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European Natural Gas Markets and Globalization: Is the Hybrid-Pricing Model Here to Stay?

Student: Stefano Pignatelli del la Leonessa
Thesis Advisor: Prof. Rögnvaldur Hannesson

Master Thesis within the Major Profile in Energy, Natural Resources and the Environment

ABSTRACT

The European markets for natural gas are characterized by a dual pricing structure which reflects the continents very significant import dependence: the price of imports fluctuates following different dynamics than the price determined by the domestic markets' supply/demand balance. This thesis researches the reasons for this price duality and questions the sustainability and desirability of such a hybrid pricing structure in the future. The time frame varies between a short-term period (defined as roughly 3 years) to a long-term period (roughly 10 years).

To answer the research question, the distribution of reserves, consumption and production as well as their historical development have to be analyzed to determine the emergence of possible new trends as well as the market power of the main exporters. Considering security of supply, geopolitical dimensions are also taken into account, namely the EU's energy policy and import diversification strategy. Finally, the paper focuses on the emergence of domestic markets within the context defined previously, with a particular attention towards these markets' role in comparison to the bulk of the volumes imported under long-term sales arrangements.

The result of the above analyses is a framework for describing the evolution of the European markets within a globalizing context. Such framework allows discussing the potential development of EU natural gas hubs according to 7 variables as mutually exclusive and collectively exhaustive as possible given the vastness of the matter and the interconnection between the different elements at hand. It aims therefore at being used as a map to follow the evolution of the growth of gas hubs within the considerably uncertain environment they are evolving in. Such framework also highlights how the complete preponderance of one pricing mechanism (hub versus long-term contracts) is more likely to happen over the medium to long term rather than the short term.

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1. INTRODUCTION

Today's energy outlook is characterized by important challenges of a depth, importance and urgency that had not been witnessed in decades. First and foremost, the world still relies heavily on fossil fuels, whose usage entails well-known and ever more apparent undesirable effects on climate. Secondly, important technological advances are expanding the availability of energy sources to the market: oil and natural gas production is increasing rapidly due to technological innovations allowing the extraction of so-called "unconventional" reserves; technological advances are also reducing the reliance on subsidies and bringing closer to the market renewable energy sources such as solar and wind power, while clean coal technologies could potentially allow to reduce the ecological impact of one of the most polluting sources of energy. Thirdly, following the disaster of Fukushima in Japan in March 2011, the role of nuclear power is questioned; Germany, for example, decided in the immediate aftermath of the tragic event to reduce its nuclear capacity by 8 GW. Also, the energy industry is faced by the continuous challenge of liberalization and deregulation; in this respect, the global picture varies considerably: competition among suppliers and transmission unbundling has been achieved in North America and the UK, is developing in Europe (albeit at a slow pace) and at an embryonic stage in Asia (broadly speaking). Certainly, but this is not a novel element, the energy resources are also faced with a challenge in terms of unprecedented growth in population and economic activity, which makes the need for efficiency ever more pressing. Finally, globalization acts as a blending force multiplying and catalyzing the interactions between the previous elements.

Within this global picture, Europe, with its high import dependence, its climatic targets and its progress towards liberalization, represents a challenging arena. In particular, natural gas (as well as renewable energy) has grown significantly within Europe's primary energy consumption, at the expense of crude oil & petroleum products, solid fuels (such as coal), and nuclear energy. Natural gas is also the cleanest among fossil fuels. It is conveyed to the end users via an elaborate mix of transport infrastructure, which range from transnational pipelines to LNG cargoes and regasification terminals. Roughly two thirds of Europe's natural gas consumption is imported, while one third is produced domestically. The gas businesses in the EU are structured in a portfolio of long-term contracts and wholesale trading points, commonly referred to as trading hubs, to price the gas and to optimize the different risk exposures. Such structure is commonly referred to as hybrid pricing model.

While natural gas is increasing in importance within Europe's energy mix, the domestic reserves become increasingly depleted; as a consequence, European natural consumption has to look for renewed sourcing abroad. Europe therefore becomes, by its size and internal dynamics, a central player in the globalization process of the natural gas market. Within such evolving picture, the European Union considers the creation of an efficient and flexible internal market the main response to the challenges and uncertainties to which such globalization process is exposing the Union's energy mix, most importantly global warming and security of supply.

1.1. Problem Statement and Research Question

The aim of this paper is to offer an understanding of the dynamics affecting the supply and demand sides of the natural gas market, with a particular focus on Europe. In particular, the thesis investigates the delicate balance of risks that had been regulated via the establishment of long term supply contracts between the European countries and their main gas exporters. These import contracts guarantee security of supply to purchasers while balancing price risk with volume risk: the seller is exposed to price risk as such price is indexed to a commodity, usually oil, outside of his control; also, the seller is not exposed to volume risk since long-term import contracts have take or pay clauses, which stipulate that a certain minimum amount of gas deliveries will have to be withdrawn and, even if not withdrawn, paid for. As the European natural gas market faces globalization and its important dynamics, an increasing need for flexibility and adaptability to evolving supply and demand conditions arises. Such need is in contrast with the rigid conditions stipulated in long-term contractual import agreements. Hence, the main research question of this thesis concerns the consequences of liberalizing EU's gas markets, both in terms of security of supply and pricing.

The problem statement of this thesis can therefore be summarized as follows:

Is there a trade-off for Europe between natural gas market liberalization and security of supply? Ultimately, are long-term import contracts undesirable, and is the actual hybrid pricing model destined to disappear?

Another way of phrasing such problem statement would be to ask whether the gas market liberalization implies a weakening of Europe's position within the international competition for the resource; in other words, one could ask whether gas liberalization is likely to force

Europe to "pay more" for security of supply. In fact, as discussed above, an important underlying trend of such market is the profound influence of globalization (i.e. free flows of capital and people balancing differences and a generating a convergence in GDP levels across countries). From this descend other important considerations, such as an evaluation of the benefits of deregulation, liberalization and economic efficiency, as well as an assessment of the possible role of natural gas as a solution to combat climate change. Such force, as for many other industries, appears to be a determining factor that will dominate the natural gas industry's future development and characteristics. This could manifest itself mainly in the following forms:

- Friction with the historical development of the market, including its geopolitical aspects
- Supply-demand side interacting on a much vaster scale
- Volatility of natural gas prices

The frictions and interactions between two fundamental drivers are therefore the object of this thesis: increasing volatility deriving from the globalization of the industry, and the coexistence of two price levels, namely, the hub level as well as the long-term contract import price level.

Additional questions can be useful to understand the line of reasoning followed by this thesis:

1. How is natural gas positioned within the world energy balance? In particular, how are demand and supply centers distributed across the world and how is trade organized to balance such market?
2. What is the distribution of the natural gas reserves across the world and what are the geopolitical implications of such distribution?
3. What are the new trends affecting discoveries and supply?
4. How is Europe endowed in reserves and what is the evolution of its consumption/production patterns? In particular, how is Europe's natural gas supply evolving in terms of sourcing? How will Europe's import dependency evolve?
5. How is Europe's sourcing of natural gas structured both internally (domestic market) and externally (import conditions)? What are the main characteristics of these two levels of supply and how are they evolving?

6. Finally, summing up all of the above: is the European gas market in a transition phase, or will two supply levels (i.e. the import market and the domestic market) coexist on the medium to long term?

In the energy sector, as in most sectors in an economy, there are large differences in productivity across businesses. Furthermore, the process of productivity growth demands continuous resource reallocation (trial and error and adaptation to changes in the economic environment). However, by its nature such reallocation process across firms is costly (adjustment frictions, unemployment). Globalization, i.e. the opening up of markets and the reduction of trade barriers, is one of the main factors inducing reallocation. Even though, on the medium to long term, such process should allow for specialization in the sectors comparatively advantageous, the transition period can involve substantial dislocation of businesses and workers. Such considerations allow to highlight that many components need to be in place for economies to successfully grow while opening and liberalizing markets: labor markets need to be sufficiently flexible to permit the reallocation of workers while providing them with safety nets and assistance in such process; infrastructure needs to be of sufficient quality to avoid transportation and communication challenges; markets need to be sufficiently competitive to ensure that company growth is related to efficiency gains rather than market power; regulation has to provide oversight without imposing onerous costs; financial markets have to be able to manage the risk of contraction and exit. As long as such conditions are not in pace, open up market too fast can provide significant costs to an economy.

The aim of this paper is therefore to analyse the interplay within the European natural gas industry of two apparently opposing forces: globalization, as a force towards competition, innovation and productivity, as opposed to security of supply, as a vector of stability achieved via long-term investments and contractual commitments. Globalization appears to be the underlying fundamental phenomenon catalyzing a process of creative destruction replacing large incumbent companies within the energy sector with new entrants who will justify their market share by a higher rate of productivity. However, the above considerations clearly illustrate the importance, particularly at a time of deep recession, of a gradual opening process. Furthermore, such considerations do not take into account security of supply and import dependency considerations, which are likely to further recommend caution.

1.2. Methodology

This thesis collects empirical as well as theoretical literature on the evolution of the natural gas market globally, with a particular focus on Europe. Such topic is very vast, including matters such as the distribution of all natural resources across the globe, new technological discoveries expanding the production frontier, and different pricing mechanisms and contractual structures used to negotiate the delivery of natural gas to end-users and final consumers. To analyze the former set the data provided from the British Petroleum has been heavily relied upon, in that it allows to segment the information in a way that is convenient to the questions addressed by this research, and in particular to isolate the European Union and its main sources of supply (present and potentially future). Also, the US Energy Information Administration has been a very relevant source of information. To discuss the second set of arguments, i.e. aspects concerning contractual structures and pricing mechanisms (both on pipeline and LNG trade), this thesis has relied mostly on papers and research from the Oxford Institute of Energy Studies as well as official organizations such as the International Gas Union.

Also, key aspects of this issue, in that they affect the possible future demand/supply scenarios, are the geopolitical relevance of different areas (first and foremost the Middle East, followed by Russia) as well as the liberalization and pro-competition forces within the European Union. In particular, to set the framework for the latter point, official press releases from the EU Commission and the European Parliament have been used, as well as policy journals such as the European Energy Review.

A vital part of this subject is finally the "live" evolution of matters such as, for example, new unconventional gas discoveries, the building of new infrastructure (pipelines, LNG terminals) resulting in a greater supply diversification and therefore competition between exporters, the evolution of disputes between exporters and importers, and the rulings of the European Union concerning antitrust measures against exporters or domestic incumbent importers. To this extent, professional journals and newsfeed have been used such as Reuters, Platts, Russia Today, The Economist and Forbes.

1.3. The Structure of the Paper

In order to tackle the research question, the paper has been organized around three main sections. The first sections deals with the place and role of natural gas within the world's

energy balance, with a particular emphasis on the relevant factors for Europe (both economically and geopolitically). It firstly gives an idea of the increasing role of natural gas within the world's primary energy supply as well as of the main players in the natural gas market; it then details the consumption and production centers to highlight the global imbalances and Europe's import dependency. To such purpose, data from the British Petroleum 2011 Statistical Review of World Energy has been re-elaborated and grouped according to the relevant strategic dimensions in focus. A comparative picture of gas versus oil is also described, with the goal of introducing topics such as the potential creation of a gas OPEC and the dual pricing (oil-indexation versus hub-indexation) that will be discussed in the later sections. The consumption, production, and reserves distribution analysis also highlights the main global competition for supplies between Asia and Europe, with Asia promising tremendous growth and subjecting Europe to the risk of shortages. Finally, a specific focus is developed around two main issues which are likely to affect heavily the development and global interactions of natural gas supply and demand and which will then be used for the development of future scenarios: new unconventional gas resources and the growth of the LNG market. Unconventional gas is described both in terms of its (relatively) recent exploitation in the United States as well as its worldwide potential. The growth of the LNG market is detailed particularly in relation to its supply diversification potential, its arbitrage capability across the main price areas, and the development of a spot LNG market (as opposed to the dominant long-term contractual form).

The second section transitions towards the gas market liberalization in Europe and the development of hub-pricing by presenting the geopolitical environment for natural gas. It starts with discussing the potential for a gas OPEC, particularly as a threat to EU gas liberalizations. Indeed, as the EU diversifies its supply mix and seeks lower prices via competition, it might submit itself to the risk of an oligopolistic response from a cartel of gas producers. The EU's diversification is then illustrated, with a particular attention to the routes via Ukraine and Byelorussia and Russia's key role when taking into account the increasing competition from Asia. To start crossing the dimensions so far illustrated, four scenarios are developed for the future of the supply/demand balance of natural gas, based on the progress of liberalization and unconventional gas exploitation. Such scenarios create a framework within which natural gas' specific dynamics (liberalization and resource growth) can be studied in relation to the geopolitical context in which such resource evolves, which are of outmost importance in determining the success or failure of a gas market globalization. Finally, this

section concludes by illustrating the development of the gas market in Europe from a historical perspective, with the objective of illustrating how security of supply issues as well as very large investments led to the establishment of long-term supply contracts based on oil-indexation. The following questions transition to the last section: in a globalizing natural gas market, are long-term import contracts still desirable? Does oil-indexation make any sense for a growing resource such as gas?

The third and last section presents the liberalization process within Europe and the hybrid pricing model it has led to, with the goal of discussing whether such pricing model is desirable and sustainable. It starts by describing the motivations and the evolution of the liberalization process, guided by a strong political will from the European Union. The focus is mainly on transmission unbundling as well as on the EU's 10 priority projects aiming at supply diversification. To discuss oil versus hub indexation, the relative role of oil and gas in Europe's primary energy mix are discussed. A global perspective is then again taken to discuss how all the trends discussed above have led to diverging prices globally and to question whether a complete exposure to such variability is desirable or necessary for Europe. In particular, Europe's *gas glut* is described. Then follows a discussion on European hubs, particularly concerning their liquidity and their role: do hub prices really reflect directly Europe's supply/demand balance of natural gas, or are they closer to a balancing market of residual volumes? A key question here is whether long-term contracts and hub prices are mutually exclusive or whether in fact such combination provides greater value to Europe, providing volume flexibility, a price signal indicating over/undersupply (as a basis for renegotiations) while at the same time securing supply. Finally, the reorganization and restructuring of Europe's gas business, as a consequence of competition and liberalization, is presented.

2. NATURAL GAS WITHIN THE WORLD ENERGY BALANCE

Natural gas has acquired over the past years a new and central role in the world economy. An important factor contributing to this success has been natural gas' lower environmental impact. As a fuel, natural gas is cleaner than its rival sources, as illustrated by the following chart:

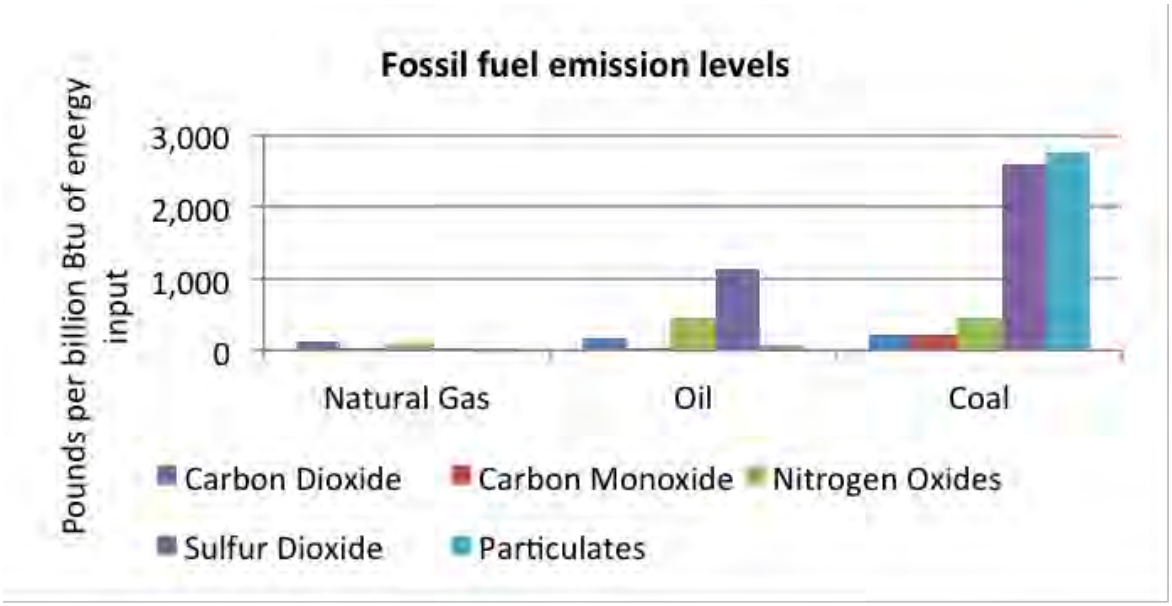

Figure 1: Fossil Fuel Emission Levels (Source: EIA, 1998)

In addition, natural gas' resource base is growing. The USA have been able to bring large volumes to the market, helping determine a new role for natural gas in the world's economy. This has been due to exploitation of unconventional natural gas sources (shale gas, tight gas, and coal bed methane). In the USA, the owner of a plot of land also owns the resources found underneath, as opposed to Europe, where such resources are owned by the State; furthermore, due to the country's relative geographical isolation, the USA have historically had a greater incentive to develop non-conventional energy sources.

Finally, global LNG movements, which today, according to BP, account for roughly 1/3 of all natural gas trade (which in turn accounts for 1/3 of global consumption), are set to play an increasing role in providing price and volume flexibility to markets worldwide, thereby acting as a catalyst to liberalization, supply and demand diversification, and the integration of the global natural gas market.

2.1. Consumption and Production

A. Building a Place for Natural Gas within the EU's Future Common Energy Policy

Natural gas is a versatile fossil fuel. It can be used for cooking, heating, producing electricity, transportation, and as an industrial feedstock. In the industrial sector, the main competitors to gas are coal or crude oil products, such as heavy fuel oil; in the domestic sector, the main competitor is electricity. As mentioned above, gas is the least polluting of other fossil fuels, coal and oil. However, if "clean coal" technologies, allowing on-site carbon sequestration, were to become cost-efficient, natural gas could face a formidable competition from coal.

Concerning natural gas' status within the EU, Percebois (2008) states that: "The place of natural gas is very different from one EU country to another, looking at the primary balance or at electricity generation. The disparities observed in the structures of energy balances are the product of history and the consequence of strong differences of opinion concerning the role of the nuclear sector. This is why there is no real common energy policy in Europe but a simple consensus on three priorities: competitiveness, security, and sustainability".

However, the EU is the world's biggest importer of oil and natural gas: it imports roughly 80% of its oil and 60% of its natural gas (Associated Press, 2007). It is therefore crucial for the EU to develop a clear common energy policy that will enable it to speak as one voice to third-party countries. For the time being, each country has the freedom to determine the composition of its energy mix; on a European scale, common energy policies are aimed at achieving the following goals: develop an economy less dependent on carbon (and therefore on fossil fuel imports), as well as create liberalized and interconnected energy markets.

B. Natural Gas in an International Perspective

On a more international perspective, as shown in the chart below, the United States, after a short decline, are now back in competition with Russia to be the world's leading gas producer (Canada, the world's third largest producer, has been inserted for scale in figure 2). As mentioned above, unconventional gas, particularly shale gas, has had a key role in this development: in 2010, US shale gas production reached 130 bcm (EIA, 2011), i.e. roughly 22% of total gas production, compared to 11 bcm in 2000. Another important difference

between these two gas giants is that the US consume all domestic production, whereas Russia exports roughly 1/3 of it:

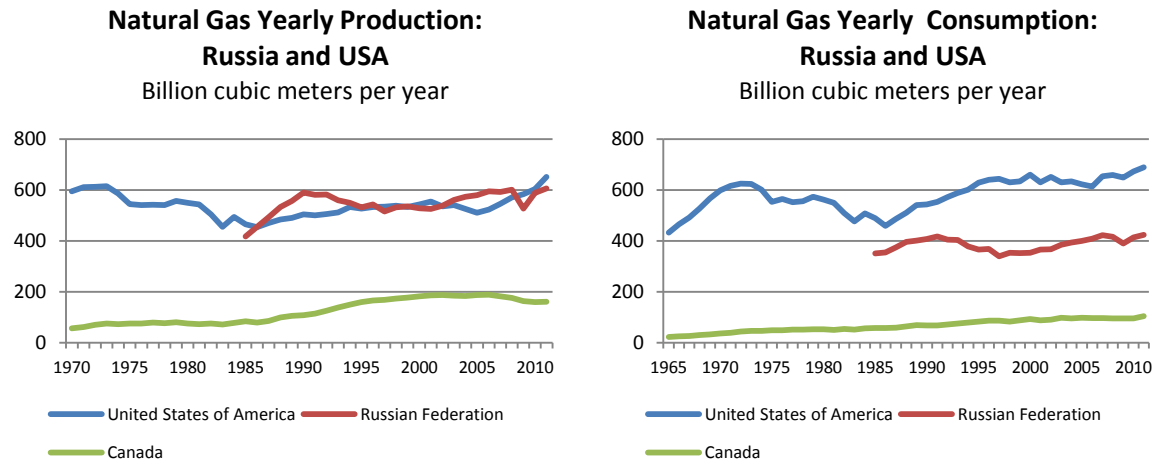

Figure 2: Natural Gas Yearly Production and Consumption (Source: BP Statistical Review of World Energy, June 2012)

Figures 3 and 4 chart the distribution of consumption and production of oil and natural gas around the world. The area split is suggested by the author and will be maintained along the paper. The following areas might require to be detailed in their composition as they do not necessarily correspond to standard geographical areas:

- Rest of Europe: Albania, Bosnia-Herzegovina, Croatia, Macedonia, Gibraltar, Serbia, Montenegro, Norway, Switzerland
- Eurasia: Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan, Azerbaijan, Armenia, Georgia, Turkey
- Former Soviet Union: Belarus, Latvia, Lithuania, Moldova, Russian Federation, Ukraine

Most of Eurasia is in reality a subset of the Former Soviet Union group; however, these countries have been split in a different category to reflect different geopolitical logics as well as a different supply/demand balance. In particular, the above split has been operated in the more generic category "Total Europe & Eurasia" offered by the BP Statistical Review to reflect the distinctions subject to different supply/demand balances as well as different legislative powers.

Looking at oil, it is immediately clear how the world can be divided into regions with a production surplus (Africa, the Middle East, and the Former Soviet Union) and regions with a production deficit (North America, EU 27, Asia). This clear distinction has been an obvious catalyst for the development of oil trade around the globe, as well as to the creation of a

producers' cartel, the OPEC. Such split is also valid when looking at natural gas, albeit in a somewhat more limited extent. Referring to natural gas, however, the EU 27's vulnerability in terms of security of supply is apparent. Asia comes second in this respect; its position is similar to the EU 27 regarding oil, but is somewhat limited in its dependence when looking at gas. The same applies, to a wider extent, to North America: still dependent on foreign oil, this area has become virtually self-sufficient when it comes to natural gas thanks to its development of non-conventional resources (this point will be developed below)

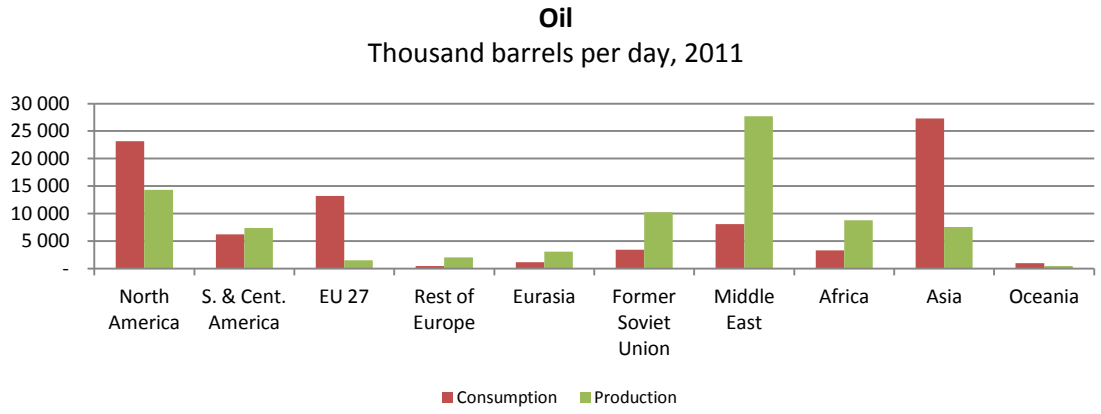

Figure 3: Oil Yearly Consumption and Production (Source: BP Statistical Review of World Energy, June 2012)

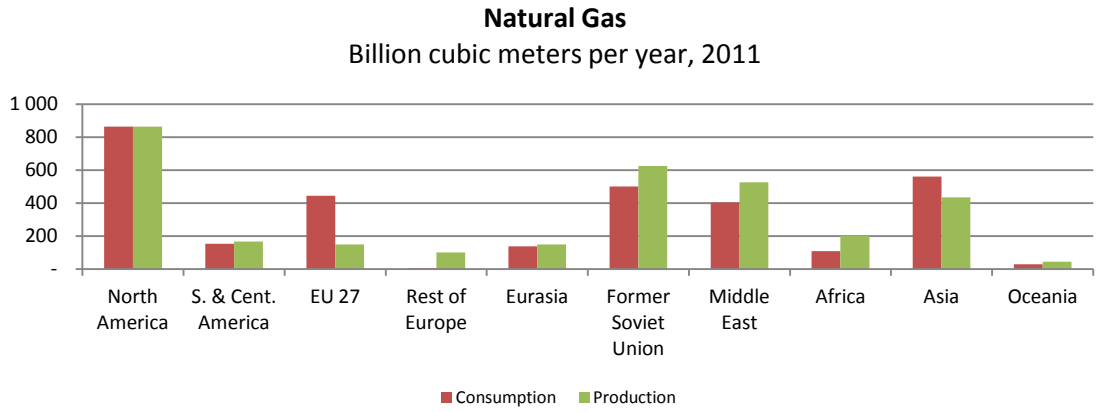

Figure 4: Natural Gas Yearly Consumption and Production (Source: BP Statistical Review of World Energy, June 2012)

Looking at the development of natural gas consumption and production over time, it is clear that both have been generally trending upwards following a twofold dynamic: the increase in global primary energy consumption, as well as the increasing role of natural gas in such mix. There is however a noticeable exception: the EU 27's production has been steadily decreasing since the year 2000, despite most of those years having been characterized by a growing GDP; this appears to be an indication that such production has peaked, exacerbating

the import dependency highlighted above. The Former Soviet Union's production has also suffered from a steep halt in 2008, but this appears to be mostly related to the sudden crisis that hit the EU. A pattern closer to the development of the GDP is visible when looking at consumption. Asia and the Middle East are increasing both consumption and production at a high pace, with consumption outpacing production in Asia and vice versa in the Middle East.

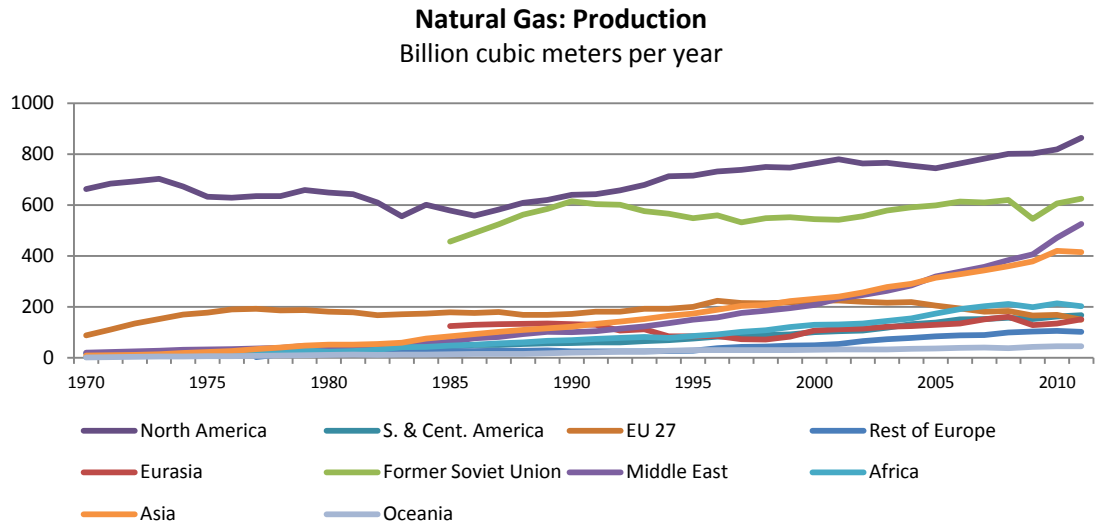

Figure 5: Historical Development of Natural Gas Production (Source: BP Statistical Review of World Energy, June 2012)

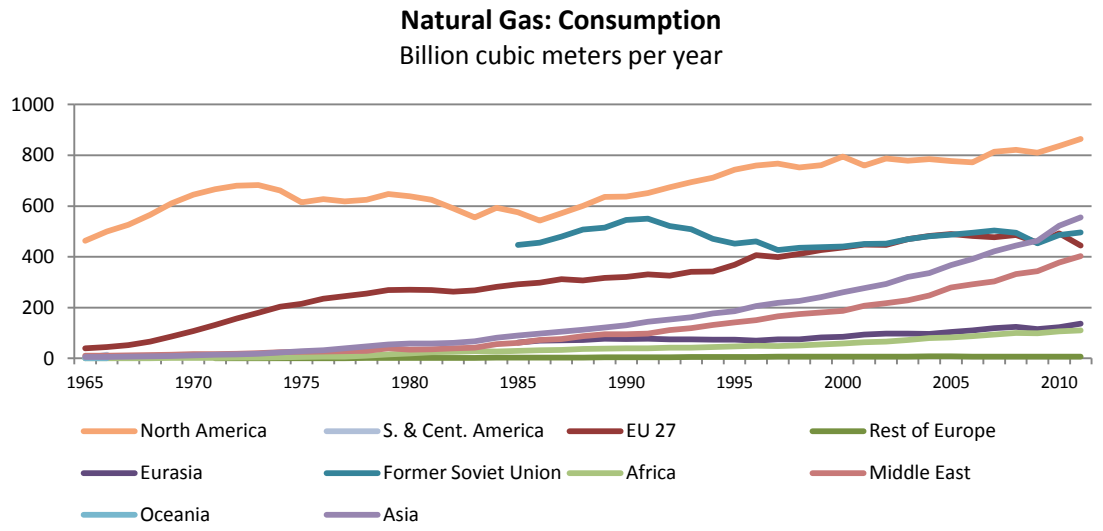

Figure 6: Historical Development of Natural Gas Consumption (Source: BP Statistical Review of World Energy, June 2012)

2.2. Reserves

The Middle East and Russia hold the largest reserves of conventional gas. On the contrary, available sources of unconventional gas are spread across the world, and can be found in countries that are currently net importers, such as the USA and China.

A. Conventional Gas

Conventional gas is extracted from well-defined reservoirs and can be developed using only vertical wells, with recovery of roughly 80% (of the original gas in the deposit). Such fields are commonly found in association with oil reservoirs, either mixed with the oil or floating on top. This is why, as shown in the charts below, the distribution of natural gas reserves generally follows that of oil. As can be seen, the EU 27 lacks both of oil and natural gas proven reserves. However, its neighbors are heavily endowed with natural gas: the Middle East, the Former Soviet Union and Eurasia are the three most resource-intensive regions of the world.

The fact that conventional oil fields are generally associated with oil reservoirs can act as a partial explanation to why the price of gas has been historically linked to oil: as gas was being extracted as a by-product of oil, it made sense to link its price to its main counterpart. Another major reason was the substitutability in use between oil and gas for their main purposes, e.g. heating and power generation.

Such geographical distribution also does little to alter the geopolitical equilibria which characterize today's world. As will be discussed further, however, shale gas has the potential to disrupt this structure.

Finally, in 2011, global natural gas consumption amounted to 3 223 bcm, while total proven reserves amounted to 210 000 bcm (R/P ratio discussed below).

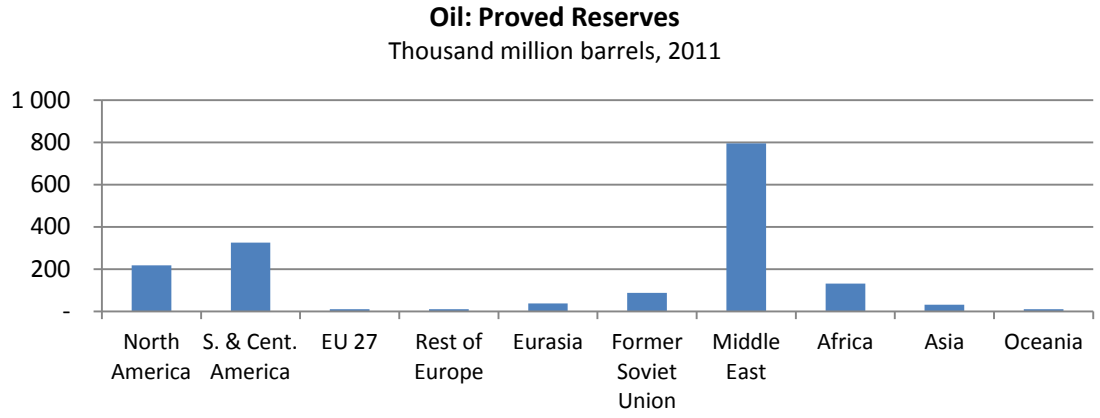

Figure 7: Oil Proved Reserves (Source: BP Statistical Review of World Energy, June 2012)

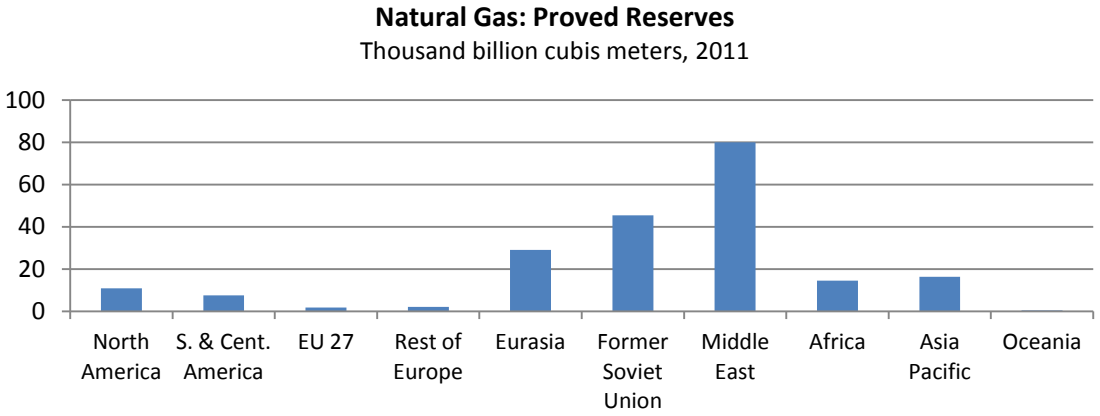

Figure 8: Natural Gas Proved Reserves (Source: BP Statistical Review of World Energy, June 2012)

B. Unconventional Gas

Unconventional resources are trapped in less permeable rock, where the resource may be distributed over a very large area. They usually require well-stimulation measures, but recovery rates are typically of the order of 15-30%. Unconventional deposits are more difficult and costly to exploit than conventional ones. They are mostly composed of shale gas (natural gas trapped in fine-grained sedimentary rock), tight gas (natural gas trapped in impermeable hard rock), and coal bed methane (natural gas trapped in coal strata).

However, unconventional gas exploitation has the potential to revolutionize the energy markets in the coming decades, by altering geopolitics and preventing the rise of new cartels, as well as accompanying the transition to renewable energy. Shale gas reserves, spread across the world, have the potential to diversify supply risk away from unstable regions (such as Iran). Such a supply side shock, once its impact will shift from local to global, will potentially

stabilize the economies of industrial countries. If such potential is exploited, however, the growth of the LNG market might reduce its pace, as the reliance on foreign supplies will be reduced.

The success of the United States and the potential for further shale gas development has initiated an evaluation by most countries of their possible natural gas resources. However, whether the USA's success in shale gas can be reproduced elsewhere is still under debate. Outside the United States and Canada, it is unlikely that commercial production will be achieved before the end of the decade. Michael Ratner, analyst in energy policy, writes in a Congressional Research Service report for the US Congress on December 22nd, 2010: "Most countries looking at shale gas do not have the data, technology, or equipment required to evaluate their shale gas resources, let alone successfully exploit it, at this point" (Ratner, 2010). As noted by The Economist (2011), in comparison to the USA, costs are higher in Europe: its shale deposits tend to be harder to extract as they are deeper underground, Europe does not have a history of drilling and a vast and competitive oil-services industry (and associated equipment and know-how), Europe's gas industry faces more regulations, and finally its pipeline network isn't as far-reaching and developed. Some European countries also oppose shale gas for environmental reasons, namely seismic fears and pollution concerns both of air and groundwater.

On the other hand, the potential, according to the EIA, is there. Initial assessments of 48 shale gas basins in 32 countries suggest that shale gas resources are also available in other regions of the world. Shale-gas resources are believed to extend into countries that currently depend heavily on natural gas imports, such as France, Poland, Germany, Turkey and Ukraine. Poland should have Europe's most favorable geology, and it might become a significant producer in a matter of years. This is fortunate, as shale-gas production would most likely make it easier to phase out Poland's subsidies to local coal production, while also reducing the country's dependence on Russia for gas.

According to the EIA's 2011 report, *World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States*, roughly 160 000 bcm of technically recoverable shale gas reserves are available outside the US, which, including US recoverable reserves, amounts to roughly 190 000 bcm of reserves. This is likely to add to the present 210 000 bcm of proven natural gas reserves available worldwide. Given today's total world consumption, this switches the Reserves to Production ratio (R/P) from 65 years to 124 years.

This is just to give an idea of the scale, as such ratio is subject to different dynamics which can alter its value over time (consumption grows with economic growth and production cannot physically stay at the same level as fields are depleted). In particular, there isn't yet a consensus on how quickly the rate of production from currently producing wells will slow in the future. Nevertheless, such estimates point out to a revolution in natural gas' geopolitical landscape, as shown in the chart below:

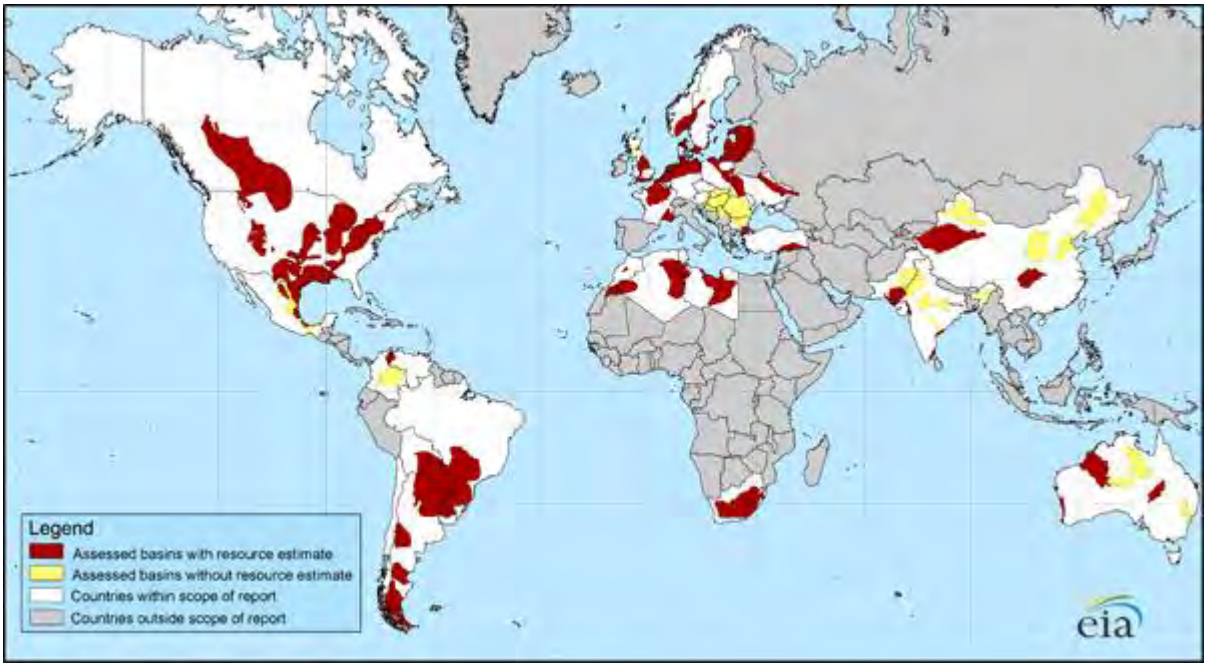

Figure 9: Shale Gas: Technically Recoverable Reserves (Source: US Energy Information Administration, 2011)

The results from the EIA's study are likely to be conservative, as they exclude areas such as Russia and the Middle East, do not consider all shale basins in the studied countries (yellow areas in the chart above) as well as the offshore resources.

Concerning Europe and its current deep economic depression, perhaps the most significant conclusion has been given by Daniel Gros, Director of the Center for European Policy Studies (2012): "In an environment of ultra-low interest rates, the economic cost of being late is low. The best option for Europe might be to wait and let the market operate. Fracking is not yet a mature technology, and thus it is very likely to improve over time. Maybe Europe will become a leader in "advanced fracking" when the shale-gas deposits in the US have already been exhausted."

2.2. Trade

A. Overview of Global Trade Movements

The table below is the result of the author's own extrapolation based on the data collected by the BP Statistical Review (2011). "Total imports" are defined as the sum of imports to countries within each area; "intra-regional trade" is trade which has taken place among countries within a given area; "net imports" represent therefore the total volumes that have effectively been imported (only) by each area.

	LNG			Pipeline			Total		
2011	Total Imports	Intra-Regional Trade	Net Imports	Total Imports	Intra-Regional Trade	Net Imports	Total Imports	Intra-Regional Trade	Net Imports
North America	17,35	-	17,35	128,77	128,77	-	146,12	128,77	17,35
S. & Cent. America	10,94	6,11	4,83	15,63	15,63	-	26,57	21,74	4,83
EU 27	84,44	0,49	83,95	327,16	176,74	150,42	411,60	177,23	234,37
Rest of Europe	-	-	-	5,93	3,47	2,46	5,93	3,47	2,46
Eurasia	6,23	-	6,23	45,11	36,06	9,05	51,34	36,06	15,28
Former Soviet Union	-	-	-	91,54	91,54	-	91,54	91,54	-
Middle East	4,60	2,50	2,11	31,59	19,20	12,39	36,19	21,70	14,50
Africa	-	-	-	5,66	5,66	-	5,66	5,66	-
Asia	207,26	70,99	136,28	36,91	22,66	14,25	244,17	93,65	150,53
Oceania	-	-	-	6,30	6,30	-	6,30	6,30	-
Total	330,83	80,08	250,74	694,61	506,03	188,57	1 025,43	586,12	439,32

Figure 10: Natural Gas Trade Movement (Source: Author's elaboration based on data from the BP Statistical Review of World Energy, June 2012)

Several interesting conclusions can be drawn:

- Global net imports account for roughly 15% of 2011 total world consumption.

- Intra-regional trade and international trade are roughly balanced.
- LNG plays a major role in connecting the areas, as LNG total net imports are more important than pipeline total net imports.
- On the other hand, pipeline gas has a major part in intra-regional trade.

As shown in the following chart, the EU 27 and Asia are by far the most import dependent areas; however, the EU 27 is much more dependent on its pipeline imports, whereas Asia relies mostly on its LNG supplies (clearly, such chart is much more relevant for these two areas, as they are the in deficit). LNG is of major relevance in Asian intra-regional trade, which is likely to lead to the creation of a relevant spot market, driven by the creation of a hub in Shanghai and Singapore (more below).

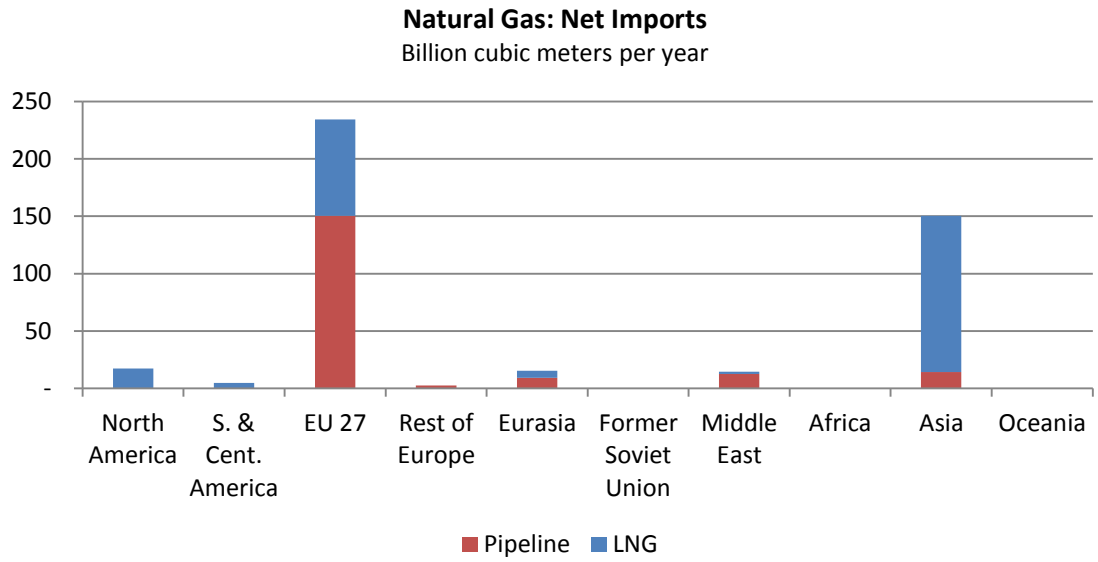

Figure 11: Natural Gas Net Imports (Source: BP Statistical Review of World Energy, June 2012)

Percebois (2008) provides interesting statistical information: "60 % of the gas consumed in the EU crosses at least one border, compared with 10 % for electricity". As clearly evinced by the chart above, supply disruptions are a major threat to Europe and is therefore a major preoccupation of the European Commission. The supply security is maintained via long-term supply contracts with the main gas exporting countries (Russia, Norway, and Algeria). Such contracts appeared in the 1960s as a means to reduce the uncertainty surrounding the investments in costly transnational pipelines (to import gas from the Netherlands, and later in the 1970s from Norway and Russia) or in liquefaction and re-gasification facilities to import Algerian gas. According to Percebois (2008): "Price fixing

was done on the basis of "net back", which came down to charging a price that was slightly lower to countries that were the furthest away from the export location; this was to compensate the additional costs associated with gas transmission. Such clause has disappeared has disappeared but the "take or pay" clauses, which force the importer to pay for the amount of gas according to the terms of the contract, regardless of whether or not the delivery was made, still exist". In parallel, the LNG market is developing globally allowing countries to diversify their sources of supply.

B. LNG Market Development

The technology for LNG first started being developed in the 1960s, quickly establishing itself, particularly in Asia, where Japan has always imported gas as LNG. Such technology allows "stranded gas", i.e. gas whose consumption destination is too far from its production well to be transported via pipelines. According to the International Gas Union's World LNG Report (2011), there are today 18 countries exporting and 27 countries importing liquid gas. Global trade increased from 3 bcm in 1970 to 331 bcm in 2011. Qatar is the world's largest exporter, followed by Indonesia, Malaysia and Algeria. It now accounts for a quarter of the world's LNG exports.

The IGU World LNG Report (2011) provides us with the following table listing the major LNG exporting and importing countries. Data in MT has been converted in bcm according to the following conversion: 1 MT = 1.31643 bcm (Interconnector, 2011).

Importer	bcm	Exporter	bcm
Japan	103,7	Qatar	99,4
Korea	47,1	Malaysia	32,9
United Kingdom	24,5	Indonesia	28,2
Spain	22,5	Australia	25,3
China	16,9	Nigeria	24,6
India	16,7	Trinidad	18,3
Taiwan	16,1	Algeria	16,6
France	14,1	Russia	13,8
Italy	8,4	Oman	10,4
United States	7,8	Brunei	9,0
Turkey	6,1	Yemen	8,8
Belgium	5,9	Egypt	8,4
Argentina	4,2	UAE	7,8
Mexico	3,8	Equatorial Guinea	5,3
Chile	3,7	Peru	5,0
Canada	3,2	Norway	3,8
Kuwait	3,2	US	0,4
Portugal	2,9	Libya	0,1
UAE	1,6		
Greece	1,3		
Dom. Rep.	1,0		
Thailand	1,0		
Brazil	0,9		
Netherlands	0,9		
Puerto Rico	0,7		
Total	**318,0**		**318,0**

Figure 12: Main LNG Importers and Exporters (Source: IGU World LNG Report 2011)

The Economist (2012) states that the costs of LNG projects have been increasing since the end of the 1990s, mainly due to two reasons: firstly, steel, of which LNG projects are intensive, has shot up in price; secondly, the most relevant growth in liquefaction capacity is expected from Australia, which is not a low-wage developing country. Finally, The Economist (2012) states that "liquefying the gas, carrying it to its destination and regasifying it can cost between $4 and $7 mBtu, a lot more than the $2.50 mBtu that the gas itself currently sells for in America".

However, global LNG trade has nevertheless been growing at a pace much higher than the one of the gas market as a whole. If we rely on the figure below provided from the IGU LNG Report (2011) as well as the figures from the BP Statistical Review (2011), we can see how the LNG market has grown from accounting for roughly 4% of global consumption in 1990 to roughly 10% in 2011.

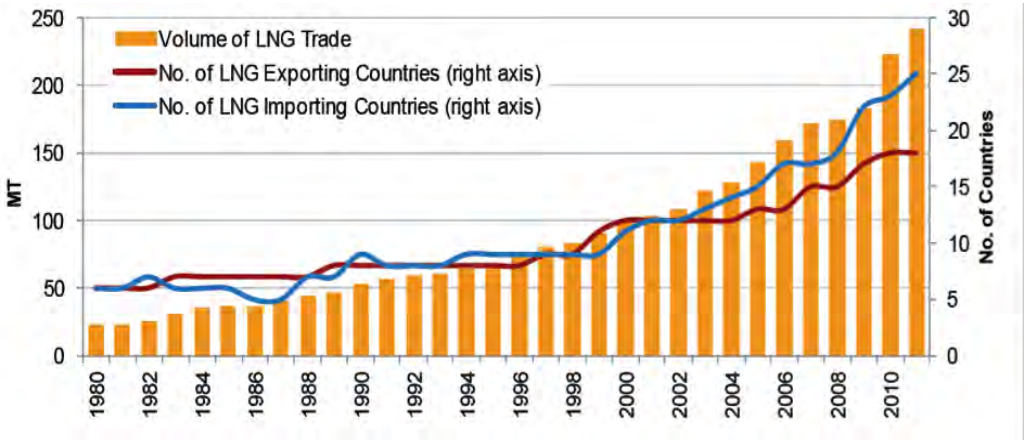

Figure 13: LNG Trade Volumes 1980-2011 (Source: Cedigaz, Waterborne LNG Reports, US Energy Information Agency (EIA), US Department of Energy (DOE), PEC Energy)

In the United States, Cheniere has managed to get an export license, allowing it to sell American gas to shippers such as BG Group or Union Fenosa, at Henry Hub (the US national market reference) prices plus a 15% mark-up. The destination of such gas is likely to be Asia, which will create an explicit link between the prices of the two markets. However, it remains to be seen how many exports, which will effectively increase prices for US consumers, will be allowed. Transportation costs are also an unknown variable. In particular, if the Panama Canal authorities decide on a special premium for LNG tankers routing from the Gulf of Mexico to Japan, China or South Korea, the US might end up being a minor exporter of gas.

Asia appears to be the main source of growth for the LNG market. On the long run, Canada might ship significant volumes of LNG from its west coast to Asia, as well as Africa and Russia. In particular, Gazprom, Total and Statoil, have been discussing a final investment decision on Shtokman, a big gas field in the Barents Sea. The main issue is marketing the gas: its original intention was to produce LNG for the US, but its output seems now more likely to be destined for Asia. China is quickly building LNG import terminals: it has four already operational, five under construction and twelve more planned. Shanghai and Singapore could become a regional hub for spot markets based on competition between LNG, pipeline gas and domestic production.

Although the LNG spot market is growing fast, in 2011 the industry delivered on spot only roughly 25% of total LNG traded volumes (see figure below from the IGU LNG 2011 Report). These in turn count for roughly 10% of global natural gas consumption in 2011, which means that in 2011 spot LNG cargoes account for roughly 3% of global consumption. However, some signs suggest that LNG markets are getting more flexible: Europe, looking to

diversify away from Gazprom's dominant position, is adding LNG import capacity. Asian buyers are also getting reluctant to sign 20-year oil-indexed contracts in current negotiations with Canadian suppliers.

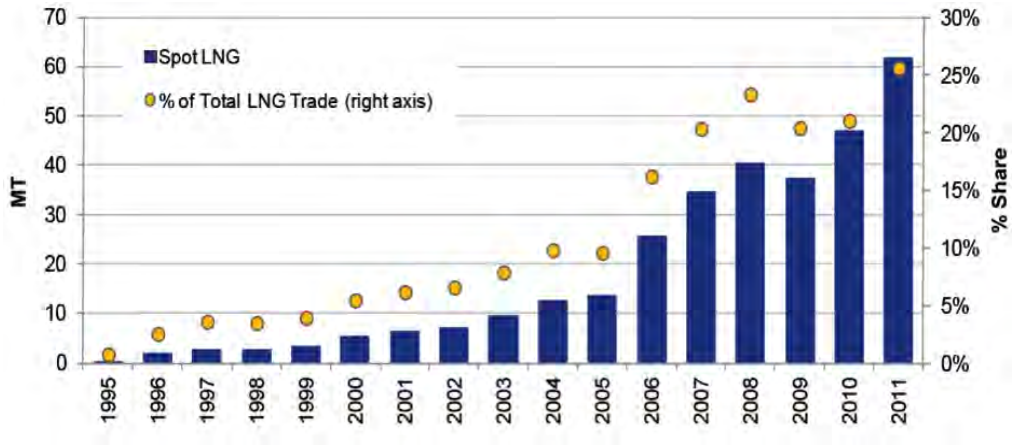

Figure 14: Volume of Spot LNG Trade and Share of Total LNG Trade 1995-2011 (Source: Cedigaz, Waterborne LNG Reports, US DOE, PFC Energy)

In the longer term, as shale gas becomes more widespread outside America, some countries will no longer need to import LNG. This, on one hand, might free more supplies for the spot market; however, if shale gas extraction expands rapidly, this could also deter the creation of a liquid global LNG market, as local supplies become more abundant.

Percebois (2008) states that: "Gas transmission is expensive; its cost is similar to that of electricity and much higher than that of oil". This can be linked to the following quote from The Economist (2012): "Oil […] used to be bought and sold largely in regional markets in the 1950s and 1960s, but the development of supertankers has since made it a global product. Paul Stevens of Chatham House points out that in the early 1950s transport accounted for a third of the cost of Persian Gulf oil shipped to America. Only 20 years later that share had dropped to a mere 5%. The industry had been convinced that the world would become ever thirstier for oil, so it made huge investments in refining capacity, infrastructure and tankers. […] A similarly dramatic change in the economics of shifting gas is much less likely. Pipelines remain costly to build, and a buyer has to be found and a price (generally linked to that of oil) agreed on before construction can start. Much of this applies to LNG too".

However, The Economist (2012) concludes that "in 20 years' time gas around the world will probably be sold under an array of contractual arrangements based on a single price, set by supply and demand. When deep, liquid markets with credible prices develop, supply is assured and long-term contracts become unnecessary. MIT's boffins believe that integrated

global markets would increase gas supplies, raise demand and bring down prices. It may be a long way off, but the foundations for such a market are starting to be built".

C. LNG Arbitrage

As discussed, pipeline natural gas has traditionally supplied adjacent markets. Such regional markets were characterized by their own supply-demand balances, gas price formation mechanisms and contractual structures. In parallel to pipeline supplies, LNG projects have developed; such projects are significantly capital-intensive, which led the project developers to cover their future LNG production with sales arrangements (thereby sharing the risk of such projects with the buyers of LNG). Even though long-term contracts remain central in the LNG industry, significant changes have started taking place recently, such as the elimination from some new contracts of the destination clause (which constrained the destination of the LNG exported volumes), as well as an increase in the number of uncommitted "spot" LNG cargos.

With the growth of an increasingly flexible LNG supply, regional markets, previously relatively isolated, become progressively more connected. As LNG producing and consuming countries grew and uncommitted LNG volumes appeared on the market, the liquidity of the LNG market has increased, as well as the arbitrage opportunities between markets. Such trend is a key development for the speed and magnitude of the interaction among the different regional gas markets.

As will be further developed below, gas prices in different markets have diverged historically to the point of creating opportunities for LNG arbitrage. However, such type of trading has not yet developed enough to create a price convergence between different markets towards a unique global price (both on short and long maturities). Ms. Polina Zhuravleva wrote an interesting paper in 2009 for the Oxford Institute for Energy Studies in which she details a framework of barriers and conditions for LNG arbitrage to be developed. Using online questionnaires, interviews as well as discussions at the Oxford Institute of Energy Studies, Ms. Zhuravleva developed in particular the following definition of LNG arbitrage: "LNG Arbitrage can be defined as a physical cargo diversion from one market to another, which offers a higher price. The diversion of the cargo can be regarded as arbitrage if the cargo was initially committed to the first market and to the initial buyer in a commercial contract". Therefore, an LNG arbitrage is a practice that allows contractually committed LNG to be diverted to another market (clearly, granted the mutual agreement of both the seller and

the buyer), allowing to benefit from market inefficiencies and regional supply/demand imbalances.

Therefore, re-routing of LNG cargoes can be considered an arbitrage only if such cargoes were contractually intended for another market. The gain resulting from the arbitrage will usually have to be shared between the seller and the initial buyer. There are several ways to perform an LNG arbitrage: based on the seller's initiative (i.e. the seller want to sell the cargo on another market to acquire the gain), based on the buyer's initiative (if, for example, the cargo can be replaced with cheaper purchases on the local market, or if the buyer does not need that cargo any longer), and based on the initiative of an independent trader (buying the cargo from an initial buyer and diverting to another customer. Hence, the participants of the deal can be: the seller, the initial buyer, the end buyer, and/or an independent intermediary.

Ms. Zhuravleva identified the following barriers to the growth of LNG arbitrage:

- An insufficient price differential between markets (the price spread has to be sufficient to cover the transaction costs).
- A very tight LNG market: a buyer won't agree to a cargo diversion if the market is very tight and it is very difficult to replace the diverted LNG cargo from the spot LNG market or the domestic gas market. In a tight LNG market, the security of supply dimension becomes much more relevant, hindering the possibilities for LNG market diversion.
- Small number of players in the LNG market.
- Missing global LNG trading and information platforms: trading platforms as well as global information media would facilitate the LNG arbitrages.
- Lack of price transparency: it is not frequent for LNG importers to publish the prices for LNG.
- Lack of experienced traders and specialists: in an environment in which information is lacking, experience and personal contacts make up for it.
- Contractual limitations: clauses such as the destination clause clearly hinder market arbitrage; as new liquefaction capacity comes online and demand growth rates soften, buyers will have an increased capacity to ask for more flexibility with the sales arrangements.

- Technical restrictions: arbitrage is complicated as LNG specifications and infrastructure is not standardized, thereby restricting the diversion of LNG cargoes.
- Regulatory and market restrictions: LNG ship authorizations and controls are frequently time consuming, thereby restricting LNG arbitrage.
- Potential lack of shipping and regasification capacity (this, however, does not seem to be the case in reality).
- Inefficient hedging instruments: due to the specific conditions of LNG trade, it is difficult to define a price/volume match between the actual deal in place and the (standardized) price/volume conditions of the hedge.

Such barriers can then be organized in the following framework (Zhuravleva, 2009), which illustrates the complexity before arriving at the realization of an actual LNG arbitrage. Of all the above, the first two appear to be the most likely to effectively hinder the development of a global LNG arbitrage market.

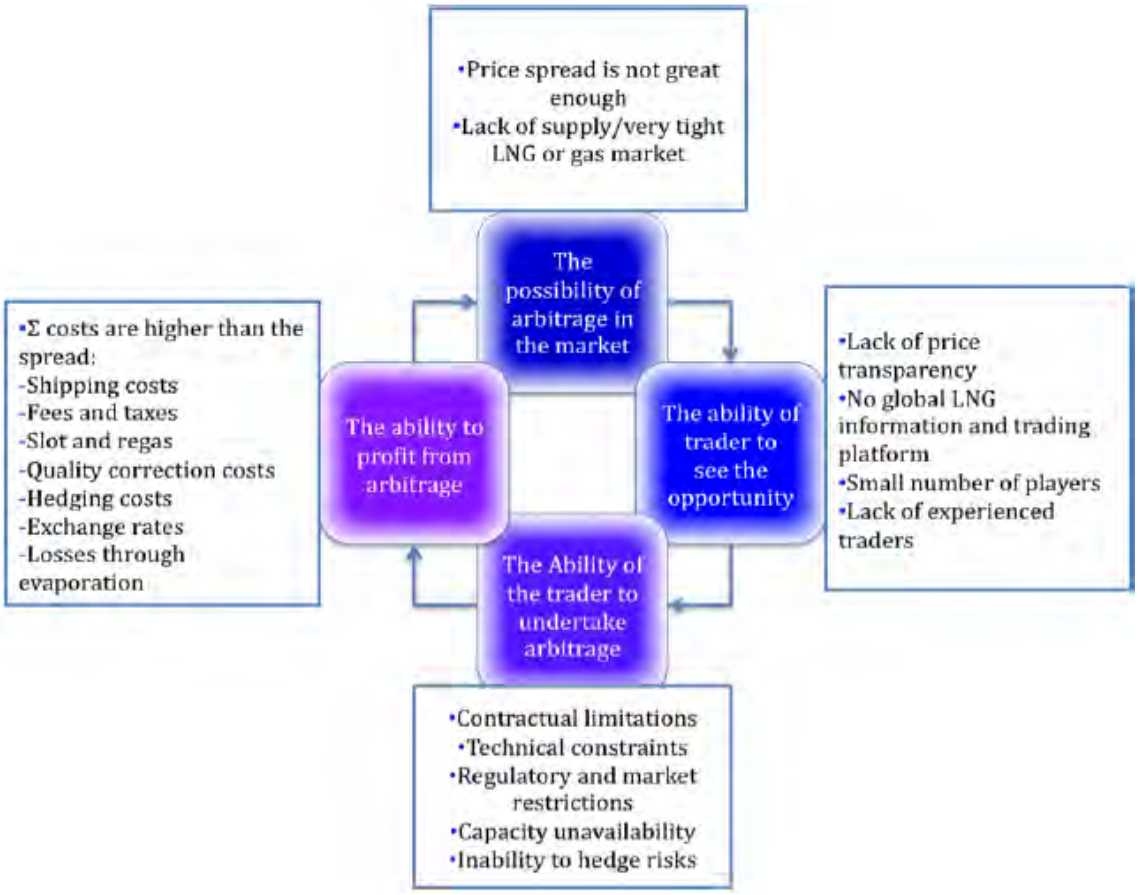

Figure 15: An Analysis of LNG Arbitrage (Source: Zhuravleva, 2009)

In short, LNG arbitrage between markets internationally appears to be, for the time being, limited due to a high number of inefficiencies within such process. Therefore, international natural gas prices might still diverge. Furthermore, and maybe more importantly, the LNG spot market, as discussed above, is still of limited relevance – it accounts for roughly 30% of the LNG market, which in turn accounts for roughly 30% of the total world imports. However, if we look only at the net imports (i.e. international trade among macro-regions, excluding intra-regional trade), LNG becomes much more relevant, as illustrated in table 1. Also, it can be argued that the LNG spot market could be used as a price signal for the re-negotiations of long-term arrangement, similarly to what has taken place for imports via pipeline (this point will be discussed below). Therefore, despite significant rigidities in the LNG market concerning both spot trading and arbitrage opportunities, it appears to be quite likely that the development of the spot market as well as of the arbitrage market will, over the next years, bring a greater convergence within global natural gas prices. It is important to distinguish between arbitrage and price convergence: the fundamental trend appears to be the development of uncommitted and flexible volumes on the spot market; as arbitrage opportunities become increasingly accessible (reduction of transaction costs, next to the purple box in the figure above), such convergence is likely to accelerate. A key aspect behind such developments is the maintenance of a long global system for gas.

3. GEOPOLITICAL CONSIDERATIONS AND THEIR IMPACT ON NATURAL GAS IN EUROPE

3.1. Market Power

A. Oil OPEC

Looking at oil, the "call on OPEC" is an expression which represents the possibility that OPEC will have to make up for a growing discrepancy between total oil consumption and non-OPEC production. This is illustrated graphically in the following chart by the red area. As the world's non-OPEC production appears to stagnate, the implication is that OPEC will be expected to supply an increasing share of the world's total oil demand. However, OPEC might not be interested in doing so, as its domestic consumption increases and as increasing prices might create an incentive to hold oil in the ground.

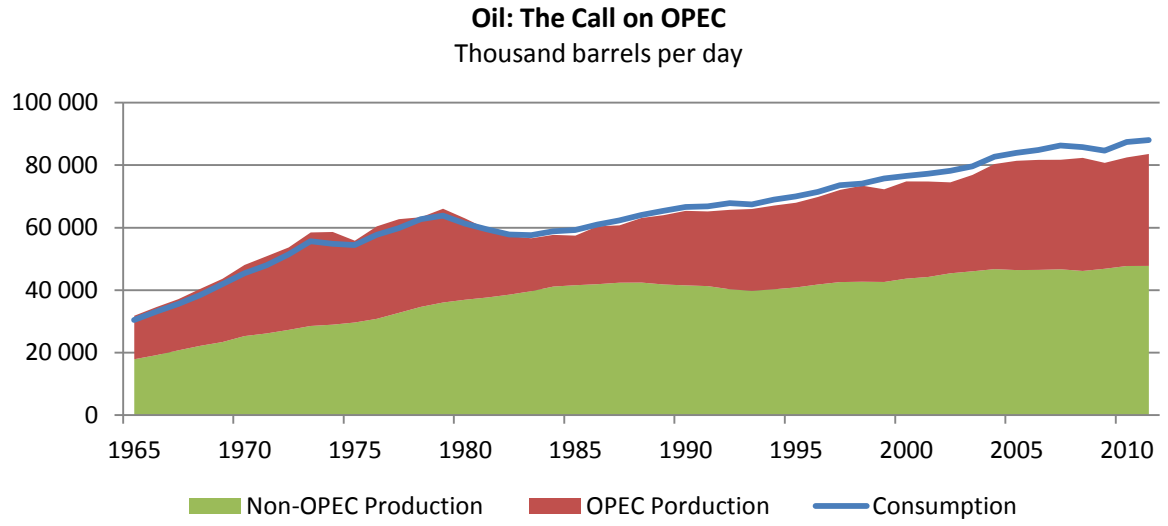

Figure 16: Oil the Call on OPEC (Source: BP Statistical Review of World Energy, June 2012)

B. Gas OPEC

The following chart illustrates a much more limited, albeit increasing, role for OPEC members in the natural gas world scenario.

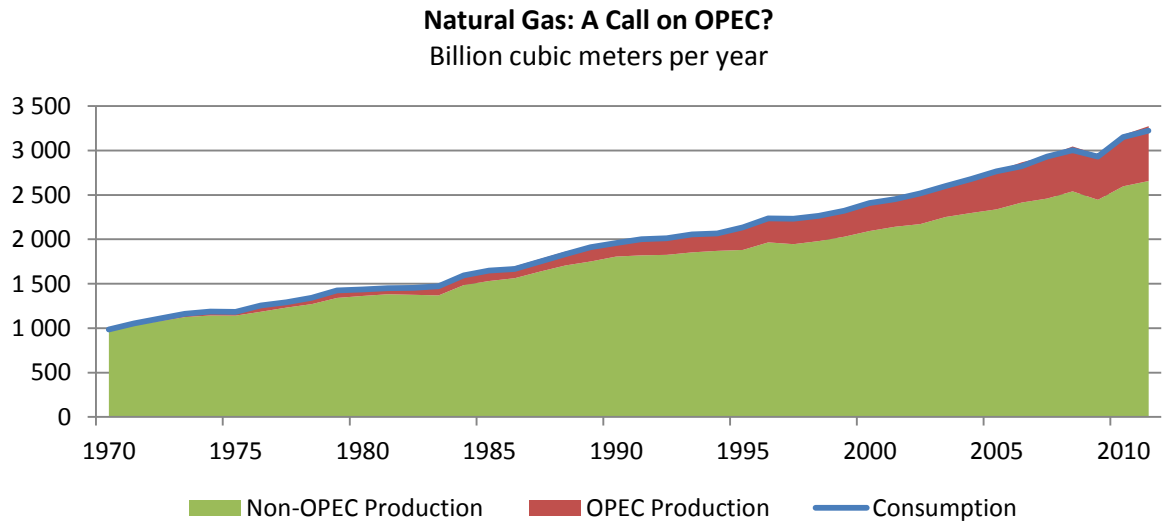

Figure 17: Natural Gas: A Call on OPEC? (Source: BP Statistical Review of World Energy, June 2012)

Furthermore, as the following charts show (and was already partially illustrated above), percentagewise, natural gas consumption and production are roughly balanced, except for the very import exception of the EU, China and Japan. However, if we look at the distribution of today's proven reserves, 60% are concentrated in the hands of the Middle East and the Former Soviet Union (such percentage would increase to 74% if the FSU were to include Eurasia). 45% of global proven reserves are concentrated in Africa and the Middle East. These considerations might illustrate a potentially ever growing role for OPEC countries in the world's natural gas supply. However, it should be noted that, reserves in Eurasia (Turkmenistan), Asia, and North America are growing rapidly.

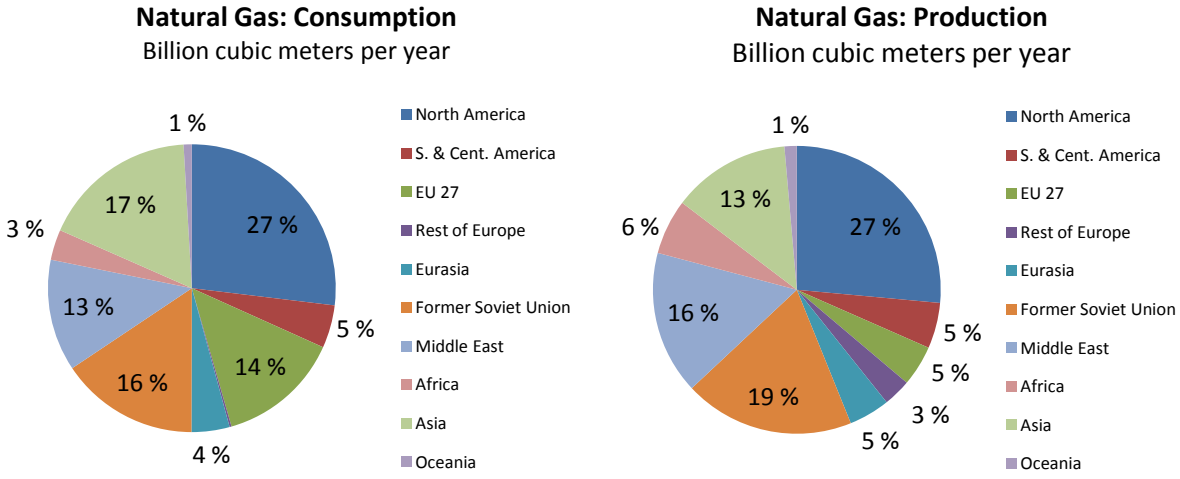

Figure 18: Natural Gas Consumption and Production Percentagewise (Source: BP Statistical Review of World Energy, June 2012

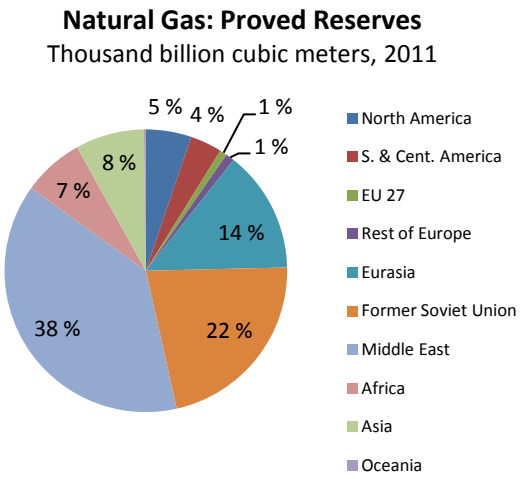

Figure 19: Natural Gas Proved Reserves Percentagewise (Source: BP Statistical Review of World Energy, June 2012)

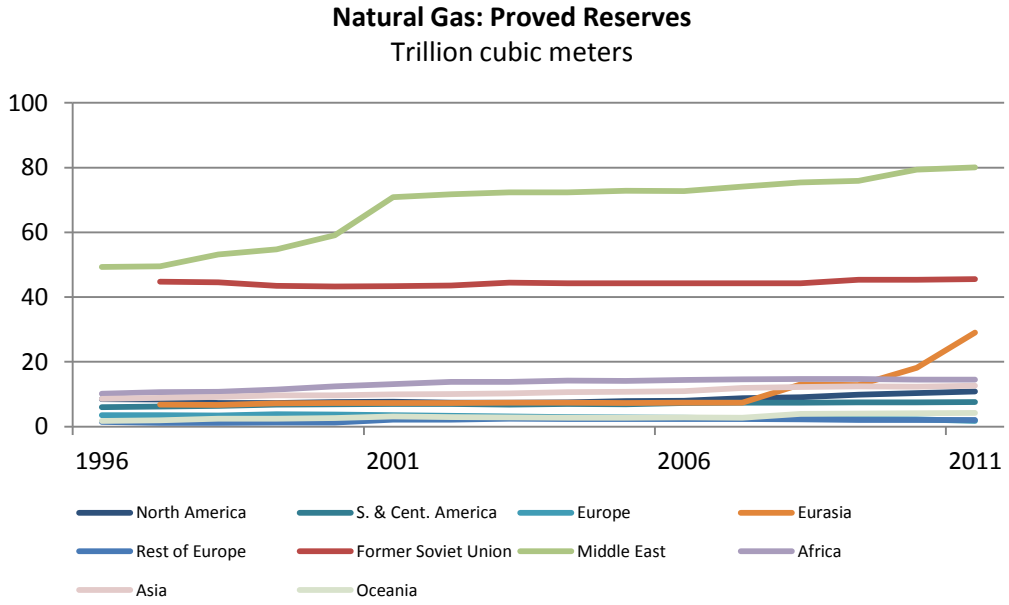

Figure 20: Historical Development of Natural Gas Proved Reserves (Source: BP Statistical Review of World Energy, June 2012)

On the other hand, if we chart a possible "call on OPEC" for natural gas, where the "gas OPEC" is defined as including OPEC as well as Russia (this will be explained in more detail below), we obtain the following result:

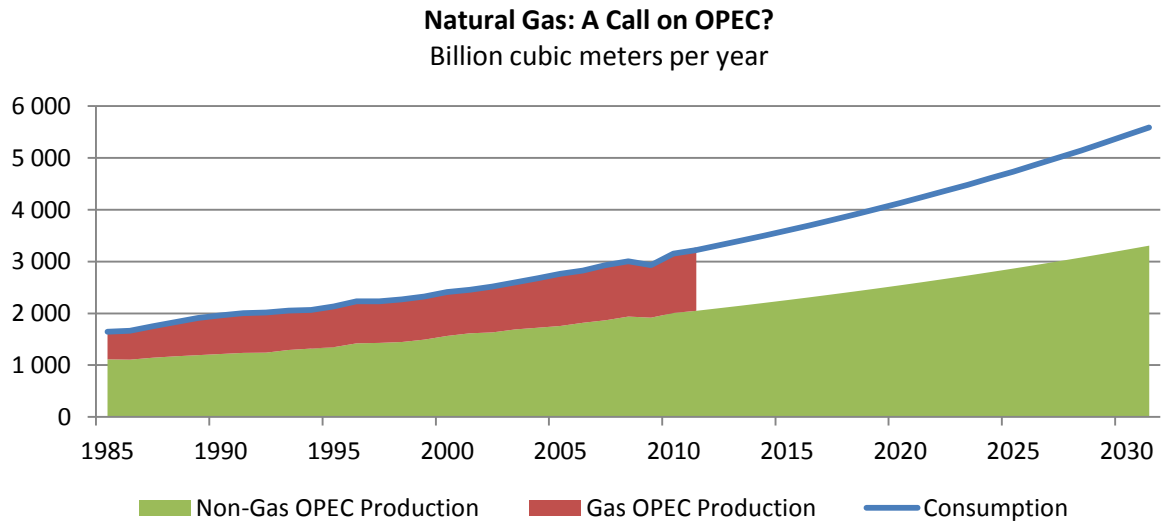

Figure 21: Natural Gas: A Call on OPEC? Looking forward (Source: Author's elaboration of data from the BP Statistical Review of World Energy, June 2012)

This has been charted using simple average growth rates for consumption and non-gas OPEC production over the past 10 years (equal to, respectively, 2.8% and 2.4%). A gas OPEC role appears to be limited, in any case reduced if compared to the case of oil. Finally, this is, of course, subject to a high degree of uncertainty depending on the global development of the unconventional gas industry, as discussed above.

So far, a gas OPEC has not yet been instituted. However, the Gas Exporting Countries Forum exists, comprising Algeria, Bolivia, Egypt, Equatorial Guinea, Iran, Libya, Nigeria, Qatar, Russia, Trinidad and Tobago and Venezuela. Its members together control roughly 60% of the world's natural gas reserves. Its main objective is to foster dialogue between producers and thereby enforce the concept of mutuality of interests. Such organization has not yet acted effectively as a cartel, determining production and prices of natural gas. Follow some of the main reasons:

- The global market for natural gas is yet too fractured; as gas is used primarily as a electricity and heating source, it has several substitutes (such as coal, renewable, nuclear energy).
- Furthermore, two of the main producers, Venezuela and Iran, do not have much left in the market: they have grown from net exporters to net importers of natural gas.

- Also, given the important developments in unconventional gas production, a natural gas cartel aiming to fix prices would have little effect on North America.
- Most natural gas is still shipped through a regional network of international pipelines. As discussed all along this paper, gas sales are typically, for the time being, directed towards specific buyers under long-term contracts.

To increase cooperation, important gas producers such as Russia and Algeria could try to exert some influence on the rapidly developing LNG industry. In general, Russia appears to have filled the leadership void that was characterizing the GECF. In December 2009, following the election of the vice-president of the Russian energy engineering company Stroytransgaz, Mr. Leonid Bokhanovsky, as Secretary-General of the GECF, Russia's Energy Minister Sergey Shmatko stated: "Today we can speak about gas OPEC as a fully fledged international organization. By a unanimous decision a Russian national was elected its secretary general. This is to show that member countries expect Russia to use its political weight to promote it" (Russia Today, 2009).

However, as huge quantities of unconventional US shale gas have been brought to the market, causing Henry Hub (the main US reference pricing point for gas) prices to tumble and changing the geopolitical picture for the United States by making it self-sufficient in gas at least for the near future, patterns of trade have shifted globally and other countries in Europe and Asia have, as discussed above, started exploring their own gas potential. Such global developments, which affect the supply situation as well as the trade movements from one continent to another, are starting to put pressure on longstanding arrangements, such as oil-linked gas contracts. The separate dimension of North American, European, and Asian gas markets is being brought into question as the interactions become more evident, and unprecedented strategic shifts, such as the weakening of Russia’s dominance in the European gas market, appear increasingly plausible.

3.2. EU Supply Diversification

In 2011, roughly 26% of the gas consumption of the EU came from Russia. There are two principal routes exporting gas from Russia to Europe (Percebois, 2008): via Ukraine (transferring roughly 80% of the total gas) and via Byelorussia. The gas conflicts between Russia, on the one hand, and Ukraine and Byelorussia, on the other, in 2006 and 2007,

represent a threat for Europe's security of Supply, which is the reason why alternatives routes started being developed (as mentioned above). Furthermore, as a result of the "gas wars", Russia (Gazprom) obtained the control of the transmission pipelines in the Ukraine and Byelorussia. This added to the participation of Gazprom in the capital of many transmission firms across Europe (in the Baltic countries, in Hungary, Slovakia, Germany and Romania). According to Percebois (2008), "Gazprom has accompanied this strategy of downstream integration by a policy to increase transmission capacity, and this for two main reasons: to expand and to secure export channels to Europe". Thereby, Russia is a majority shareholder in the consortium for the construction and operation of the North Stream gas pipeline, which avoids Byelorussia as well as Poland and the Baltic countries.

However, the Nabucco project is also currently under development. As mentioned above, such project is being developed by a consortium including Austrian (OMV), Hungarian (MOL), Turkish (Botas), Bulgarian (Bulgargaz) and Rumanian (Transgaz) oil and gas companies, and its purpose is to transport natural gas from the Caspian Sea to Europe via Turkey, Rumania, Bulgaria, Hungary, and Austria. Such pipeline could theoretically also transfer gas from Iran (the second ranked country in the world in terms of gas reserves), whose exports are nowadays still limited.

Russia's response to the Nabucco project is the South Stream project, launched in 2007 in collaboration with ENI, and whose maximum discharge is projected to be 31 bcm/year. Such pipeline would connect Russia to Bulgaria via the Black Sea by 2015. It would then divide into two routes heading to Austria and Italy. Furthermore, Russia has also signed long-term supply agreements in 2007 with Kazakhstan and Turkmenistan, to continue buying gas from these countries at low price (as they do not have many export routes, being landlocked) for its domestic consumption, in order to export its gas at a higher value towards European markets). Such agreements directly enter into competition with the Nabucco project as well as with the TCGP (Trans-Caspian Gas Pipeline) for Turkmen and Kazakh natural gas reserves, undermining their profitability.

During 2007, Gazprom and the public Kazakh firm, KazMunaiGaz, also signed an agreement over 15 years in order to create a joint company, which will ensure the treatment of Kazakh gas in the Orenburg complex in Russia. The Kazakh firm has promised to supply 16 bcm of gas each year to Gazprom, and during the Achkabad summit which took place in May 2007 in Russia, Turkmenistan and Kazakhstan agreed to construct, by 2013, a gas pipeline of

an overall capacity of 20 bcm, which will cross both countries, border the Caspian Sea and end in Russia. This agreement could compromise the economic profitability of Nabucco, and above all, it could jeopardize the 'Trans-Caspian Gas Pipeline' (TCGP), which has been constructed to export gas from Turkmenistan to the EU by passing via the Caspian Sea and Azerbaijan.

Furthermore, India and China would like to construct gas pipelines giving them access to Russian, Kazakh and Turkmen gas. Projects are currently being developed to exploit such potential, and the competition could become fiercer as natural gas demand from Asia increases. If such development were to materialize, Russian exports could increasingly be diverted towards Asia, putting the EU effectively in competition for the resource. As economic growth recovers in Europe, and as a consequence natural gas demand, Russia could see its own strategic relevance increasingly sustained.

As we can see, political considerations strongly affect the economic factors in the international natural gas exchanges in Europe. The idea that Gazprom or Sonatrach could attempt to take over European gas networks is more plausible, as they are Government owned firms who tend to obey political logics. However, this problem is minimized; such companies are likely to face strong resistance from the EU who will implement legal barriers for companies outside the EU seeking access to the gas networks in Europe.

3.3. Looking Ahead: Four Scenarios Based on Unconventional Gas Growth and Liberalization Progress

Harvard University provides a very interesting framework to analyze natural gas geopolitics. As part of its "Geopolitics of Energy Project", the university organized a workshop in which a group of country experts, economic modelers, and industry representatives developed four scenarios for the future of natural gas markets. Such scenarios change according to two dimensions: gas liberalization and success of unconventional gas. The modelers used seven variables or drivers (Harvard University, 2012):

- Geopolitics, i.e. the international impact of individual country decisions.
- "Great powers and their interactions", i.e. the relative fortunes of United States, Russia and China as well as their ability to influence the world.

- Critical events, such as natural disasters, political change, accidents, or new scientific information which lead, for example, to a ban on shale fracking or more stringent environmental regulations.
- Regime stability in countries such as Russia, Saudi Arabia, and Venezuela affecting supply (both on the short- and medium-term) and demand (namely, altering demand as a consequence of price disruptions).
- Gasification of the power and transport sectors (the latter being more uncertain than the former).
- Renewables and carbon pricing, which could play a critical role in influencing the competition among fuels and enhance the "window" for natural gas as a bridge fuel.
- Resource access and NIMBY (acronym for "not in my back yard" denoting opposition by residents to a project guilty of being developed too close to them), limiting, in particular, the development of unconventional gas.

The four scenarios are as follows:

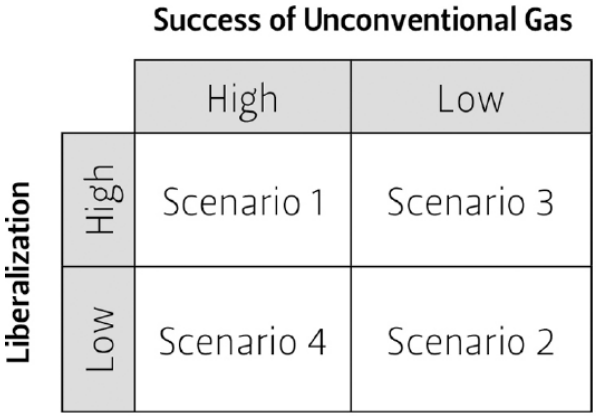

Figure 22: The Geopolitics of Natural Gas (Source: Harvard University, 2012)

A. Scenario 1 – High Success of Unconventional Gas & Liberalization

The first scenario assumes a high success of both unconventional gas and market liberalization. An oversupplied US market causes national prices to tumble, fostering economic growth. Exports to Europe are limited by its depressed economy and its established renewable energy sources. Europe looks at the US with envy: its lawmakers enact further market liberalization as well as reverse anti-fracking legislation, while also reducing remaining subsidies to renewable sources. Shale production rises, further lowering the demand for LNG shipments to the US as well as pipeline imports from Russia. As a

consequence, competition among gas suppliers in Europe intensifies. Trading hubs develop, driving Russia towards "gas-on-gas" pricing (i.e. indexing the price of its long-term exports to hub price signals given by European markets).

LNG exporters therefore divert their attention to Asia, particularly China. In the light of increasing supplies from Africa, Latin America (Argentina), North America and Australia, China becomes more willing to increase its dependence on natural gas markets, mostly via LNG imports. At the same time, China's regulators put in place market mechanisms to prepare for the development of its own shale gas resources while the investments in necessary infrastructure (pipeline and storage) are kicked-off. Asian markets benefit from the global downward trend in gas prices; some buyer competition comes from Japan (nuclear phase-out following the Fukushima disaster), but perceptions of ample long-term supplies sourced from outside the Middle East keep attracting new buyers towards the natural gas market. A substitution effect starts taking place towards oil demand.

Middle Eastern uncertainties, as well as climatic concerns, create incentives for consuming economies to switch to alternative fuels in transportation as well as public transportation.

In 2020, the development of natural gas markets worldwide has isolated the Middle East. Furthermore, the region is further affected by the fall in oil revenues, which creates further civil unrest and spiking oil prices. In the natural gas industry, a strong downwards trend in prices starts creating renewed consolidation; however, demand centers pick up, helped by carbon pricing, thereby reducing such dynamic and preserving competitive natural gas markets. A global switch towards alternative transportation, gas supply abundance and diversification, growing gas hubs, and soaring oil prices all eventually create a transition away from oil to natural gas and renewable energy as the main drivers of economic activity.

B. Scenario 2 – Low Success of Unconventional Gas & Liberalization

The second scenario is diametrically opposite, assuming low unconventional gas development as well as low liberalization success. A flat US demand, as well as environmental concerns on shale gas (following several severe incidents) combine to push legislators towards a moratorium on fracking. As the possibility of US-sourced LNG disappears from the global market, Europe and Asia shift their focus towards the Middle East,

which in turn limits its supply. Furthermore, this gives ever more power to Iran, increasing the regions instability.

Europe remains locked in a regional supply system (comprising Algeria, Norway, and Russia), with producers attempting to get ever higher prices. The death of competition among gas exporters blocks all political incentives towards creating a regional transport network (in particular, Russia denies transit to Turkmen gas towards Europe).

Oil and gas prices continue to trend upwards, creating a comparative advantage for coal. The threat of energy insecurity exacerbates tensions between China and the United States. Resource nationalism soars, particularly in Latin America, which decides not to take the risk to alter its oil subsidy schemes to enhance the development of its shale gas resources. As coal consumption increases, global carbon emissions increase, creating enthusiasm for renewable energy sources, carbon pricing schemes and nuclear energy. Prospects for international trade become increasingly bleak, as major economies become increasingly protectionist.

C. Scenario 3 - Low Success of Unconventional Gas & High Liberalization

The third scenario is based on a low development of unconventional gas, but a high degree of progress towards liberalization. Again, a temporary ban on fracking is imposed in the US as a consequence of, for example, methane leakage during gas production. The US increase pipeline imports from Canada. European and Asian markets also resort to cross-border trade to offset higher energy prices. Russia's market share in the European market is mitigated by increasing LNG deliveries from Qatar. Asia's demand for LNG is addressed by Australian suppliers. The priority in Europe is to protect its energy security by developing a regional transport network, diversifying its supply sources (supporting, for example, the Trans-Caspian pipeline) and increasing gas and power trading and grid connections. EU's leaders coordinate a new regulatory framework for the construction and long-term coordination of a cross-border pipeline system. Trading hubs and forward markets gain momentum.

Russian leaders, losing authority over Caspian flows and European pricing, respond by turning towards the creation of a "gas OPEC". Declining conventional gas production in North America, the North Sea and Europe increases reliance on Middle Eastern supplies, a

region again exposed to increasing instability as a result of Iran's policies. The US, increasingly import-dependent, see their economy and global influence fade in the face of increasing oil and gas prices, as opposed to China, whose economy and status as a global trading partner keep growing. Negotiations between China, Qatar and Iran result in the formation of a new gas cartel.

The international community turns towards energy efficiency to moderate demand. Firms begin to focus more on carbon sequestration and renewable energy as natural gas loses its status as a reliable transition fuel. Facing a tight energy source, China pursues conventional gas development in Latin America, Africa, and the Caspian region. The OECD, to avoid global conflict on increasingly limited oil and gas resources as well as the abandon of liberalized markets, focuses on renewable energy, clean coal, and coal gasification projects.

D. Scenario 4 - High Success of Unconventional Gas & Low Liberalization

The fourth and final scenario is one of high unconventional gas development and low liberalization. Such scenario is triggered by a Middle Eastern crisis (for example, a Saudi regime transition) which creates an oil spike and promotes natural gas as a substitute fuel. In the US, lawmakers grow concerned over the nation's energy security, and exports of LNG are banned. Low gas prices give rise to an "energy-intensive manufacturing renaissance", as well as a switch towards natural gas in the US transportation market. Japan returns to nuclear. Japan, India and China increase LNG imports and start exploring domestic shale potential.

The oil spike puts EU leaders under pressure to create protectionist policies. The Russian dependency has become more alarming than ever. Europe turns to nuclear as well as massive investments in shale, slowly displacing Russian imports. Momentum towards gas liberalization and trading slows as producing European countries try to ensure that domestic supplies are not exported, causing price-diverging paths between different national hubs. Russia responds by re-routing its supplies to Asia. Eventually, low gas prices phase out coal-fired power generation.

For Europe, the first scenario is clearly the most favorable one, as abundant LNG imports allow it to diversify away from Russian dependency, and ultimately pivot the region towards a full gas-on-gas pricing mechanism. A high unconventional gas development combined with low liberalization is also possible, mostly if an oil spike were to make Europe

more dependent on gas and therefore indirectly foster protectionist policies within the EU. Low unconventional gas development scenarios are triggered by a ban on fracking. These are the worst scenarios for Europe, as it would most likely remain locked in a regional supply system, highly vulnerable to competition with Asia. A high degree of liberalization is possible if Europe works towards creating a regional trading system to diversify away from Russian imports. To this Russia is most likely to respond with the creation of a "gas OPEC". Low liberalization is also possible if all LNG supplies are absorbed by Asia, blocking supply diversification and further incentives towards the creation of a regional transport and trading network.

3.4. Long-Term Contracts and Security of Supply

A. History and Rationale

Long-term natural gas import contracts were created in the 1960s to import gas from the Netherlands, as well as, later on, from the Soviet Union and Norway. Such contracts linked a gas producer with each of the import monopolies of the European States, while managing the risks (both of volume and price) in such a way that they would be shared between buyer and supplier. As will be developed below, the EU's liberalization of the natural gas and energy markets, by allowing competition among suppliers and the development of spot and forward markets, is likely to increase the exposure of the EU's traditional gas suppliers to price risk and volume risk. This will create an environment of greater uncertainty, in which prices will adapt more rapidly to the interaction of the supply and demand sides with the global condition of the natural gas resource. On the other hand, such an environment can be perceived as a threat to security of supply (if long term import contracts were not to exist anymore), again, both in terms of price and risk.

The security of natural gas supply is in general addressed via the negotiation of long-term contracts with suppliers outside the EU (Norway, Russia, Algeria, Libya and LNG exporters such as Qatar), while the promotion of competition takes place through the development of regional European markets (providing both a spot and forward price signal). As discussed in the introduction, supply diversification has a strong political connotation, which implies that market logic has to be taken into account along with strategic and geopolitical considerations.

The aim of long-term contracts is to combine the interest of the seller and the purchaser over a long-term horizon in order to make heavy investment in costly transnational pipelines or liquefaction and regasification facilities pay-off. A main feature of such long-term agreements are the *take-or-pay* clauses, which force the purchaser to pay for a certain amount of gas according to the terms of the contract, regardless of whether or not such gas volumes were indeed needed and delivered. Such clause guarantees the maintenance of security of supply.

B. Arguments in Favor and Against

Percebois (2008) lists a series of arguments in favor and against long-term contracts. Among the contrary arguments are the following:

- Long-term supply contracts (20-25 years) can be considered as entry barriers likely to hinder competition, as they limit the development of spot markets upon which operators could supply themselves more easily and that would offer a price signal fully reflecting the demand/supply balance present in a national market at a given point in time.
- The increasing development of LNG is a favorable competition factor as importers have many supply locations to choose from and exporters have many destinations at their disposal.
- As the international gas pipeline network expands, the constraints stemming from the rigidity of pipelines are reduced as gas can take several routes to reach its destination.
- Finally, such contracts prevent buyers and sellers from taking advantage of opportunities present in spot markets (whose prices are sensitive to short-term market conditions) since long-term contracts use prices indexed on oil products with time-lagged monthly averages. In particular, the use of financial derivatives or portfolio management on forward markets could provide protection against spot market volatility while allowing taking advantage of short-term opportunities. However, smoothed averages could also benefit the consumer if oil prices were to fall and gas spot prices to rise.

The following arguments were listed in favor of long-term contracts:

- For the seller, who invests in the exploration, production and construction of pipelines or of gas liquefaction facilities, signing a long-term contract is a guarantee on the

profitability of the investment. As natural gas transportation is expensive, long-term contracts are needed to finance the operations. The seller is taking a price risk as the price of the delivered volumes is indexed on oil products whose price is not known ex ante (and which guarantees the competitiveness of gas compared to its main alternatives), but not a volume risk (since the volume if secured by the take-or-pay clauses). Nevertheless, such system remains advantageous in the context of high oil prices.

- Security of supply is the main advantage of long-term contracts for the purchaser. The buyer, however, must also diversify its supply sources in order to gain some flexibility from being able to choose between long-term contracts and spot market deliveries (stemming for example from the LNG market).
- Finally, long-term contracts are not necessarily incompatible with the entry of new operators provided that the regulator enforces regular gas releases, which oblige incumbent suppliers to place a certain amount of imported gas at the disposal of the wholesale market.

3.5. Oil-Indexation in Long-Term Contracts?

As discussed, oil-indexation in Europe exists mainly for historical reasons: when the first pipelines to import gas from Russia and the first liquefaction and regasification facilities were built to import gas from Algeria, oil was the most commonly used fossil fuel. Natural gas was also extracted as a co-product of oil, which meant that oil exporters were also gas exporters. It was not interesting for the gas exporters to encourage competition with oil, encouraging price linkages. Furthermore, the two energies are substitutes, which implies a degree of logical correlation between the two prices.

Oil-indexing based gas prices on those of competing alternatives. Such pricing mechanism included mathematical formulae linking gas prices to those for other fuels used mainly for heating and industrial purposes (such as coal and heavy and light fuel oil) at a discount, thereby ensuring that gas remained competitive with respect to competing fuels. As a consequence, gas increased its market share.

Indexation was built with certain features (mainly to reduce its volatility and to align with monthly payment and invoicing methods): indexation formulas including a smoothing mechanism in the form of a time differential and a moving monthly average. Furthermore,

indexation also has another important quality: it protects purchasers from arbitrary gas price increases by producer countries; a gas OPEC would not have significant effects if gas prices remained indexed on oil products, which would not be the case in the case of a dominant regional European spot markets.

However, oil-indexation can be seen as impeding the development of a free gas market as well as hindering security of supply, preventing the gas price from being set by gas market fundamentals. The oil price is considered more likely to increase as reserves decrease and demand increases, creating an oil shortage. As the ratio between reserves and production is much higher for gas, the validity of maintaining the linkage between abundant gas and exhausting oil is brought back into question. Furthermore, new unconventional technologies for exploiting both oil and gas reserves mean that such products are no longer extracted as co-products and the geographical distribution of reserves can differ significantly among the two resources. Therefore, one could suggest, and this will be discussed all along this paper, that future long-term contracts be signed with spot indexation clauses rather than oil indexation (assuming a good degree of flexibility of European gas spot markets).

4. COMPETITION AND THE TRANSITION TOWARDS HUB-BASED PRICING

4.1. EU Regulatory Framework

Percebois (2008) summarizes the EU's priorities as follows:

1) Sourcing of the best price for the final consumer via confidence in market mechanisms favoring competition
2) Satisfactory supply security, i.e. diversification of imports and financing of investments to develop national energy supply
3) Promotion of sustainable development, taking into account negative externalities in energy access costs, encouraging energy savings and the promotion of renewable energies

Such priorities are the result of an ongoing process towards liberalization and competition which had its first beginnings in 2005 when the European Commission launched an inquiry into competition in gas and electricity markets. Such inquiry responded to concerns by consumers and new entrants in the sector about the insufficient development of wholesale gas and electricity markets and the consequent limited choice for consumers. The results, published in January 2007, evinced five main problems acting as barriers to competition for consumers:

- Continuing high levels of concentration, causing incumbents to maintain market power
- Barriers to entry deriving from vertical integration, as the monopolists continued to own the energy infrastructure; such inadequate level of unbundling between network and supply interests had negative repercussions on market functioning as well as investment incentives
- Too little integration between Member States' markets, as evinced by low levels of cross-border trade, due to insufficient interconnector capacity and to contractual congestion as spare physical capacity is not regularly released
- Lack of transparency about operations in the wholesale energy sector, making it difficult for new entrants to understand how the markets work in practice and the risks that they imply

- Lack of confidence that wholesale energy prices are the result of meaningful competition.

The sector inquiry conclusively demonstrated that the existing regulations were not adequate to address the issues above. Claude Turmes, a Luxembourgish politician and Member of the European Parliament for Luxembourg's Green Party, part of the European Greens, declared in 2002: "Without stricter rules on market dominance and a phase out of the existing market distortions in favor of some big players, the European electricity market will be dominated by a handful of oligopolies. This is a threat to the functioning of the market and the democratic control of a vital public service". Neelie Kroes, European Commissioner for Competition Policy, declared in a speech at the European Energy Institute in Brussels on the 19th September 2007, that she identified the following three major problems due to joint ownership of network and supply businesses:

- "First, the fact that there is discrimination in access to infrastructure exerted from TSOs towards supply companies.
- Secondly, there is the issue of information leakage. In some cases the top management of the supply branch has access to strategic business information of the transport company, either directly or as a result of their presence on the Board. Or on a more practical level, e-mails are copied to affiliated companies. In some cases it appears that central functions, such as legal advice, are still provided by the group holding company to all members of the group, which clearly reduces the scope for objective treatment of all market participants by the Transmission System Operator. There are therefore limits to how far Chinese Wall arrangements can actually achieve their function on the ground.
- Most importantly, there is the fact that under present structures investment incentives are badly distorted. Transmission System Operators' investment decisions are in practice often taken by the group as a whole. For example, the Italian competition authority fined ENI for stopping the expansion of the Trans-Tunisian gas pipeline proposed by its network business. The investment would have introduced more competition in the Italian market, and you can see who would gain and who would suffer as a result! In addition, integrated Transmission System Operators have a chilling effect for the investment strategy of third parties who will think twice about investing if they fear unfair treatment by the network operator."

A. The Third Energy Package

As an answer to the issues mentioned above, and in line with the revitalizing of the Lisbon agenda (a 10-year strategy proposed by the European Commission on 3 March 2010 for reviving the economy of the European Union via targets on, among others, investments in R&D -3% of GDP- , greenhouse gas reduction -20% compared to the levels of 1990-, share of renewable energy in final energy consumption -20% increase-, energy efficiency -20% increase-, and education), the European Union developed the Third Energy Package for an internal gas and electricity market. Its purpose is to further open up the gas and electricity markets in the EU to true and effective competition, to the benefits of consumers (businesses and households). The package was proposed by the European Commission in September 2007, adopted by the European Parliament and the European Council in July 2009, and entered into force on the 3rd of September 2009. After this date, EU Member States had 18 months to transpose the two Directives (for gas and electricity) into national law. However, the complete transposition of the European electricity and gas legislation in all Member States is still not complete. Because of this, the Third Internal Energy Market Package was adopted in 2009 to accelerate investments in energy infrastructure to enhance cross border trade and access to diversified sources of energy.

The main feature of the third package is third party access, which states that, in order to have effective competition the operators of transmission networks must allow any electricity or gas supplier non-discriminatory access to the transmission network at regulated conditions to avoid any abuse of dominance. Transmission networks, given their structural condition of natural monopoly, must be subject to regulation. The rules on unbundling of transmission networks aim at preventing companies which are involved both in transmission of energy and in production and supply of energy from using their privileged position as operators of a transmission network to prevent access of their competitors to such network.

Member States can decide between three models of unbundling: Ownership unbundling, the Independent System Operator (ISO), and the Independent Transmission Operator (ITO). Ownership unbundling requires the separation of companies' generation and sale operations from their transmission network. Production companies and suppliers are only allowed to have minority shareholding, with no voting rights and no appointment of administrators. The second and third options to diminish the market power of the biggest energy firms are the ISO and the ITO. The ISO gives the opportunity to let the transmission

networks remain under the ownership of energy groups, but transferring operation, control, maintenance and investment of their business to an ISO (an independent company in the legal form of a trustee). Several other countries (among which France, Germany, and Austria) presented a proposal for a third option, the ITO. Such model envisages energy companies retaining ownership of their transmission networks, but the transmission subsidiaries would be legally independent joint stock companies operating under their own brand name, under a strictly autonomous management and under stringent regulatory control, while investment decisions would be made jointly by the parent company and the regulatory authority.

Finally, the third energy package instituted high standards of public service obligations and customer protection (such as provisions enabling customers to switch suppliers within three weeks and obligations on suppliers to provide information to consumers), stronger powers and independence of national regulators (together with the creation of the Agency for Cooperation of Energy Regulators, and the European Network of Transmission System operators), as well as new tools to harmonize market and network operation at a pan-European level (common principles in order to facilitate cross-border trade and reduce transaction costs).

Importantly, such legislative package also addressed the issue of supply of security by defining conditions of energy solidarity in emergency situations, requiring Member States to co-operate in the event of "severe disruptions" of gas supply, by coordinating national emergency measures and developing electricity and gas interconnections.

Percebois (2008) highlights the following relevant distinction between the effect of the reforms on the gas and power industries: “A fundamental point must be highlighted when it is a question of natural gas prices formation. Market opening wished for by Brussels does not concern the foreign companies that supply the EU as neither Gazprom or Sonatrach […] are affected by European directives. This is the major difference between the gas and electricity industries. Most of the upstream part of the gas production chain escapes Brussels’ influence, and market opening should not weaken importers confronted by foreign suppliers who are generally government owned companies anyway. […] Gas rent is largely in the producers hands today, which is also the case in the oil sector.”

However, such ownership unbundling could run the risk of leading to a situation in which transmission networks are bought and controlled by companies outside of Europe, such as Sonatrach or Gazprom.

Also, in many EU states regulated tariffs have had a deterring impact on the development of competitive markets since they have been set at low levels and cover most of the potential retail market.

B. The Ten Projects of European Interest

Concerning transnational gas pipelines, the Commission had selected ten projects of European interest mainly financed by project finance (European Commission, 2006), meaning that projects are financed by a separate project company acting as a joint venture of energy and transmission companies Such projects were all defined as of European interest because of their cross-border nature. Such projects are the following:

- North Stream, connecting Russia to Germany. Maximum discharge 55 billion cubic meters (bcm) per year. To be completed in October 2012.
- Yamal-Europe pipeline, connecting natural gas fields in Western Siberia and (in the future) Yamal Peninsula to Austria (Baumgarten Gas Hub) and Germany. Maximum discharge: 33 bcm/year. Completed in 2005; since 2005, building the second leg of the pipeline has been subject to planning. However, in November 2007, the Russian minister of industry and energy Viktor Khristenkosaid stated that Russia had abandoned such project in favor of the construction of the Nord Stream pipeline.
- Baltic Gas Interconnector, which was a project of submarine pipelines between Germany, Denmark and Sweden connecting the existing pipeline networks of southern Scandinavian and Continental European countries. The pipeline was scheduled to come online in 2005. However, after receiving delayed authorizations from the Swedish and Danish governments, the project is still waiting for the authorization from the German government, and has not been implemented yet. Gas was planned to be transported from the North Sea which is now in depletion. As a consequence, Russian gas has been considered as an alternative source for the pipeline. However, the BGI is being reconsidered due to considerations about linking North Stream to the Swedish pipeline network. Maximum discharge: 3 bcm/year.
- Increase in transmission capacity on the Germany — Belgium — United Kingdom axis.
- Expansion of the TransMed, a natural gas pipeline from Algeria via Tunisia to Sicily and thence to mainland Italy. A third line spanning 550km was built in March 2010 to carry natural gas from the Hassi R'Mel gas field to Tunisian border

where it is coursed into the Transmed pipeline. A 35km-long extension line was also constructed from Italian Mainland to Slovenia. It has the capacity to deliver 30.2bcm/y (billion cubic meters per annum) of natural gas. Its capacity will be increased to 33.5bcm/y by 2012.

- Algeria-Italy gas pipeline, via Sardinia and Corsica, with a branch to France (GALSI). The pipeline is expected to become operational in 2014. Maximum discharge: 10 bcm/year.
- Medgas gas pipeline (Algeria — Spain — France — Continental Europe), linking Algeria to Spain. Inaugurated on the 1st of March 2011. Maximum discharge: 8 bcm/year.
- Turkey — Greece — Italy gas pipeline, linking the Greek and Turkish gas grids. Inaugurated on the 18th of November 2007. Maximum discharge: 11 bcm/year.
- The Nabucco pipeline, also known as the Turkey — Austria gas pipeline, linking Erzurum in Turkey to Baumgarten an der March in Austria diversifying natural gas suppliers as well as delivery routes for Europe, thereby diminishing European dependence on Russian energy. The project is backed by the European Union and the United States and is seen as rivaling the Gazprom-Eni South Stream project. The main supplier is expected to be Iraq with potential additions from Azerbaijan, Turkmenistan, and Egypt. An intergovernmental agreement between Turkey, Romania, Bulgaria, Hungary and Austria in preparation for the construction was signed in July 2009. If built, the pipeline is expected, as of today, to be operational in 2017. Maximum discharge: 31 bcm/year.
- The Greenstream pipeline (or Libya-Italy gas pipeline) linking Libya to Italy. Inaugurated in 2004, it has a maximum discharge of 11 bcm/year.

Figure 23: Russian Gas Corridors to Europe - North Stream, Yamal & Brotherhood (Source: The Economist)

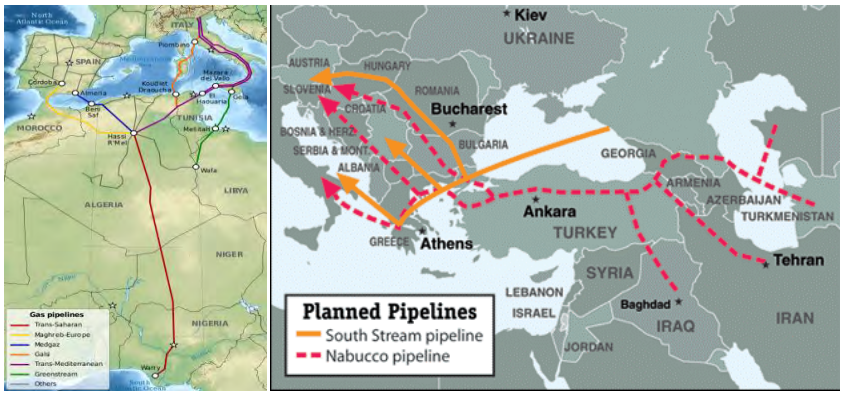

Figure 24: Gas Pipelines across Mediterranean and Sahara & Nabucco Pipeline Project (Source: Wikipedia and The Economist)

4.2. Oil and Gas in a European Perspective

A. Europe's Energy Mix

In Europe, as the following charts illustrate, natural gas (gradually following on long trend) and renewable energies (rapidly but more recently) have increased their share of the total primary energy supply. In particular, natural gas' consumption growth has surpassed (largely in the 1960s and 1970s, steadily in the 1980s, 1990s and 2000s) the one of oil. Oil appears to have entered a steady downwards trend in European consumption over the past 15 years, despite an increasing total primary energy consumption; natural gas' consumption development for the time being is harder to characterize, and appears to have become more volatile as the recession hit in 2008.

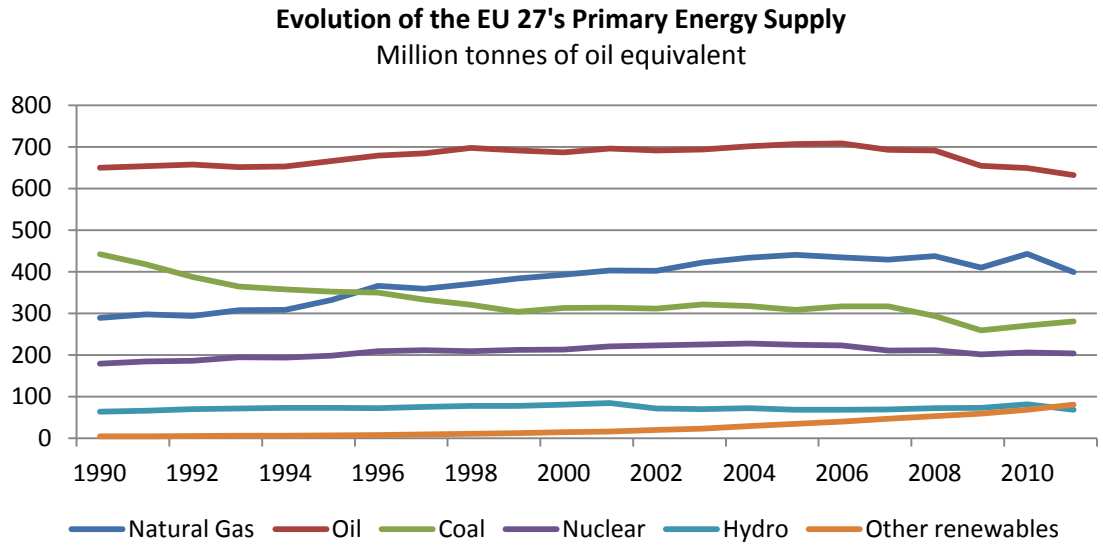

Figure 25: Evolution of the EU 27's Primary Energy Supply (Source: BP Statistical Review of World Energy, June 2012)

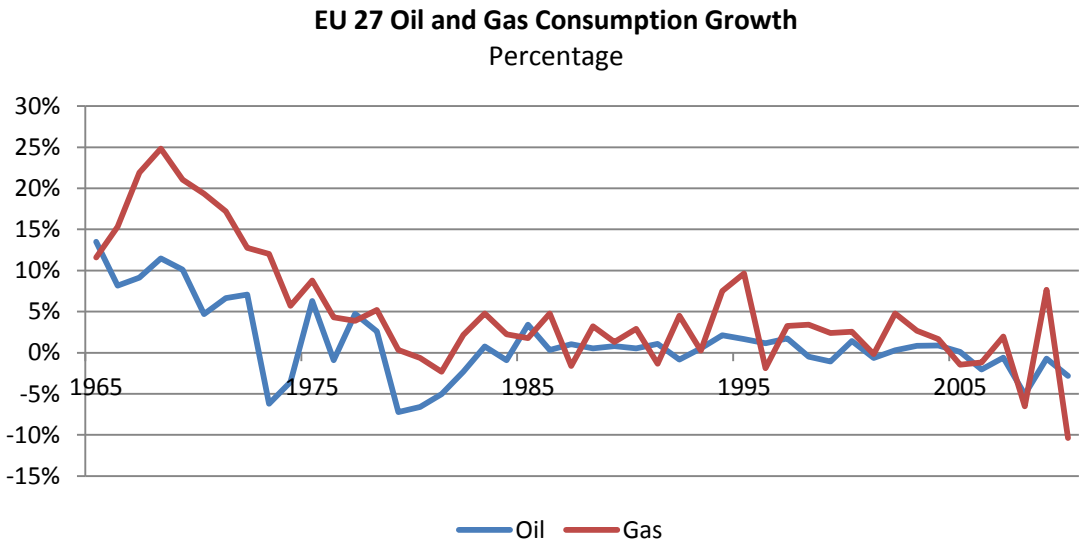

Figure 26: EU 27 Oil & Gas Consumption Growth (Source: Author's elaboration on data of the BP Statistical Review of World Energy, June 2012)

According to Stern et al. (2011), the elimination of oil from many stationary energy sectors, the inconvenience of maintaining oil-burning equipments and related oil stocks, the emergence of modern gas-burning equipment and the tightening environmental standards all have contributed to question the validity of the linkage of long-term contract prices to those of oil products.

B. Import and Hub Prices in Europe

After 2008, as Europe entered a prolonged phase of economic depression, a gap formed between oil-linked import prices and European hub prices, as illustrated in the chart below (generating a "two-price" or "hybrid" market). Oil-linked prices have been nevertheless defended by producers with market power; gas producers have also put forward that no other appropriate price mechanism is available, as European hubs are considererd too illiquid and prone to manipulation by local players. On the other hand, abandoning oil-linked prices generates fears of price manipulation by exporters such as Gazprom as well as of a potential creation of a "gas OPEC". Finally, it has been commonly expected that such prices would recouple (i.e. return to the same level) by 2012.

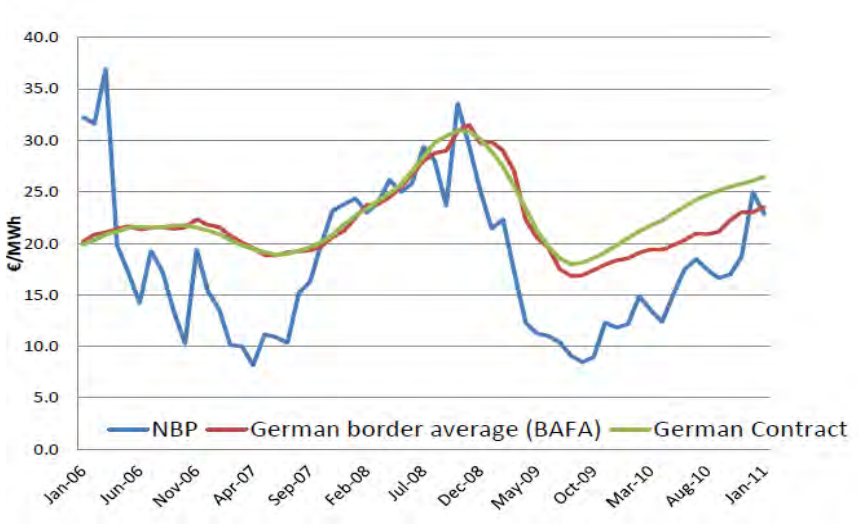

Figure 27: German Oil-Linked Contract and Border Prices and NBP Prices (Euro/MWh) (Source: Stern et al. 2011)

Figure 27 shows three time series: the NBP (National Balancing Point – the UK hub) monthly average spot prices, the German border average monthly price (which is the only transparent and official price available for oil-linked import contracts) as well as the "German contract", i.e. the purchase price in oil-linked long term contracts mainly with Gazprom, Statoil and Gasterra. Interestingly, the BAFA price appears to de-couple from the "German border" price: this is due to the fact that the EU importers, using the price signal given by European hubs, successfully negotiated a new discounted price level for imports, which took effect in the summer of 2009.

Prices in long term import contracts are generally reset quarterly based on the evolution of the average of oil prices on the preceding 6 to 9 months (often with additional time lags). Traditional European gas renegotiations were held thanks to price review clauses, according to which the components determining the price level (the base price and the indexation formula) could be periodically renegotiated on the basis of evolving country-specific conditions such as the GDP growth rate, inflation, prices of competing fuels and so on.

Hence, the evolution of the price in long term imports is rigid by construction. After 2008, such rigidities became particularly painful for European importers as the recession hit Europe and hub prices tumbled. Furthermore, as natural gas markets become more integrated internationally and "globalize", movements in supply and demand as well as prices in other areas have a much more immediate impact on European gas prices. The chart below illustrates

how the economic crisis as well as differently evolving supply and demand balances in different areas has brought commodity prices to follow diverging paths.

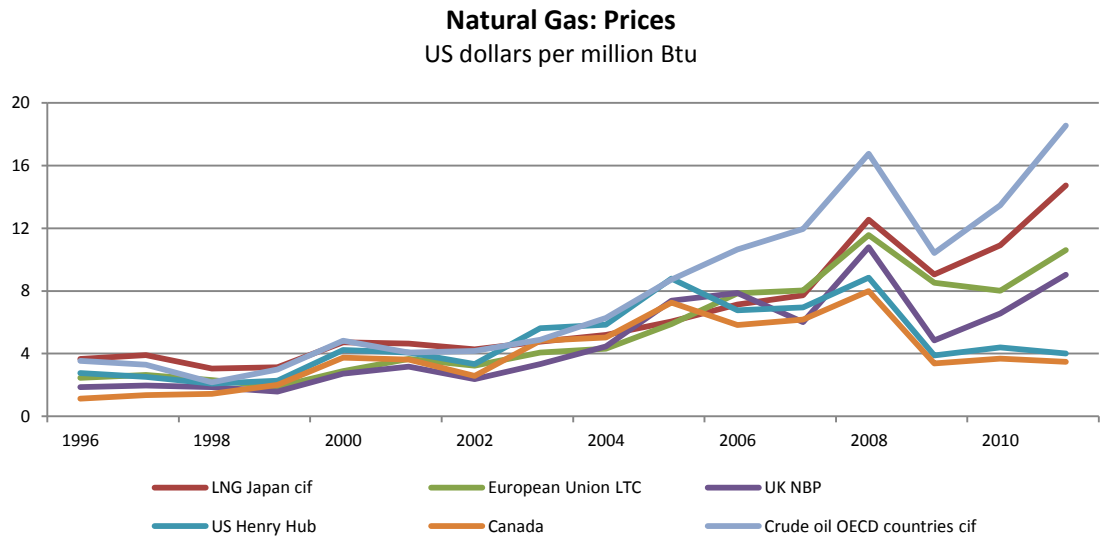

Figure 28: Natural Gas Prices (Source: BP Statistical Review of World Energy, June 2012)

Examples of diverging supply and demand conditions since 2008 are:

- The 2008-09 global recession (especially important for Europe).
- The collapse and quick substantial recovery of LNG demand in Asia (particularly in the established LNG markets of Japan, Korea and Taiwan) while demand in the new markets of China and India was significantly less influenced by recession.
- The rapid development of shale gas production in North America (with a consequent substantial fall in Henry Hub prices), effectively isolating the North American market from the rest of the world.
- Fluctuations in international coal prices and their impact on gas demand.
- Finally, fluctuations in power and carbon prices leading to fluctuations in spark and dark spreads (spark spreads represent the theoretical gross margin of a gas-fired power plant, whereas dark spreads represent the theoretical gross margin of a coal-fired power plant).

The following trends could halt a transition away from oil indexation:

- A European economic recovery sufficient to bring back energy and gas demand to its 2007 levels.

- US prices would have to rise above NBP prices, diverting LNG away from Europe, which seems unlikely to happen.
- Asian LNG demand would have to rise significantly, again taking away surplus LNG from the European markets (this is partially happening as a consequence of a the terrible earthquake which hit Japan in March 2011, causing it to close 11 GW of nuclear generation).
- Further technical or political delays in LNG supplies (particularly, for example, increasing domestic demand in countries like Algeria and Egypt).
- A prolonged fall in oil prices to close the gap between hub prices and long term prices
- An insufficient development of liquidity at market hubs, as well as a permanent market power of dominant suppliers and buyers, maintaining the pricing and contractual status quo (Stern et al., 2011: "Liquidity increased at all the European market hubs and, due to improvements in third party access, competition increased and the market power of incumbents declined").
- Cold weather patterns absorbing the European oversupply.

Looking at a longer-term horizon, additional gas supplies to Europe markets may be limited due to:

- Lack of expansion in exports from North Africa, mainly due to increasing domestic demand in countries such Algeria, Egypt and Libya.
- Lack of substantial contribution from Middle East and Caspian (e.g. from Turkmenistan) supplies to Europe.
- Lack of substantial development in domestic unconventional gas production to replace declining conventional gas production.
- Uncertainty concerning the scale and timing of *new* global LNG supplies from key countries such as Nigeria, Qatar, Australia, Venezuela and Iran.

However, sources of additional European gas supply could be:

- Increasing LNG supplies principally from Qatar (which will however be subject to increasing global competition).
- Russian supplies, seen as undesirable because of security reasons related to transit (principally through Ukraine and Byelorussia) and political manipulation.

- A falling demand due to the introduction renewable energy sources as well as an increase in energy efficiency could also act as a limitation to additional import requirements.

Stern et al. (2011) clearly state that such multitude of influences is the reason why a structurally rigid import price, indexed on a commodity different than the one it is pricing, is not sustainable: "The proponents of the "status quo", (i.e. those unwilling to countenance replacing the current oil-linked pricing with an alternative formula), claim that there are too many new parameters – which are changing too quickly and unpredictably – to construct an alternative index which will be sufficiently stable while reflecting changing market conditions over time. On the contrary, in a world where LNG connects regions and Europe's gas market fundamentals are impacted by events on other continents, the need for a price formation mechanism which responds rapidly to such changes is becoming crucial. This is why – with all of their imperfections […] – the emerging European gas hubs provide the best indicator of a market price which long term contracts increasingly need to reflect. In other words we believe the co-existence of oil-linked and hub-based pricing is unsustainable and that the latter is the best available indicator of supply and demand conditions in the gas market".

4.3. The Progress in Hub-based Pricing

With the unbundling of the transmission networks, the transmission infrastructure has become akin to a public transport medium whose purpose is to offer all market participants third-party access to a virtual trading place. Such developments have hindered the market dominance of the incumbent importers. Nowadays, market participants have to pay a fee for the use of the transmission network within its entry and exit points. Such points delineate regional markets, while (regional) prices are set in a virtual trading exchange.

The following figure, showing the development of volumes traded at natural gas hubs (the rest being supplied via bilateral agreements outside the hubs), illustrate the fact that trading at European hubs has made considerable progress.

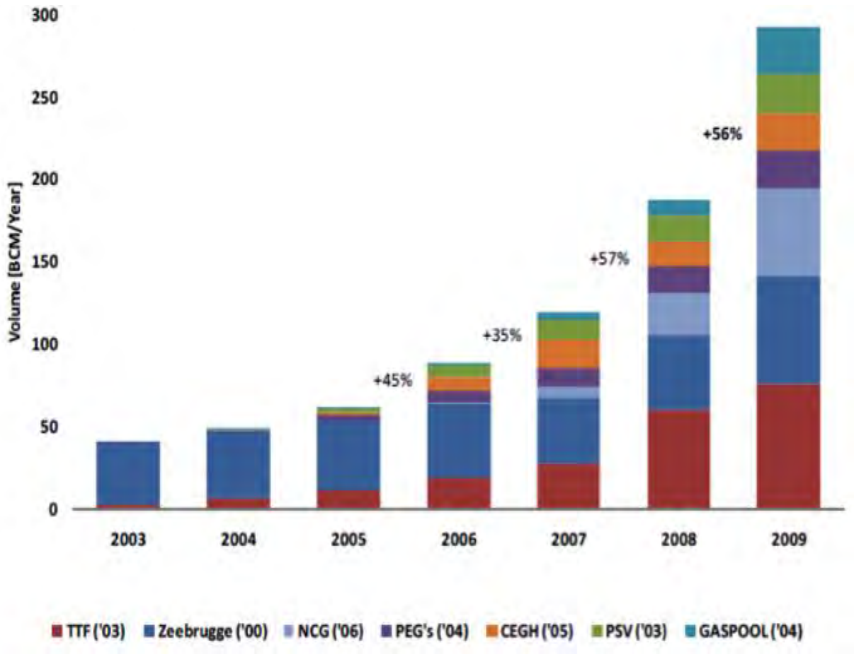

Figure 29: Development of Traded Volumes of Continental European Gas Hubs 2003-2009 (Source: IEA, Medium Term Oil and Gas Markets, 2010, IEW WEO, p. 207)

However, questions remain as to whether such hubs have sufficient liquidity to be regarded as acceptable price discovery mechanisms. The churn ratio (i.e. the ratio of traded volume to physical consumption through the grid TSO) for none of the Continental European hubs is greater than 5 (a market is conventionally considered to be liquid if it has a churn ratio greater than a minimum of 10). However, the estimates of the churn ratio for the NBP in the UK are between 15 and 19. On the other hand, as long as European hubs maintain an essentially balancing role (this aspect will be discussed further below) it will be very challenging to predict prices; this is likely to hinder the growth of the churn ratios. Interestingly, addressing this matter, Mr. Komlev, Head of Contract Structuring and Price Formation at Gazprom Export, stated this year that (Komlev, 2012) "on the Continent the available financial instruments usually offer hedging opportunities that are limited in duration to only six to nine months. It is no coincidence that the maturity of forward instruments equates to a base period in the long-term supply contract formulas. Prices of long-term contracts for oil-indexed formulas are usually quite predictable".

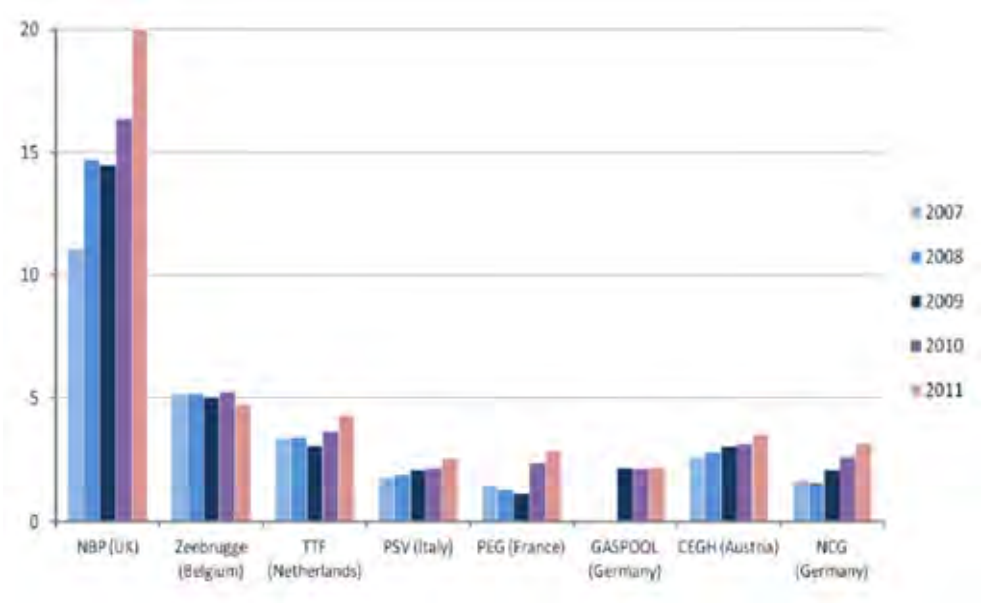

Figure 30: Churn Ratio at European Hubs (Source: Konlev, 2012)

Furthermore, European gas spot prices across different countries and market areas do not exhibit so far any significant divergence suggesting that they might be subject to manipulation. The divergence is even lesser on forward maturities. Moreover, as hubs gain additional participants and increase their liquidity, the potential for manipulation will decrease. On the other hand, the problem of the oligopolistic nature of European gas markets, where few buyers confront with few sellers thereby leaving significant potential for manipulation, remains. Sellers view EU liberalization as a reduction of their security of demand and their rents from gas sales, while buyers suspect sellers or preparing a gas OPEC.

It is also a natural consequence of the globalization process as well as of the multiplication of influences on European gas prices that hub based prices are likely to substantially increase volatility. On the very short-term, increased price volatility is a consequence of the need to balance the market. However, such volatility might not necessarily be passed to final customers, as suppliers segment the market: small and medium sized customers will not necessarily be exposed to daily or monthly changes, as suppliers will use trading strategies to reduce volatility and smooth the price pattern for smaller customers. Larger customers will most likely have in-house trading capabilities to optimize their own portfolios.

Furthermore, the growth of hub-based pricing in North West Europe is likely to have a strong impact on other European countries; such impact will be intensified by growing and diversified LNG supplies as well as increasing pipeline interconnections with bi-directional

flows within the EU. Stern et al. (2011) clearly underline this statement: "By 2013, pipeline interconnections will allow LNG arriving in Greece to be delivered to a range of south and central European countries as far north as Austria; or vice-versa for gas to be delivered from the CEGH hub to Greece. While in central and south east Europe these developments are still unfolding, it seems unlikely that any country would wish to remain, and will remain, excluded from the possibility of accessing attractively priced gas from a greater variety of sources. This will be an environment in which hub-based pricing will thrive".

The switch to hub-based pricing entailed a fundamental change of mindset for traditional buyers, from a mindset proper of an actor of a relatively captive market, to one which reflects the competitive environment of access to liquid gas markets. Traditional long term contracts represented a secure source of supply, and prices could be passed on to the end-users. Higher prices than those at the newborn hubs could be justified by the volume flexibility embedded in such contracts (typically between 80% and 120% of annual contract quantity) as it allowed buyers to vary their off take depending on their possibility to use other forms of flexibility (such as gas in storage) and, of course, the level of demand from the consumers. Indeed, sources of flexibility are the storages (which are continuously growing in Europe) as well as hub trading and, potentially, short-term LNG supplies. In a trading environment, an oil-indexed contract represents a future potential exposure and a source of rigidity. It is interesting to note that, even if the spread between oil-indexed prices and hub prices is reduced, such rigidity (future exposure) in an increasingly uncertain global gas system is likely to remain considered as a threat. As gas trading grows, *take-or-pay* conditions and contractual flexibility become of secondary importance since operators are given the opportunity to buy and sell short-term gas to balance their portfolios. This highlights the importance for buyers to develop alternative sources of supply and flexibility.

4.4. Long-term Import Price Review and Arbitration

European long-term import gas contracts typically contain an arbitration clause: such clause declares that, if a disagreement between the parties should occur, a decision (binding on both parties) will be requested from an arbitral tribunal. For example, if the dispute concerns the price, the arbitral tribunal will have to set a price whose application will be backdated to the beginning of the legal proceedings. This represents a process whose outcome is highly uncertain. Nevertheless, starting in the late 2000s, the frequency with which arbitrations were reported in the press has increased.

Such gradual process of transition away from oil-linked pricing in long term import contracts does not automatically hinder the existence of such contracts. However, if hub-based pricing becomes predominant in Europe, sellers will ask themselves what remaining purpose is being served by long term export contracts. Traditionally, such framework allowed sellers to rely on the legal obligation of gas buyers to take a minimum volume of gas at an oil-linked price. As sellers were not granted access to downstream markets, they relied on their buyers' access to a large customer base and sufficient market power to ensure and defend such price level. However, as discussed above, competition and third party access in European gas markets mean that oil-linked prices can no longer be forced by utilities on their customers (as third party access implies that buying gas at hub-based prices has become accessible for most final customers). Therefore, if sellers receive hub prices from buyers under a long term contractual arrangement, there will be practically no difference with the price they could get by themselves selling directly to end-customers (via third party access).

Therefore, the arbitration and renegotiation of contracts could cause sellers to decide that they can obtain similar, if not greater, value by selling the gas directly to end-customers. If this is the case, transitioning to hub-based pricing is therefore likely to be associated with a termination of existing long term contracts. Probably not all existing contracts will be terminated; it seems quite likely that the different operators will develop a portfolio of contracts, including long-term, medium-term and spot pricing. The main characteristics of the new framework are likely to be a greater degree of flexibility, smaller volumes and shorter lengths than in the preceding contractual framework.

4.5. A Hybrid Pricing Model for Europe?

Is there really a reason why oil-indexed and hub-based prices cannot continue their historic relationship in a synergistic fashion? Would it be suitable for an import-dependent market like Europe to move towards a purely hub-based short-term pricing model, similar to the one existing in the United States? Sergei Komlev, Head of Contract Structuring and Price Formation at Gazprom Export, discusses these (semmingly provocative) questions in a very interesting article published on the European Energy Review on the 7th of May 2012. His main point is that such a short-term model would leave Europe at the mercy of market forces, which do not necessarily deliver security of supply. From Mr. Komlev's point of view, the current hybrid pricing system is of value to Europe, in that it possesses the virtues of ensuring security of supply while providing at the same time a framework for competition and

flexibility (i.e. adaptability to the EU's supply and demand balance). Both systems are seen in fact as complementing each other in the current market conditions, as different types of risks will determine ad hoc choices of contracting and pricing conditions.

According to Mr. Komlev, "existing long-term contracts are especially designed for oil-indexation". If a switch to hub-indexation were to occur in long-term contracts, the seller would remain burdened with the obligation to deliver gas while having no means of controlling its selling price. On the other hand, sufficiently liquid hubs would provide a substitute for long-term contract obligations. As discussed above, however, a shift to hub-pricing would put into question the need for long-term contractual agreements. Furthermore, in a context of dynamic change actors become mostly interested in optimizing their own business and strive for greater efficiency within their own segment. This however also implies the loss of redundancy and spare capacity in the supply system, whose importance could be non-negligible in the event of a crisis. Gas suppliers have an interest in scarcity, which implies that the market alone will not ensure security of supply.

It has to be noted that, for the time being, hub pricing on the European continent is not the result of total supply and demand, but rather the result of a supply-demand equilibrium (influenced by balancing and arbitrage –between pricing structures and between hubs) within residual volumes that are left once long-term contract have met the bulk of demand. In the current hybrid pricing model, European hub prices are not the result of the aggregate supply and demand balance, but rather act as an indicator of the hybrid system's status of over or undersupply. Mr. Komlev states that, "in contrast to North American hubs, hubs in the hybrid pricing model do not provide a true indication of the supply-demand balance but only a fake imitation of it. But the hub price is a perfect instrument of all kinds of arbitrage, a role delegated to it by the hybrid model".

Mr. Komlev then continues to address the reasons that justify having long-term oil-indexed prices at a higher level than spot prices:

- As discussed above, a major reason for such price difference is the value of flexibility provided by long-term pipeline supplies.
- Furthermore, balancing on hubs tends to have a "one-sided" characteristic: in case of undersupply, existing long-term arrangements will likely ensure additional deliveries at a cost which is more convenient than other sources. On the other hand, in case of oversupply, selling gas on the hubs is a "quick-fix".

On the other hand, spot prices have increased, historically, above long-term import prices (such as in the month of February of 2012 due to a record cold snap); this however appears to be more the result of a capacity problem on the European gas infrastructure at a time of great stress. The more such infrastructure is developed, the less probable such occasions are likely to become.

Broadly speaking, competition enhancement policy might run the risk of putting a group of market players which do not import gas to Europe under long-term arrangement and are not responsible for gas storage but rather source their gas on the spot markets in an advantageous position with respect to incumbent importing companies. This creates a power shift hindering the possibility for importers to renegotiate prices with producers in the light of the new market situation; big exporters, such as Gazprom, now have to deal with smaller partners with less leverage and market capitalization. As Europe becomes increasingly import-dependent, oil-indexations can be considered a protection from price manipulations, as none of the main suppliers is able to influence the price of oil.

Furhtermore, as discussed in the Harvard University's scenarios above, big exporters might be unwilling, in the long run, to remain dependent on the European market, as Asia appears to be headed towards significant growth rates. Also, as climatic issues become increasingly pressing, gas might be reduced to a niche role of transitional fuel, thereby effectively creating a situation of unknown demand. In a long-term business like gas, the possiblity to forecast future demand is necessary for investments to be made in gas fields and infrastructure. Demand insecurity halts the diversification processes while undermining relationships with traditional producers.

According to Ms. Kirsten Westphal, Senior Researcher at the German Institute for International and Security Affairs (Westphal, 2012): "A mix of commercial contacts and long-term contracts - the latter now being discouraged by legislation – appears a judicious way to provide basic quantities for the market at predictable prices and thus limit volatility. That would also restrict the possibilities for big gas producers to influence prices and quantities. With the international gas market dominated by an oligopoly the possibility of price-fixing cannot be ruled out, especially where producers are beyond the regulatory and judicial reach of the EU".

5. SUMMARY AND CONCLUDING REMARKS

As stated in the first section, natural gas can be used for heating, cooking, producing electricity, transportation, and as an industrial feedstock. It is in competition with oil, coal, hydro, nuclear and renewable energy in terms of share of the world's primary energy mix. Percentagewise, natural gas has been steadily increasing its share of the world primary energy mix over the last decades. Such trend has been recently (starting in the late 1990s) accompanied by a similar dynamic from renewable energy (however,the growth of alternative sources has been at an increasing pace). Coal's share has also recently picked up again, mostly as a consequence of the unconventional gas exploitation in North America which has shifted most of the US demand for coal towards natural gas and thereby created an oversupply of coal and tumbling prices. Such developments have been mostly at the expense of oil's share withing the world's primary energy mix. Oil's falling share is being compensated for by coal, gas and renewable energy, as well as by a general increase in the energy efficiency (i.e. decreasing energy intensity) of the economy. Such evolving picture is being further modeled by the technological developments which have allowed the exploitation of unconventional gas sources.

Internationally, natural gas production is dominated by Russia and the United States, which together account for 40% of the world's production. The distribution of the production and consumption across the 10 regional areas defined in this paper shows that the EU 27 and Asia clearly exhibit a strong import dependency, while the Rest of Europe, the Former Soviet Union, the Middle East and Africa all exhibit a greater production than consumption. On the other hand, North America, South America, Eurasia and Oceania are all roughly balanced. This explains the distribution of trade flows from surplus areas to deficit areas.

From an historical perspective, the production of natural gas has been on an increasing trend over the last 2 decades (to the least) in all regions with the exception of Europe, where it appears to have peaked and has been constantly decreasing since the first half of the 2000s, and the Former Soviet Union, where it has remained generally flat. The evolution is similar for consumption, with the slight difference that Europe's decrease in consumption is taking place at a lesser pace.

In terms of proved reserves, the landscape is vastly dominated by Eurasia, the Former Soviet Union and the Middle East, which are therefore likely to acquire an ever increasing

role in the global natural gas trade. Africa and South America as well as (interestingly) Asia are well endowed with reserves if compared to their annual consumption. This therefore leaves, over the mediumg to long term (3 to 10 years) only one major deficit area, both in terms of current annual consumption versus current annual production and proved reserves: the EU 27.

Furthermore, proved reserves are, for the time being, concentrated for 76% in the Middle East (38%), the Former Soviet Union (22%) as well as Eurasia (14%). This might, over the medium to long term, place some market power within the hands of the producing countries of these areas. However, the creation of a gas cartel appears, at current conditions, unlikely: the global market for natural gas is fragmented (such areas encompass many countries), natural gas has serveal substitues as it is used primarily for electricity generation and heating, and most natural gas remains shipped through a regional network of international pipelines. If, on the other hand, natural gas liberalization and hub liquidity were to greatly improve in Europe, and the international LNG spot market were to increase considerably, the conditions could be set for a defensive reaction from the main natural gas producers.

The picture described above might be substantially revolutionized by the worldwide development of unconventional natural gas exploitation: given today's total world consumption, such development could increase the R/P ratio worldwide from 65 to roughly 120 years. Such exploitation is for the time being limited to North America, and is broadly opposed in Europe due to the environmental concerns it generates. Also, Europe's shale deposits appear harder to extract and its gas industry is faced with more regulations as well as with a less developed pipeline network than North America. Unconventional gas exlpoitation could, however, represent a radical change for Europe, in two aspects: reduce its import dependency (the EU's R/P would be roughly tripled if technically recoverable unconventional reserves were to become proven reserves) as well as split the producers' market power (since such resource is vastly distributed wordlwide).

In terms of trade, the EU and Asia are the main import areas. The majority of imports in Europe are via pipeline (LNG, however, accounts for roughly 1/3 of EU net imports), whereas Asia's imports are for the vast majority via LNG vessels. Pipeline trade supplies adjacent markets, while LNG trade supplies distant markets. In 2011, the total LNG traded volumes accounted for roughly 10% of the world's total consumption. The same spot/long-term trades split existing for pipeline volumes also exists on the LNG market. On this market,

roughly 25% is traded spot (i.e. for short term deliveries, typically within a few months). Also, due to such rigidities, LNG volumes cannot be easily and efficiently arbitraged. Hence, it is important to underline that the growth of the LNG market does not automatically entail a "gas price globalization": the focus here should be on the growth of the LNG spot market, as well as on the development of mechanisms facilitating LNG arbitrage (such as global LNG trading platforms and standardization, both technical and contractual). Of course, a growing LNG market is likely to imply a greater LNG spot market and more arbitrage possibilities; this is however not a necessary implication (for example, if the global gas market were to tighten, LNG arbitrage would be hampered as security of supply would prevail).

The discussion above allows listing the following key developments of international gas dynamics and their impact on EU hub trading growth. They aim at being as mutually exclusive and collectively exhaustive as possible. They variables can then be organized in a framework according to their relevance for the EU's price level (EU supply/demand imbalance) and for global price convergence. The variables are the following

a. Strong Asian consumption surplus: it is likely to tighten the global gas market; Asian and European prices are likely to converge, while additional exports become more likely to come to the market (hence, a high impact on the EU's price level, with an indirect effect on global price convergence as Asia and the EU enter a tighter competition).
b. Strong EU consumption surplus: if the recent decline will be temporary, increasing demand might put pressure on hub prices; on the short term this might lock the EU within its import system and potentially realign hub prices with long-term import prices, thereby hindering hub liquidity growth; however, on the longer term, such development is likely to emphasize the natural gas' market supply/demand dynamics and render the EU market more dependent on the global supply/demand balance (a high impact on the EU's price level, with an indirect effect on global price convergence as Asia and the EU enter a tighter competition).
c. Strong development of unconventional gas production within the EU; it is likely to have a strong (downwards) price level impact as well as a strong boost to hub liquidity (following the EU's guidelines); on the other hand, the impact on global price convergence might be low as markets might remain

nevertheless relatively separated; nevertheless, the impact on hub development would certainly be favourable as it would reduce the exporters' market power.

d. Strong development of unconventional gas production outside the EU; it is likely to have a strong indirect (downwards) price level impact on the EU; on the other hand, it might not necessarily reduce the EU's dependency on long-term imports; furthermore, the impact on global price convergence might be low as markets might remain nevertheless relatively separated; hence, such development is likely to have a strong price impact on the EU while maintaining a relative/weak impact on EU liquidity as well as on global price convergence (due to infrastructure rigidity and long-term sales arrangements).
e. Development of a deeply interconnected EU pipe network: this would strongly promote a favourable environment for trading as well as security of supply; on the other hand, the impact both on the EU price level as well as on global price convergence is likely to be secondary.
f. Strong growth of the LNG spot market as well as of LNG arbitrage opportunities: these are the most powerful catalyzers of a global gas price convergence; on the impact on Europe's price level is also likely to be strong as regional supply/demand imbalances will interact on a much vaster scale.
g. EU supply diversification: the impact on the EU's price level is likely to be low (supply diversification, in itself, does not affect the supply/demand balance); however, the impact on global price convergence seems likely to be strong.

If we look at figure 31, the relative importance of these variables defines different roles for EU hubs, particularly in the light of their dualism with long term import arrangements. Variables a. b. c. and d. point towards the development of regional markets; variable e. in itself, all other conditions being equal, merely foster regional balancing markets (if, however, local supply/demand imbalances increase, such variable represents key infrastructure for the creation of regional markets); variable f. is the strongest catalyzer for the creation of a global market; finally, variable g. points towards the creation of interconnected global markets whose relevance however remains in the shadow of long-term sales arrangements. Hence, most scenarios indicate the creation of regional markets rapidly reacting to supply/demand imbalances. However, even in the case of the development of volatile regional markets, the case remains for security of supply demands by Europe (implying oil indexation as a protection from price manipulation) accompanied by security of demand

concerns of exporters. Key to a complete move towards hub pricing in Europe will therefore be both the EU's diverisification of supply as well as the exporters' diversification of exports (e.g. Russia moving volumes towards Asia). To get globalized markets a strong growth in LNG spot volumes and LNG arbitrage possibilities is necessary.

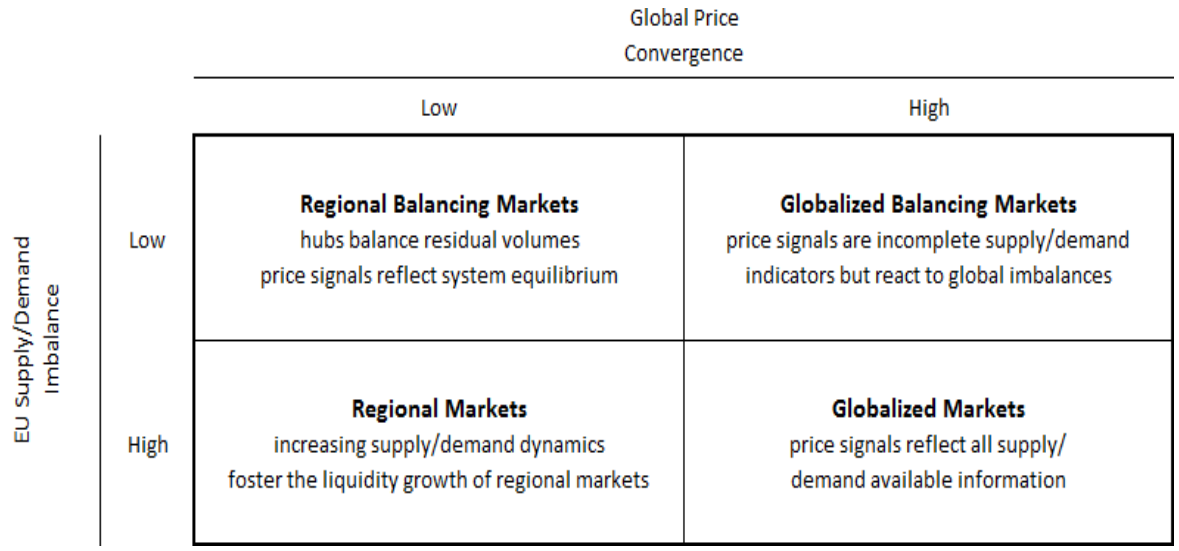

Figure 31: The Role of European Hubs in Different Global Scenarios (Source: Author's model)

Within such evolving and uncertain context, the EU's position appears quite delicate, as it runs the risk of remaining locked in a regional import system if LNG supplies are drained by an increasing Asian demand. Traditionally, the EU has protected its supply security via long-term agreements with its main import sources indexed on oil. This allowed to make heavy investments in infrastructure and ensured that volumes would be delivered while at the same time removing the seller's possibility to control the price (as it was indexed on another commodity). As the EU's consumption grows, such long term contracts started to represent entry barriers hindering competition (as they limit the development of spot markets which can represent a supply source for alternative suppliers). Furthermore, oil-indexation can be seen as hindering security of supply as it prevents the gas price from being set by gas market fundamentals.

The European Union reacted to this situation of increasing uncertainty by promoting an energy policy based on the development of market mechanisms which would ensure the best price for the final customer, diversifying imports and financing investment to develop national energy supply, and finally promoting sustainable development. This was formalized by the selection of the Ten Projects of European Interest in 2006 and the Third Energy Package in 2007. However, a key point here is to highlight the main difference between the

gas and electricity markets, namely the fact that most of the upstream part of the gas chain is outside of the EU; market opening therefore runs the risk of weakening importers. This has notably been the case since the start of the depression in the EU, which has led to regional hub prices traded at a discount with respect to the long-term import prices. It has to be noted, however, that a major reason for such price difference is the value of the flexibility provided by long-term pipeline supplies (i.e. buyers can typically purchase within 80% or 120% percent of the contracted volumes without having to pay penalties, whereas volumes bought on hubs have to be traded on short-term markets to adjust for consumption's profile). Also, balancing tends to have a one-sided characteristic, as undersupply is typically dealt with by sourcing via the long-term arrangements, whereas oversupply typically entails selling volumes on the hubs.

In a world where LNG connects regions and in which the fundamentals of the European gas markets are impacted by events in other continents, the need for an efficient pricing mechanism is becoming ever more important. As EU sourcing diversification improves and as the internal pipeline network develops, contractual flexibility becomes of secondary importance as operators are given the possibility to buy and sell short-term gas to balance their portfolio. Furthermore, security of supply is fostered as gas can choose one of many routes to arrive to its destination. These developments are likely to create an environment in which hub trading will thrive. Transitioning towards hub pricing could also cause sellers to decide that they can obtain similar or greater value by selling gas directly to end users, thereby effectively hindering the existence of long-term contractual agreements. On the other hand, in a liberalized market gas suppliers have an interest in scarcity, as it entails higher prices, which implies the loss of redundancy and spare capacity in the supply system, and therefore the fact that the market alone cannot ensure security of supply.

To conclude and answer the research question, the global natural gas market is affected by a multitude of variables. To anlayze the effect of these variables on the EU's pricing structure, it is important to understand the nature and the effect of each one of them. For the time being, the EU's future is very uncertain. Supply/demand shocks might provoke important shifts in price level. However, the relative role of the European hubs might remain limited if Europe's dependency on imports does not decrease. Over the medium term the present hybrid pricing system appears maintainable, as well as prudent: it ensures security of supply while guaranteeing competition and volume flexibility. Also, it limits the producer's capability to influence prices via oil-indexation. For the time being, the most adviseable

appears to be the hybrid model. Hence, whether hubs will become the only price signal in Europe strongly depends on the extent to which, in the future, global supply/demand imbalances foster LNG trades as well as on the EU's diversification of its supply mix. In short, EU hub growth strongly depends on the globalization of natural gas markets.

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