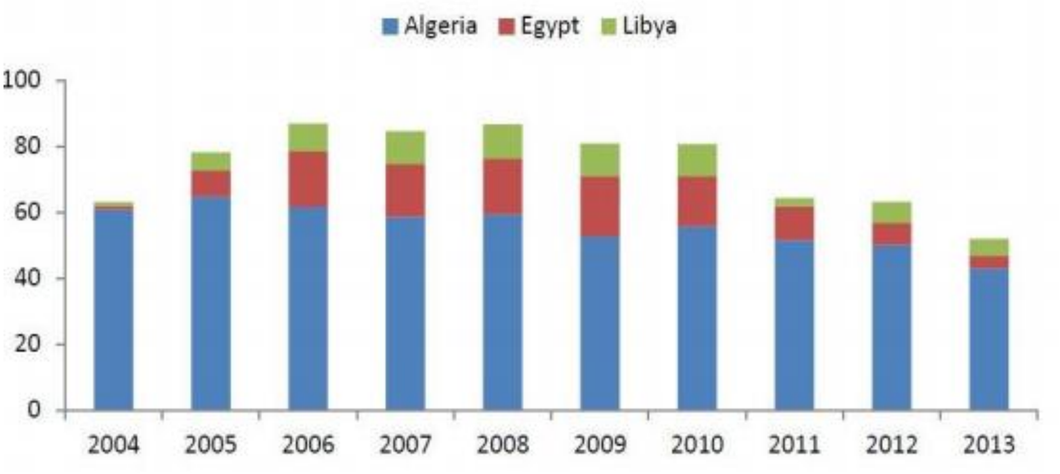
Figure 2.9- Comparison of the price of Russian gas and US LNG exports



Source: Henderson & Mitrova, 2015

Africa is another region where LNG production and exports are expected to increase. The first liquefaction plant with a capacity of 10.7 bcm per year was opened in Angola in 2014, while facilities with similar capacity are planned in Mozambique and Tanzania with a view to starting operations around 2020. Algeria and Nigeria are not expected to increase significantly. their exports, as they face problems of political instability in the surrounding countries and growing domestic demand. Egypt, on the other hand, has virtually halted LNG exports since 2013, triggering changes in the field's regulatory framework in 2012 (which prompted several producers to shut down) and directing declining production to the domestic market, with the aim of to meet growing domestic demand. The Zohr deposit at the northeastern tip of the Nile Delta geological basin was recently discovered, with initially estimated reserves of 850 bcm (ENI official press release, Aug 2015), which may mean that in the long run, Egypt will not import significant amounts of . However, it is possible that the proven reserves of the field will turn out to be lower than the above price, and even the start of the exploitation of the field is expected in a horizon of five years, so until then it is quite possible that there will be gas imports to Egypt, as we see in figure 2.10 (Energy Charter Secretariat, 2007) .

Figure 2.10- Total North African gas exports to the EU



Source: Aug 2015

In the Eastern Mediterranean region, Cyprus and Israel have made significant discoveries of gas deposits in the Levantine geological basin (Aphrodite field in Cyprus, and Tamar and Leviathan fields in Israel). There are plans to export LNG or via pipeline to Europe, although there is a possibility that the discovered quantities will be directed to the domestic market and then to the markets of the surrounding countries (eg via pipeline to Egypt).

In the Middle East, countries such as Saudi Arabia, Iraq and Iran have significant gas reserves, but factors such as growing domestic demand in the case of Saudi Arabia, political instability in the case of Iraq, and international economic sanctions have been imposed. in Iran because of its nuclear program, block the export of natural gas in any form. For Iran, the recent agreement and the partial easing of sanctions are a positive step, but the time horizon for possible exports is definitely over ten years.

Finally, Russia plans to significantly increase LNG exports with new liquefaction plants. On the Yamal Peninsula (northern Siberia) the Yamal LNG plant with a capacity of 16.5 Mtpa is expected to be built by a consortium of Novatek, Total and CNPC (China National Petroleum Corporation) and is expected to start operating in 2018, while the Arctic LNG plant is also planned. from the Russian company Novatek (16.5 Mtpa). In the Far East, Gazprom plans to expand by 5 Mtpa the capacity of the Sakhalin 2 plant (with a current capacity of 10 Mtpa) and the

Vladivostok LNG plant (10-15 Mtpa), while the Far East LNG plant (5-10 Mtpa) is also planned.) by Rosneft.

2.7 Conclusion

The Baltic LNG (10 Mtpa) and ShtokmanLNG (15 Mtpa) plants are also planned by Gazprom on the Baltic coast. But there are problems such as the financial sanctions imposed on the country by the EU and the US due to its role in the "Ukrainian crisis" of 2013-2014, the increased competition in the LNG market, and the low level of know-how of Russian companies which are likely to postpone the start-up time of the factories at least until the end of the next decade.

Chapter 3 Analysis of imports and exports

3.1 Introduction

The present chapter analyze imports and exports. Until about 2000, in most European countries (with the exception of the United Kingdom), the main buyers of natural gas were the (usually state-controlled) supply companies (and usually managers of part or all of the national transmission system and sometimes distribution systems). These companies acted as "national wholesalers" buying gas (mainly imported, but also from domestic producers) and selling it to distribution companies (possibly also state-controlled). Purchases and sales were made exclusively through long-term bilateral contracts which aimed more at creating a safe environment for new investments as both the production and the creation of gas transit routes are highly capital intensive activities.

3.2 Production

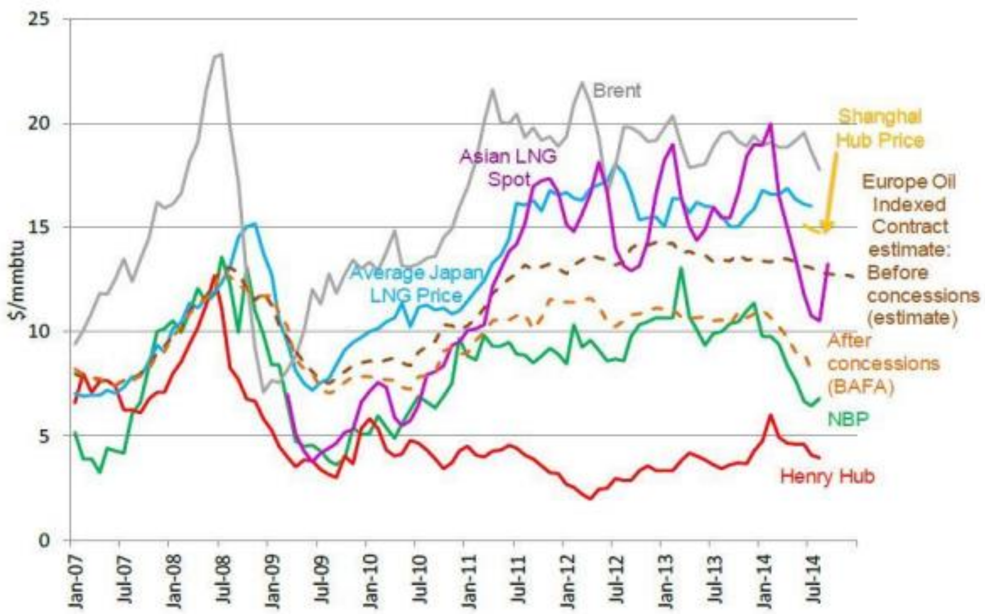
When the first contracts were concluded (around 1960 for Dutch exports, and in 1970 for Soviet exports), in the early stages of market development the contracts had a long duration (20 years or more), stable annual mandatory quantities with little flexibility (from 80% to over 90% of the nominal contracted quantity had to be paid regardless of physical receipt - Take-or-Pay clause, in combination with a clause prohibiting the re-export of imported gas). Pricing was based on the substitution value of natural gas for competing fuels (ie the price of crude oil and mainly its derivatives), in the sense that the main competitor in each market were not alternative gas suppliers (as competition of this scale does not still existed), but the substitute fuel.

Algeria exported via LNG under similar conditions from 1964, and through the Transmed pipeline to Italy from 1985 onwards, and Statoil from 1977 onwards, while this scheme survived almost intact until LNG exports to Italy. Europe from Trinidad and Nigeria in 1999 and Russian exports to the countries of the former Soviet Union until about 2005.

LNG purchases and sales since Algeria's first exports in 1964 were characterized by long-term contracts and pricing based on the price of oil. This structure is largely maintained to this day, with the difference that it is possible to divert LNG shipments from one destination to another, either because the sale to the latter will be more profitable at the given time, or because the selling to the first will change the supply-demand balance at the given time and therefore may even cause the price to collapse in that market. In the Asian market, LNG import prices have been higher than their European counterparts over time (due to the rapidly growing demand in Asia combined with the inability to cover domestic production or pipeline imports so far, and the high transport costs as the distances are longer), so Europe is a secondary destination for the main LNG producers who can make profitable sales in both markets (the most typical example of such a producer is Qatar).

Over time, as we see from figure 3-1 the global balance between supply and demand has been affected by various developments, such as the development of shale gas fields in the US that made them almost self-sufficient after 2009 and thus did not make scheduled imports from Qatar, resulting in increased global LNG supply. Another relatively recent development was the Fukushima nuclear accident in Japan in 2011, which resulted in the rapid shutdown of all nuclear power plants in Japan, and their replacement by natural gas units, thus greatly increasing the demand for natural gas. In Japan. The above developments resulted in the period 2009-2011 the increase of non-contracted quantities of LNG that were available in the short-term market (spot market) of gas sales nodes in Europe, while after 2011 Europe returned to the role of secondary destination, while Asian markets are the primary destination.

Figure 3-1: Gas prices for various regions during the period 2007 - 2014



Source: Stevens 2010

Adequate and uninterrupted satisfaction of gas demand is crucial, both from a market point of view (as in the case of prolonged supply or price volatility, the effects on all sectors of use are significant to destructive, and consumers are always for substituted fuels, even if under normal circumstances this would not be economically viable), as well as for technical reasons (eg in 1980 British Gas argued that if there was a power outage in Britain it took about three years to reconnect all consumers to the network) (Stevens 2010).

3.3 Production and distribution costs

As early as 1970 (with the beginning of gas exports from the then Soviet Union to Western Europe), security of supply in the gas market in Europe played an important role in determining the share of gas in total energy consumption. Around 2000, with demand increasing significantly in part due to the gradual penetration of gas into the electricity sector and declining production, the issue of security of supply resurfaced, as most European countries were highly dependent on gas imports, while only the countries of Western Europe could achieve a relatively sufficient diversification of import sources. The main sources were Russia and Norway and to a lesser extent Algeria (for Italy and the Iberian Peninsula), with LNG imports accounting for a very small share.

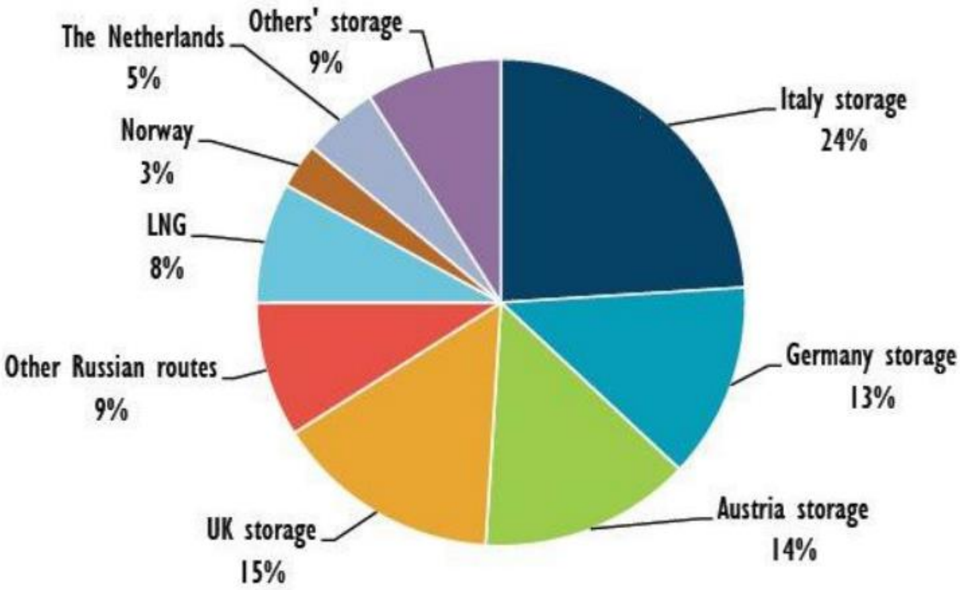
In Eastern and Southeastern Europe, imports were mostly from Russia (90% of imports) with countries such as the Baltic states, Finland and Bulgaria importing gas exclusively from Russia. During the period 2000-2015, increasing security of supply has become an important priority for the European Union and for the countries of the European area in general. The ever-declining course (and in many countries the complete absence) of domestic production in Europe from 2000 until today due to limited gas reserves has increased dependence on imports, the sources of which are still few, while on the other hand the Demand was growing steadily until 2008 and after falling until 2014, it is expected to grow slightly in the coming decades.

At the same time, import sources and transit countries pose significant risks on a case-by-case basis (Dickel et al. 2014). Russia's exports, and in particular their transit through Ukraine, have proved particularly problematic, as in two cases (2006 and 2009) Russia's Gazprom cut off gas supplies to Ukraine and through it to Europe (for some days in 2006 and for almost three weeks in 2009) for reasons of economic and political differences between Russia and Ukraine, thus causing (especially in 2009, with the interruption taking place in the winter months) huge problems in catering to EU consumers.

These two crises highlighted 28 several weaknesses in the European gas transmission system (as it was originally designed to transport gas from Europe's eastern border to the west), resulting in the creation of the large-capacity Nord Stream pipeline from Russia. to Germany, the effort to create more interconnectors (eg the "Vertical Corridor", a set of cross-border connections between most countries in Eastern and Central Europe) with the main feature of the possibility of reverse flow, and the creation of new reception terminals LNG expected to be operational within the next five years (eg in Croatia, Poland and Lithuania). The recent case of the "Ukrainian crisis" in 2014 has raised concerns about a new power outage, although due to the above changes in the European transmission system, a new interruption of flows through Ukraine will have a much reduced impact compared to 2009.

In addition, as we see form figure 3.2 imports from North Africa have been affected by continued political instability over the past five years: Libya (in complete political disarray after 2011) and Egypt have significantly reduced their exports, while Algerian exports continue to be normal. Political in stability in neighboring countries can create problems.

Figure 3.2: How gas shortages were addressed during the Ukrainian supply crisis of 2009



Source: Silverman, 2009

3.4 Analysis of imports

For the European Union, according to the Eurogas 2014 annual statistical report (Eurogas 2014), 19% of total gas imports in 2012, and 14% in 2013 were LNG, with LNG import sources for 2013 to be structured as follows: Gulf states (52%), Algeria (22%), Nigeria (12%), Trinidad (5%), Norway (5%), Peru (4%), in a total of imports in 2013 , 40.2 bcm of liquefied natural gas. The total reprocessing (and therefore market) capacity of LNG in Europe is around 210 bcm / y, and is expected to increase to 300 bcm / y by 2030. It should be noted that the reason LNG reception facilities in Europe are underused The import price of LNG is higher than the competitive gas via pipeline (from Russia and Norway), while in the European market where demand is low, long-term contracts with guaranteed quantities of imports, mainly from Russia, dominate. Therefore, the reduced flexibility of the European market currently limits LNG imports to a complementary role.

It is also important to consider whether the aforementioned new LNG export opportunities from different countries are likely to be directed to the European market. LNG from Australia and other Southeast Asian countries is expected to be mostly sold in China, Japan and other Asian countries (India, Pakistan, Korea), where demand is growing steadily following their economic growth rates. over the last decade, and transport distances are shorter than in the EU. The main reasons for this choice are the lower transport costs (which depend directly on the distance) but also the higher volume of imports and the high prices available to pay the above countries due to increased demand combined with the mostly inability to meet demand from domestic production and the lack of alternative sources of supply. For the same reasons, most US exports will also be directed to the Asian market, although some contracts have been concluded with European countries such as Spain and the United Kingdom. Europe is therefore expected to import mainly from the Middle East and Qatar, from African countries, and from Norway.

3.5 Analysisofexports

A percentage of European gas demand is covered by the domestic production of some countries, some of which also export to other countries within Europe. In 2013, about 160 bcm of natural gas were produced in Europe (IEA, 2014). The main producing countries are the Netherlands with a production of 86 bcm in 2013, England with 38 bcm and Germany with 11 bcm, while Italy (7 bcm), Poland (6 bcm), Denmark (4 bcm), Hungary (2 bcm) and Austria (1 bcm) contribute the remaining 10% of total production. But almost all European countries import much of the gas they consume, as domestic production is insufficient. Exceptions are Denmark, which imports only small quantities, and the Netherlands, which fully covers its domestic demand and exports significant quantities to its neighboring countries: Germany (21 bcm), England (8 bcm), France (7 bcm). , Belgium (5 bcm) and Italy (3 bcm), for 2013. However, the production trend over time is declining. Already in 2013 there was a 10% reduction in gas production in the EU compared to 2010 levels, while the IEA for 2020 predicts a 25% reduction in production compared to 2010, mainly due to the relatively limited gas reserves and reserves. in the EU.

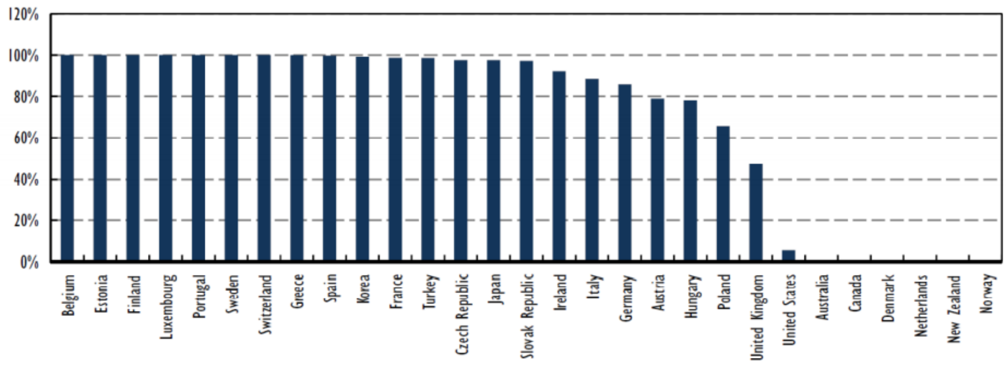
With regard to non-conventional gas fields in Europe, the only country in which production is projected is Poland, whose reserves are initially estimated at around 5.3 tcm. Non-conventional gas reserves may be available in several European countries, but due to environmental policy, increased CO2 emissions during extraction, high production costs and local community reactions, the research process is delayed.

3.6 Technologicalinventorymanagement

3.6.1 Storage

An initial assessment of security of supply can be made through the import dependency ratio, which is equal to the percentage of net gas imports to gas consumption, as we see from figure 3.3.

Figure 3-3: Index of dependence on imports for different countries for the year 2012



Source: Yin, 2002

For a more detailed quantitative representation of security of supply, the main statistical indicators used (EU Commission 2014) are the "N-1" criterion and the "import concentration index".

The "N-1" criterion reflects for each country the percentage of domestic demand (as appropriate for oil, gas or even electricity) that can be met if the largest source of imports is lost (or possibly the main infrastructure of the system), and therefore applies to the more specific investigation of the robustness of a national system. Defined as the sum of the daily capacity of all gas introducing infrastructure (Im intake pipelines, Prod production and Stor storage infrastructure, and LNG Regas regasification terminals), subtracting the largest of them (Largerst Infrastructure), to the maximum daily demand of the system (Maximum Demand):

$$\mathrm{N}-1(\%) = \frac{\mathrm{Im} + \mathrm{Pr}\,od + Stor + \mathrm{Re}\,gas - L\arg est\ Infrastructure}{Maximum\ \ Demand} \qquad (\varepsilon\xi.2.1)$$

The criterion "N-1" reflects the security of supply of a system in terms of technical infrastructure, while the value of the index is expressed in% and it is possible and desirable to exceed 100%. The higher its price, the greater the percentage of domestic demand that can be met in "emergencies" where the largest natural gas infrastructure of a national system has been lost. The price above 100% demonstrates a very robust system as even in case of increase in demand, it will be able to be satisfied by the existing infrastructure even in "emergency conditions".

According to the European Commission (EU Commission, 2014, In-depth study of European Energy Security, Commission staff working document, 2014), several EU countries (eg the Czech Republic, Germany, Slovakia, the Netherlands and Austria) achieve satisfactory values (above 100%) in the "N-1" criterion, others (eg Denmark, the United Kingdom, Finland, Hungary, Spain, and Poland) are in a marginally good position (with index values of about 100%), while in some countries (eg Greece, Portugal, Bulgaria, Estonia, and Lithuania) a significant infrastructure upgrade is required (index values much less than 100%).

The diversification of import sources is reflected in the Supplier Concentration Index (SCI), which is based on the Herfindahl-Hirschman index (an index applied to economic issues such as market concentration study and portfolio diversification), and is defined (Cavaye, 1996) as follows:

$$SCI = \sum_i \left(\frac{\operatorname{Im} ports_i}{Demand} \right)^2 \qquad (\varepsilon\xi.2.2)$$

where as $\frac{\operatorname{Im} ports_i}{Demand}$ symbolizes the share (%) of the i-th source of import in terms of total consumption (Demand) of the country

By default, the possible values of the SCI index are in the interval (0,1] with the minimum value expressing a high variation of import sources (as in this case the share of each importer will be small in relation to the total imports), while the maximum value expresses a high concentration of sources or (in the extreme case) a single source of imports, the index also differs not only in terms of the number of import sources, but also in terms of the size of import shares (e.g. if in a country there are two sources of imports with equal shares, the index will receive a lower price than in the case where one of the importers holds a dominant position and therefore the largest share).

Regarding the expected values of the index for EU countries, the more the sources of import of a country and the more equal their shares, the lower the value of the index will take. Thus, it will receive higher prices in the Baltic and Eastern European countries (which import gas almost exclusively from Russia), while the price will be lower in the countries of Western and Southern Europe (which vary their import mix between Russia and Norway). or Algeria and various LNG suppliers). Countries that also import LNG are also expected to have a low price, as this significantly differentiates their import sources. On the contrary, it will receive a higher price in countries with a high percentage of dependence on imports.

In order to take into account the relative risk of interruption for each source of imports, the extension of the index $SCI_{pol}$is defined:

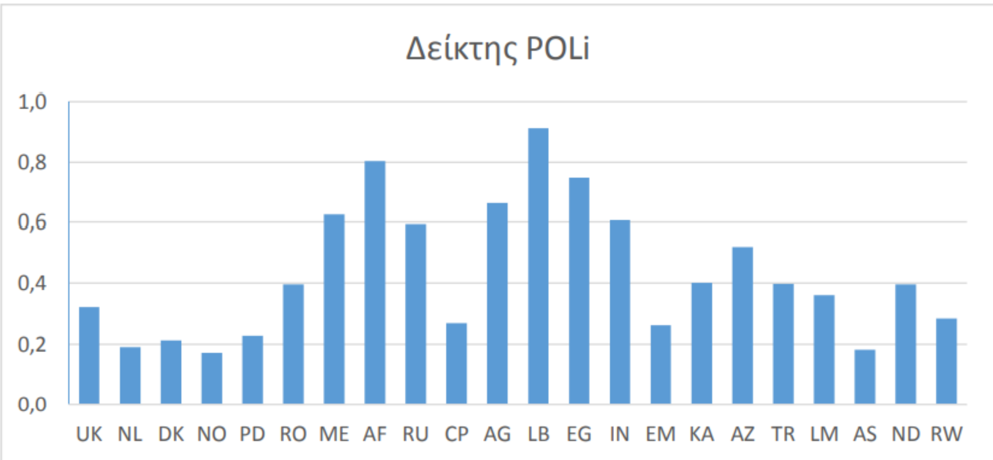
$$SCI_{pol} = \sum_i \left[\left(\frac{\operatorname{Im} ports_i}{Demand} \right)^2 POL_i \right] \qquad (\varepsilon\xi.2.3)$$

The POLi index is a measure of the aforementioned risk. In this case, the World Governance Indicator for Political Stability and Absence of Violence / Terrorism (WGI) will be used for the year 2014. Specifically because the World Bank index ranges from - 2.76 (for Syria) to 1.94 (for Greenland) and with the lower values mean higher risk (while the opposite is true for the SCI index) the following transformation applies: The values of the index are shifted so that the minimum value are zero, normalized to the range (approx. 4.7) so that the maximum value is equal to one, and the result is subtracted from the unit so that the direction of increase of the POLi index coincides semantically with the direction of increase of the SCI:

$$POL_i = 1 - \frac{WGI_i - Min\{WGI_i\}}{Range} \qquad (εξ.2.4)$$

This results in the POLi index, which fluctuates within the range [0,1) with lower values representing less risk for the country of production, as we see from figure 3.4.

Figure 3-4: POLi index for each country / region of gas production of the model



Source: Dooley, 2002

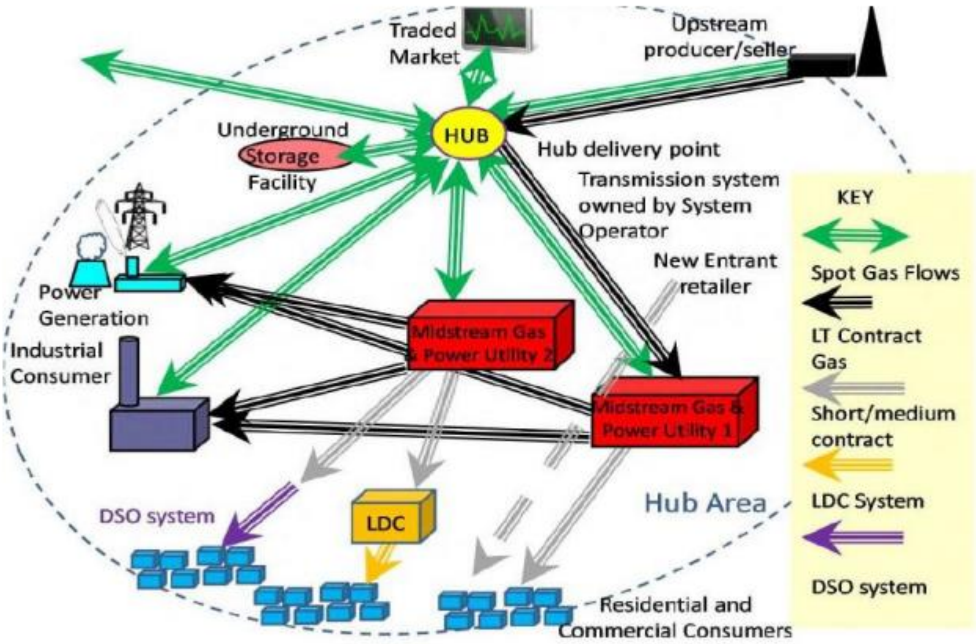
3.6.2 Transport and distribution

From the mid-1990s when the liberalization of the British gas market began (in 1996 the National Balancing Point - NBP, a "virtual" gas trading point was created), and mainly from 2005 onwards, the European Union intensified its efforts to market liberalization of all Member States. Already in 2003, with the 2nd Community Directive on natural gas - 2 nd EU Gas Directive, the simultaneous control of the transport infrastructure and the commercial or productive activity by a company became prohibitive. The possibility of using the transmission network by "third parties" became mandatory. - Third Party Access, although reforms have been systematically implemented since 2009 and the 3rd Community Gas Directive.

In general, the reforms aimed at a partial change in the market model: in many cases the desired or even appropriate sales pattern may be long-term contracts (eg the sale of gas from the Shah Deniz field via the TAP pipeline will with 25-year contracts, while the pipeline has been exempted from the obligation to provide capacity to "third parties" - TPA).

However, some categories of gas uses may require more flexible schemes than rigid long-term contracts with high minimum guaranteed market clauses (eg the electricity sector and the - currently underdeveloped - transport sector, which may be in demand. show strong short-term fluctuations, would benefit from more flexible sales patterns). In addition, the feature of the contracts that was strongly contested, especially after 2008, was the pricing of gas in relation to the price of oil (oilindexed pricing), on the grounds that in Europe, natural gas was no longer at risk of substitution by petroleum products. and that demand follows an autonomous course (Rogers & Stern 2014), so the selling price of natural gas in each country must be determined mainly by the balance between supply and domestic gas demand and the conditions of economic competition, as we see from figure 3-5.

Figure 3- 5: Typical structure of a liberalized gas market



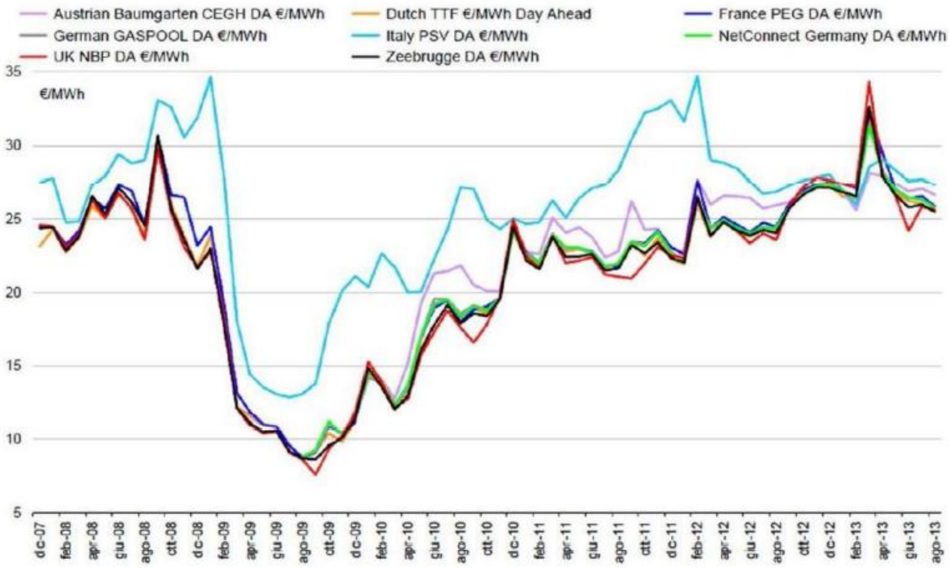
Source: Glesne, 2006

The "reference price" for each country, which reflects the balance of supply and demand, is set at virtual trading points, gas trading hubs. The first nodes were created (Herling, Weinberger & Harris, 2000) in northwestern Europe (in 1996 the British NBP was created and in 2003 the Dutch TTF). There are now sales hubs in Belgium (ZEG), Austria (CEGH), Germany (NCG and GPL), France (PEG's) and Italy (PSV), with the possibility of over-the-Counter trading) or through special energy exchanges, with natural delivery of gas within two days at most, but also with derivative exchange products (futures and options) with physical delivery time up to four months after the transaction (and not only for the purchase of natural gas gas, but possibly risk minimization through alternatives or even profitability through arbitrage[1]) and with the possibility of market participation not only by large gas supply companies, but also by distribution companies and consumers (eg large industrial consumers and power generators). Of course, not all nodes are in the same stage of market maturity and liquidity level (which is logical as they were created in a timely manner), with CEGH, NCG, GPL, PEG's and PSV being in the initial stage, ZEE in the intermediate stage and NBP and TTF in the more mature stage,

[1] Arbitrage means the economic practice of exploiting a possible price difference of the same good in different markets or at different times..

while comparatively the Henry Hub node in the USA far exceeds in liquidity even the NBP.

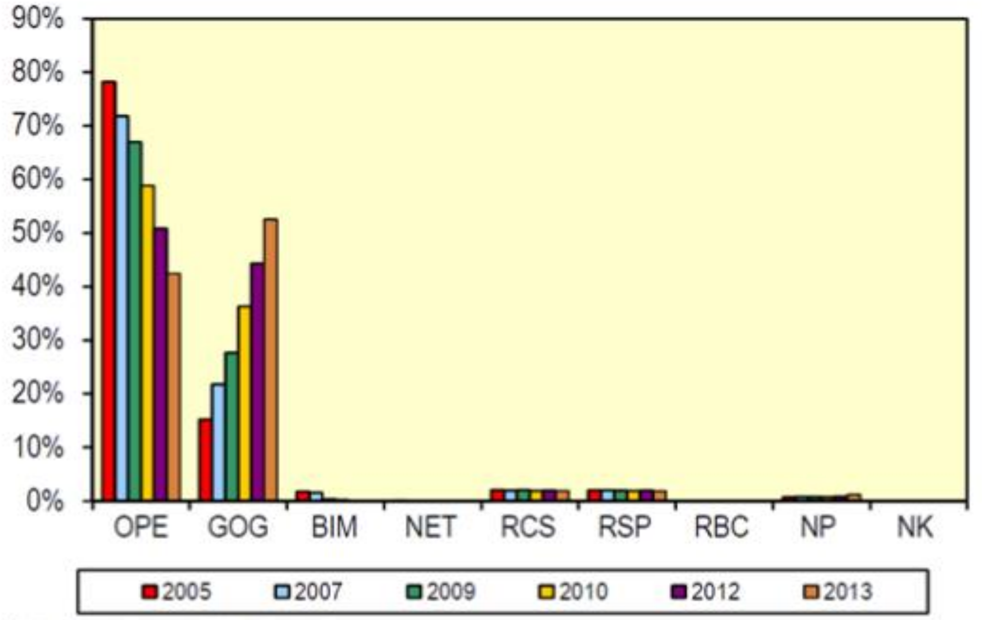
Figure 3- 6: Price fluctuations of the main sales hubs in Europe



Souce: Iosifidis, 2008

In southeastern and central Eastern Europe, on the other hand, where markets are much less liberal, long-term contracts continue to play a dominant role, mainly from Russia (both in imports and in the sale of domestic production), as we see from figure 3-7.

Figure 3-7: Shares of pricing policies of gas sold within the EU - the main ones are OPE (oil price escalation - pricing in relation to the price of oil) and GOG (Gas-on-Gas competition - pricing based on the reference price of a sales node)



[1,2] OPE: Oil Price Escalation (Oil Indexation)
GOG: Gas-on-gas competition (Hub pricing)
BIM: Bilateral Monopoly (price determined based on agreements between a large seller and a large buyer)
NET: Netback from Final Product (The price received by the gas supplier is a function of the price received by the buyer for the final product the buyer produces).
RCS: Regulation-Cost of Service (The price is determined, or approved, by a regulatory authority, or possibly a Ministry, but the level is set to cover the "cost of service").
RSP: Regulation-Social and Political (The price is set, on an irregular basis, probably by a Ministry, on a political/social basis, in response to the need to cover increasing costs, or possibly as a revenue raising exercise).
RBC: Regulation-Below Cost (The price is knowingly set below the average cost of producing and transporting the gas often as a form of state subsidy to its population).
NP: No Price
NK: Not Known

Source: Eisenhardt, 1991

3.7 Conclusion

Changes in the European supply-demand balance also contributed to the further change in the landscape, as European demand has been declining since 2008 due to the economic crisis, which has led to the renegotiation of several long-term contracts (reduction of Take-or-Pay clause levels, changes in their pricing schemes were agreed: the Netherlands and Norway now price their exports largely on the basis of hub-indexed pricing, while Russia has occasionally introduced a partial pricing component based on prices at the sales nodes while it also proceeded with direct price reductions. Now, in Western Europe a significant percentage of sales is based on the prices of the nodes (overall for Europe it is estimated that it is 35% - 45% of the gas sold in 2012, with a large part of it coming from LNG imports).

Chapter 4. Research results

According to the respondents, with oil prices constantly changing, stocks being depleted rapidly, but also the need for gradual decoupling from oil, as well as for the diversification of energy sources, gas is called to play an important role in the future. as the dominant form of energy to be used in the coming years. Continued success in gas exploration on the planet undoubtedly shows that there are globally available natural gas reserves on the planet in large quantities.

Typically, one respondent states that "recent gas discoveries are being announced almost everywhere, affecting all continents, and the prospects for larger stockpiles look promising." Another respondent states that "policies at national, regional and global level give the stigma for where society is headed. "For example, in the modern world reality, environmental concerns or the question of energy policy are reasons for critical policies and consequently economic and social decisions." It goes on to say that such political decisions set a new framework for the direction of demand. Thus the shift to gas is indicated by the new needs of society.

Regarding the origin of natural gas, the respondents agree that natural gas comes as its name suggests from natural reserves below the earth's surface. It was characteristically stated: "it is possible to find it produced autonomously by nature, other times it comes to the surface together with crude oil. Natural gas is a natural fuel. By that we mean that it is produced from organic materials stored and buried under the earth's surface for many millions of years. " Together with oil they compose the natural fuels which are also known as "hydrocarbons" since the composition of both of the above fuels is a combination of hydrogen and carbon atoms.

With regard to the term transport offer, it refers to all the services offered for the transport of a good between two or more points. The supply in the short-term period remains stable, the size of the transferred project to be carried out is determined based on the given tonnage available in the market or will soon enter it and reduced by the already agreed freight contracts, which in this case is natural gas.

As for the sale and exploitation of gas, it is done either by oil companies that discover gas, or by the states, countries with underground gas sources, or banks and economic organizations, which finance gas exploitation programs. Liquefied natural gas companies are usually large public benefit organizations, capable of developing all the appropriate infrastructure to receive, exploit and distribute this good. Every gas exploitation and distribution program contains actions necessary so that this good reaches the final consumer. In particular, this chain includes the extraction of natural gas, its transport to liquefaction plants, loading either in the pipeline network or in liquefied natural gas transport vessels, its transport, the re-gasification of liquefied goods in its first form and finally its promotion to the final consumer. One of the respondents said: "before any attempt to extract gas, the research and development of a plan for the exploitation of a natural gas source precedes". Gas quality is another factor of economic viability.

Regarding its transportation, all the respondents agreed that the transportation of natural gas today takes place on a global scale, mainly in two ways. The first concerns the transport of natural gas by sea. This mode of transport is the most common. The use of the ship in all commercial activities, and therefore in the transport of natural gas, is today the most economical and competitive method, especially when it comes to the fulfillment of a large volume and distance of transport project. Also, the pipeline is a widespread way of transporting natural gas to the international market.

Regarding the sectors that need gas, the most dynamic sector to increase gas demand will continue to be the electricity sector. In most areas, gas demand for the electricity sector is expected to grow faster than aggregate gas demand. The most notable exceptions are North America, where the share of the electricity sector in total gas demand is falling slightly, indicating that the industrial and construction sectors are growing faster than the electricity generation sector.

Regarding the growth incentives and developments of the international LNG market, the respondents agreed that the reduction of the volume of natural gas, by its liquefaction, allows its transfer on economically competitive terms in relation to the pipelines. Especially for long-distance transport (over 3,000 miles), LNG ships are generally a cost-effective option. In addition, LNG allows the development of trade between regions that would otherwise be technically or politically impossible to connect. The more specific reasons that favored the development of the international LNG market include the shift to natural gas for electricity generation due to its environmental and economic advantages. He characteristically stated "in its transfer as LNG, a reduction of costs was achieved in all stages of its supply chain with various technological improvements".

In addition, contract terms have begun to become more flexible in the face of the need for greater flexibility to meet growing demand. Gradually a part of the market started to move competitively and promise opportunities for increased profits. LNG also serves the countries' demand for security in their energy supply through the diversification of their energy sources (Corbeau,2016). In its early stages, the LNG trade consisted of ships that sailed on specific voyages and were bound by multi-year contracts. Although a portion of the LNG trade is still conducted on "inflexible" terms, a flexible market has been created and is constantly growing and now accounts for about 10% of total trade. It is now possible to change the destination of the cargo depending on market conditions and prevailing prices. Gas prices are traditionally linked to those of oil, increasingly linked to LNG price indices and this is particularly important given current oil price levels.

In terms of prospects for the LNG market, long-term supplier-buyer contracts will continue to dominate the LNG market, but will become more flexible, allowing cargo handling in an expanding short-term market. Although its conservative - inelastic and vertical structures will not be eliminated in the coming years, the market will open up to a certain range of new investors. In the traditional market model, the main players in LNG shipping were large vertically integrated energy companies and state-owned companies. With cost savings and market flexibility needed to meet growing demand and new international energy conditions, this closed "club" has opened up to independent shipowners and other investors(Kovacevic,2017).

LNG trade is now growing rapidly in the Atlantic market, which will surpass that of the Pacific. Russia and Norway intend to exploit large deposits in the Arctic. Russia, with the development of its deposits in Siberia, is expected to play a role comparable to that of Saudi Arabia in the oil market. The Middle East (mainly Qatar) will also strengthen its role as an LNG exporter to both markets. After all, the energy supply of China and India is creating new prospects. Security of supply Through the expansion and diversification of resources will determine the energy strategy of countries in the future.

Concluding the interviews, the respondents stated that the phenomenon of oversupply of liquefied natural gas in the world market is expected to continue until the middle of the year, when it will be limited due to increased demand from Southeast Asia and India. In particular, LNG prices are at an all-time low due to lower demand from the Asian region, as a result of the warmer-than-usual winters in these regions. The trade war that has broken out with the USA also played a role in the reduced demand, negatively affecting the growth rates of the economy. As one respondent characteristically stated, "at the moment, there is a kind of oversupply. "This situation is evolving and may continue until mid-year; but economic growth in the Asia-Pacific region, and especially in China, India and Southeast Asia, is evolving, which means that new energy needs are being created." . Finally, all respondents referred to the concerns about the impact that Koronaios may have, where it is still difficult to assess to what extent and to what extent it will affect.

Conclusions

From all the work it is concluded that the global gas market is in a phase of transformation changing in turn the energy map. Currently fragmented by region and mode of transport (via pipelines or liquefaction) the gas market will gradually become unified globally. The main connecting link between the three major regional markets in North America, Europe and Asia will be liquefied natural gas (LNG), which is transported by special tankers. The exploitation of gas has shown tremendous growth over the last decade, but the way it is priced remains almost entirely dependent on the oil market.

These are some of the main conclusions of a special report of the International Energy Agency (IEA) - this is the "anti-OPEC", the association of energy consuming countries - in cooperation with the Organization for Economic Co-operation and Development (OECD). Gas accounts for 21% of global energy supply with somewhat higher rates in the relatively more mature markets of North America and Europe.

According to the IEA report, rapid growth in the first half of the 2000s is expected to slow in the second half, but again global gas demand will increase by 2.8 trillion. cubic meters in 2005 at 3.2 trillion. cubic meters in 2010. The main driver of demand for OECD countries is electricity generation, while in the Middle East, China and India other sectors are also pushing demand. In fact, despite the current high gas prices, the vast majority of new power plants planned will consume natural gas.

If prices remain at these high levels, investment in gas-fired power plants will start to slow down from 2010. The countries of the Middle East and the former Soviet Union have 41% and 32% of the world's gas, respectively. , while all OECD countries only 9%. The total production of the OECD countries will remain unchanged in the period under review, as Norway and Australia will increase their production, while Britain and other countries will gradually decrease it. Gas pipelines will remain the main mode of transport, but the importance of LNG will increase.

Although liquefied natural gas (LNG) accounts for only 7% of world gas consumption, 40% of supply growth during the period 2005-2010 will be through LNG. In 2010 the degree of dependence of the three main gas consumption regions on non-OECD countries will vary from less than 10% for North America to 48% for Europe and 63% for Asia-Pacific. A particular problem, as the IEA report points out, is that the creation of strategic gas reserves to deal with emergencies has higher costs and difficulties than oil storage. Therefore, it must be combined with other options, such as the ability to change fuel.

References

Athanasiou, L. (2000). *Research Methods and Techniques in Educational Sciences,* Ioannina

Basias, N., &Pollalis, Y. (2018). Quantitative and qualitative research in business & technology: Justifying a suitable research methodology. *Review of Integrative Business and Economics Research*, *7*, 91-105.

Bridge, G., & Bradshaw, M. (2017).Making a global gas market: territoriality and production networks in liquefied natural gas.*Economic Geography, 93*(3), 215-240.

Cavaye, A.L.M. (1996). Case study research: a multi-faceted research approach for IS. *Information systems journal 6*(3): 227-242.

Clardy, A. *(*1997). *Studying your workforce*: *Applied researchmethods and tools for the training and development practitioner*. Thousand Oaks, CA: Sage Publications

Corbeau, A.-S. (2016). LNG *Markets in Transition: The Great Reconfiguration.*Oxford University Press. pp. 380–381.

Creswell, J. (2016). *Research in education.Design, conduct and evaluation of quantitative and qualitative research* (translated by Nancy Kouvarakou). Athens: Ion

Dooley, L. M. (2002). Case study research and theory building.*Advances in Developing Human Resources*, *4*(3), 335-354

EEA (2013), *Overview of Electricity Production and Use in Europe*

Eisenhardt, K. M. (1991). Better stories and better constructs: The case for rigor and comparative logic. *Academy of Management Review***,** *16*: 620–627.

Energy Charter Secretariat. (2007). *Putting a Price on Energy*. Energy Charter Secretariat.

Eurogas (2014), *Statistical Report*

European Gas Advocacy Forum, (2011), *The Future Role of Natural Gas position paper*

Ghorbani, B., Mehrpooya, M., & Omid, E. (2020). Hybrid solar liquefied natural gas, post combustion carbon dioxide capture and liquefaction. *Energy Conversion and Management, 207*, 112512.

Glesne C. (2006). *Becoming qualitative researchers: An introduction* (3 rd ed.). Boston: Pearson/Allyn and Bacon.

Henderson J., MitrovaT.(2015), *Dynamics of Russia's Gas Export Strategy*, Oxford Institute of Energy Studies

Herling, R. W. , Weinberger, L., & Harris, L. (2000). *Case study* research: *Defined for application in the field of HRD*. St. Paul: University of Minnesota

Herold A., (2003), *Comparison of* CO_2 *emission factors*, ETC/ACC Technical Paper 2003/10

Honore A., (2014), *The Outlook for Natural Gas Demand in Europe*, Oxford Institute of Energy Studies

Hrastar, J.(2014). *Liquid Natural Gas in the United States: A History* (First ed.). Jefferson, North Carolina: McFarland & Company, Inc., Publishers

Hughes, P. (2011). "Europe's Evolving Gas Market: Future Direction and Implications for Asia" .*Pacific Energy Summit*.

IEA (2014), *Medium Term Gas Market Report*

IEA (2014), *World Energy Outlook*

Iosisfidis, Th. (2008) *Qualitative Research Methods in the Social Sciences*. Athens: Review

Isari, F., &Pourkos, M. (2015).*Qualitative research methodology*. Retrieved from: 15327_Isari-KOY.pdf (kallipos.gr)

Kovacevic, A. (2017), "Towards a Balkan gas hub: the interplay between pipeline gas, LNG and renewable energy in South East Europe", the Oxford Institute for Energy Studies, OIES PAPER: NG 115, https://www.oxfordenergy.org/wpcms/wpcontent/uploads/2017/02/Towards-a-Balkan-gas-hub-NG-115.pdf

Kumar, R. (2019). *Research methodology: A step-by-step guide for beginners*. Sage Publications Limited.

Lin, W., Zhang, N., &Gu, A. (2010). LNG (liquefied natural gas): a necessary part in China's future energy infrastructure. *Energy, 35*(11), pp.4383-4391.

Mohajan, H. K. (2018). Qualitative research methodology in social sciences and related subjects. *Journal of Economic Development, Environment and People, 7*(1), pp.23-48.

Mokhatab, S., Mak, J. Y., Valappil, J. V., & Wood, D. A. (2013).*Handbook of liquefied natural gas.* Gulf Professional Publishin

Noor, K. B. M. (2008). Case study: A strategic research methodology. *American journal of applied sciences, 5*(11), pp.1602-1604.

Papaefthymiou, G., Grave, K., & Dragoon, K. (2014). Flexibility options in electricity systems. *Project number: POWDE14426, Ecofys*.

Paraskevopoulou-Kollia, E. A. (2008). Qualitative research methodology in the social sciences and interviews.*Open Education: the magazine for Open and Distance Education and Educational Technology, 4* (1), 72-81.

Poling, J., Griffin, K., Bawks, B., Feld, L., Gaul, D., & Kendell, J. (2003). The global liquefied natural gas market: status and outlook. *Energy Information Administration*.

Silverman D. (2009). *Doing qualitative research*. London: Sage.

Stevens P. (2010), The History of Gas, *POLINARES working paper n. 5*

Ulvestad, Marte; Overland, Indra (2012). "Natural gas and CO2 price variation: Impact on the relative cost-efficiency of LNG and pipelines". International *Journal of Environmental Studies. 69* (3): 407–426.

Yin, R. K. (2002) *Case Study Research, Design and Methods,* 3rd ed. Newbury Park, Sage Publications