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A GOLDEN AGE FOR GAS? | IS NON-CONVENTIONAL GAS A GAME CHANGER FOR EUROPE AND THE WORLD?

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"Natural gas is the world's fastest growing fossil fuel with consumption increasing at an average rate of 1.6 %/year from 2008 to 2035. Growth in consumption is more concentrated in non-OECD countries (2.2%/year) where demand increases nearly three times as fast as in OECD countries (0.8%)"[1].

Beginning 2011, more than half of the world's proven conventional natural gas (NG) reserves was concentrated in Russia, Iran and Qatar whereas the first exporters were Russia, Norway and Canada[2]. The biggest conventional natural gas reserves in the world are to be found in the Middle-East (about 40% of the world's proven reserves of conventional gas), although the Middle-East is only the fourth largest producer of NG. Nearly two third of the gas in that region, outside Qatar and Iran, is "associated gas" or gas tied to oil production. It is also to be noted that many of those producing states are facing rising domestic power demand which has an impact on their exports.

"The development of non-conventional gas is overturning the market. The reserves of shale gas are massive. In the US, almost 1/3 of the whole territory has shale gas deposits under its feet. Interestingly, the largest reserves are situated in the North-East of the country, which is also the main region for gas consumption. In Europe, Poland is the country with the biggest prospect for shale gas production [...][3]. China hopes to boost its energy production with shale gas. In Canada, there is a strong discussion to start up shale gas production in Quebec, bringing energy production closer to the more populated South-East of the country and to the North-East of the US. It is important to know that shale gas is not a bonanza story about a potential extra production in the future […]. [It] is already happening now and [...] is already having an effect on the world wide supply-demand balance of gas. In the US, gas production peaked at 555 bcm (billion cubic meters [...] since 2005, the US have expanded their gas production with a staggering 16% and have become the world's largest producer of natural gas again. This reversal [...] can be completely attributed to the shale gas development. This obviously made more LNG available for other markets [...]. If shale gas development would stall, it will not be for lack of funds. The big energy companies are currently pouring huge amounts of capital in shale gas development. The development was started by smaller companies, as is so often the case. The big oil companies are now scrambling to buy these smaller companies.[4]"

At the end of 2010, world's gas consumption was 3,169 bcm (3.169 trillion m^3) and the world's gas proven reserves 187.1 trillion cm^5.

In 2009, the EU was importing more than 60% of its gas consumption via pipelines or LNG facilities. EU's gas imports are going to grow in the future if non-conventional gas (see below) is not part of the game. Europe's dependence on foreign gas is a central issue in the EU's internal debates about its relationship with gas exporters. However there are important differences between EU's Member States.

The bigger western markets benefit from greater supply diversity than EU's eastern national gas markets highly dependent on Russia, although Germany and Italy together account for almost half of all Russian gas consumed in the EU. "These national differences would not matter too much if there were a single European gas market. But the reality is that Europe's gas market is fragmented along national lines. There is little cross-border trading within the EU, and when supply disruptions occur [...] we see very little re-allocation of supply between national markets. The result is that Russian gas has become an extremely divisive issue in European policies. The highly dependent countries in eastern Europe resent German, Italian and French pro-Russian stance [...]. The EU and Russia have divergent interests. Europe wants to de-politicise the EU-Russia gas relationship in order to integrate Russian gas imports into a competitive pan-European gas market and to maximise the volume it can import from Russia. But Russia […] wants precisely the opposite: to keep politics in the gas relationship."[6]

World's conventional gas proven reserves in 2010 were sufficient to meet more than 60 years of global consumption. In any case, the market share of natural gas in the EU is expected to increase because, among other reasons, more and more gas-fired power stations are being and will be built to compensate for intermittent sources of power generation and to replace other types of thermal power plants. EU's gas demand is expected to grow to 544 bcm within 2030.

[1] *International Energy Outlook 2011*, US Energy Information Administration, September 19, 2011.

[2] Proven reserves are generally taken to be quantities that can be recovered in the future with reasonable certainty based on geological and engineering information, from known reserves under existing economic and operating conditions.

[3] Although shale gas reserves appear to be less important than expected.

[4] E&C Consultants, *Marketvision*, October 8, 2010.

[5] *BP Statistical Review of World Energy*, June 2011.

[6] Pierre Noël, *Beyond dependence: How to deal with Russian gas*, European Council on Foreign Relations, November 2008.

Thus in spite of the European energy and climate policies targeting a 80% share of renewable source of energy by 2050, natural gas (NG) will continue to play a major part in the coming decades. "The NG share is expected to grow from 26% in 2010 to 32% in 2050, with an increase from 26% to 30% between 2010 and 2030… However, in 2030 in the EU 27, the market share of the residential and services sector could decrease to about 35%, the total gas volume dropping from 210 bcm in 2010 to 152 bcm in 2030"[7] without expecting the European population to lower its standards of living. This is due to technological progress, market penetration of efficient heating technologies, micro-cogeneration and so on. Of course appropriate support has to be maintained or implemented.

According to *Eurogas Roadmap 2050*, for the transport sector, the natural gas market share should increase between 2030 and 2050, reaching, under the conditions spelled out in that document, 13% and 33% respectively for passengers and freight transport and representing a volume of 33 bcm in 2050. To promote natural gas and bio-methane as a transport fuel, the European Parliament voted on the 19th April 2012 an extension of tax benefits for these fuels. To ensure that natural gas can deliver its potential contribution, the industry needs a stable and predictable policy framework that encourages investments. Beginning 2012, about half of the EU's gas consumption comes from within its territory and from Norway.

1 | Non-conventional gases

A | Types of non-conventional gases

Shale gas is extracted from dark shale, a fine grained sedimentary rock rich in organic matter that is both the source, the reservoir and commonly the seal of the gas. Shale gas is stretching through large territorial areas unlike conventional gas, which is available in a more concentrated fashion. Shale has very low permeability and requires, therefore, either natural fracture systems or to be artificially fractured by a variety of techniques to increase its permeability to an economically viable level.

Tight gas is trapped in unusually impermeable, hard rock, in sandstone or to a lesser extent in limestone formation that is unusually non-porous (tight sand). The permeability is too low for the contained gas to flow naturally at rates profitable under existing economic conditions. To be economically viable, their permeability must be artificially enhanced by means of hydraulic fracturing or other stimulation techniques to increase the gas flow rate.

Coalbed methane is trapped within the coal seams themselves or in the surrounding rocks. Coalbed methane is generated during the "coalification" process, and most of it (98%) is found adsorbed in the coal, which is a microporous solid with large internal surface areas in the matrix pore structure that can adsorb very large amounts of gas. Lesser amounts occur as free gas in fractures (called cleats) and large pores, and/or dissolved in the groundwater present in pores and fractures.

Methane hydrates is a clathrate consisting of methane trapped within a lattice of water ice, found in the permafrost or into the sea floor at the lower edge of continental slopes where temperatures and high pressures permit it to exist. Most methane in gas hydrates is of microbial origin, although some is believed to be the result of thermogenic processes. However recovering methane from hydrates is a long way off but it could have a "huge impact on the availability of natural gas" said professor Holder, dean of the engineering program at the university of Pittsburgh. Japan Oil, Gas and Metals National Corporation (SOGMEG) has been drilling test wells into methane hydrate reserves, off Japan's south west coast. Testings/studies are being carried out in Alaska, Norway and in other countries.

This chapter is essentially focusing on shale gas. A number of the following remarks are also applicable to tight gas. Shale is moderately to deeply buried clay; if that clay comprises a high degree of organic matter, it could be a layer that contains recoverable reserves of shale gas. The organic material is made up of remains of plankton, tiny

[7] Eurogas, *Eurogas Roadmap 2050*, October 2011.

single-cell organisms, deposited on sea beds millions of years ago. These layers were subsequently buried in the earth's crust. A combination of high pressure and high temperatures results in the formation of gas at a depth of several kilometres. The estimation of the fraction of the gas in place recoverable from organic black shales is still controversial and difficult to compute. It is variable from region to region and from rock unit to rock unit, depending on the presence and degree of natural fracturing, the richness of the organic matter, the thickness of the shale and other reservoir properties.

B | Shale gas technology

Innovative American hydraulic fracturing (fracking) and horizontal drilling (directional boring) improvements have enabled the US shale gas boom. These major technological advances have essentially been conducted by the three leading US petroleum service companies: Schlumberger, Halliburton and Becker Hughes.

Fracturing is indeed necessary to improve the permeability of the shale rock formations that have poor porosity and permeability, in order to enable production in commercial quantities. To achieve such fracking, horizontal drilling is necessary to penetrate the bearing rock several thousand feet instead of a few feet with vertical wells as it is the case for conventional gas.

Hydraulic fracking is using huge quantities of water. It is obvious that using less water is an important development field that is actively investigated. Halliburton has worked out a technology which halves the volume of water with respect to current fracking procedures. Further researchs are underway.

The process starts with drilling vertically to just above the known shale deposit at a depth comprised between 1,000 and several thousands meters, and then continues with horizontal drilling through the shale at an angle to maximise horizontal stress for fractures.

A key feature of this process is the high pressure injection of hydraulic fracturing liquid, a mixture of about 90% water, 9.5% sand or ceramics and 0.5% chemicals (acids, chlorides, salts, isopropanol etc). The proppants (sand, ceramics) hold the cracks open whereas the chemical additives are gelling agents to cause the rock to crack, biocides to kill contaminating micro-organisms and substances to sterilise the well.

The horizontal steel pipe is perforated within the target zones that contain gas so that when the fracturing fluid is injected into the well it flows through the perforations into the target zone. Eventually the target formation will not be able to absorb the fluid as quickly as it is being injected. The pressure created causes the rock to crack or fracture. Once the fractures have been created, injection ceases and the fracturing fluids begin to flow back to the surface and is processed. Location and guidance of the drilling is an essential operation. There are several types of devices for locating and guiding the bore head.

The *walkover* system uses a transmitter behind the bore head, registering angle, rotation, direction and temperature. This information is transmitted to the surface in a walkover device. A receiver is manually positioned over the underground transmitter, that decodes the signal. Based on the data so collected, steering directions are relayed to the bore machine operator. In a *wire-line* system, the information is transmitted through the cable fitted within the drill system. The gyro guided drilling is working automatically and is very accurate with small deviations. Typically 15 to 16 wells need to be drilled to find a "sweet spot" which is easily fractured and has sufficient gas saturation to make production economical.[8]

Compared to conventional gas reserves, shale and tight gases are spread over much wider areas. Hence shale (and tight) gas require many more wells to be drilled. Furthermore shale wells deplete faster than conventional gas wells.

Each shale play is unique. As a consequence, the exploration, prospection and production of shale gas are non-standardised processes. The unique characteristics of each play mean that it can take a number of years for a producer to find the best way to exploit an area.

The race is now for the next generation super-fracking techniques able to release larger quantities of gas at even more commercially viable costs, using much less water. However the impact on the environment still needs more testing.

[8] NRG Expert, *Shale Gas Technology*, September 2011.

C | Shale gas market

The large international oil companies have recently begun to take a serious interest in non-conventional gas. It is likely that the interest of non-US companies investing in that sector in the US is driven by gaining experience that can be transferred to their home country.

In Western Europe, the prime targets (based upon geology) are Poland, Germany, the Netherlands and the UK. Latin American countries potentials are being investigated; Argentina seems to have the largest shale gas reserves. China and India are also actively investigating the possibility of extracting non-conventional gases from their domestic deposits. The non-conventional gas situation of the US, China and Europe is briefly reviewed hereafter.

1 | The United States

According to CERA[9], shale provided 20% of US gas supply in 2009 and is expected to rise to 50% by 2035 (Kefferputz)[10]. There may be as much as 23 trillion cm (or 23,000 bcm) in recoverable gas from US shale formations[11]. However such estimate could be already out of date due to developments in fracking technology and exploration. The EIA estimate of shale gas in the US in 2009 was less than half the 2011 estimate!

"Shale gas contribution to the US GDP in 2010 was over USD 76.9 billion, by 2015, it is projected to be USD 112.2 billion and by 2035, 231 billion. According to BP's latest world energy outlook 2012, America is on course to become "almost totally energy self-sufficient by 2030 [...] US gas production has already led to a glut, with domestic prices having slumped, leading to a stabilizing effect on global gas prices, and a 50% cut in electricity prices for US power industries, with a consequent boost for investments"[12].

The horizontal drilling and hydraulic fracking techniques are mastered by north American companies which give an economic opportunity for the US to export those technologies world wide. China is already eager to buy shale gas related equipment and know- how. In his 2012 State of the Union address, President Barack Obama said that the shale gas industry would support 600,000 jobs with more to follow because of cheaper energy. Oil and gas business models are expected to shift from owning the product to supplying the technology and getting paid in tradable shares of proven reserves.

2 | China

China is expediting exploration and development of shale deposits and is slowly moving towards producing shale gas although the country does not have any production yet. The Chinese Ministry of Land estimates that the country holds around 31 trillions m^3 of shale gas. If developed, the country annual shale gas output could exceed 100 bcm by 2020 according to the Land Vice-Minister. Chinese reserves are almost 50% greater than those of the US.

At the end of 2011, China's oil giant SINOPEC (SNP) and CNOC have expressed interest in acquiring a 30% stake in privately held Texas-based fracking company Frack Tech Holdings inc. If that deal ever closes, China would gain the necessary expertise to pursue shale gas exploration at home. However there are significant difficulties. Many early exploration projects are in the quake-prone Sichuan basin. On the other hand, the country lacks the extensive pipeline infrastructure needed to bring the gas to the market. Another concern is the availability of water of which China faces growing shortages.

3 | Europe

In Europe it is more expensive to exploit shale gas than in the US because of deeper and more complex geological

[9] Cambridge Energy Research Associates, American consulting association.

[10] Associate research fellow at CEPS (Center for European Policy Studies).

[11] *Annual Energy Outlook 2011*, US Energy Information Administration.

[12] Peter Glover, *Energy Tribune*, January 24, 2012.

structures, stricter environmental legislation and higher density of population in the relevant areas (in built-up Europe it is more difficult to obtain the necessary drilling and exploitation permits). Moreover contrary to US landowners who benefit from any fossil fuels found on their land, in Europe, they do not own underground resources. Currently it is thought that the Baltic region represents the biggest potential for recoverable shale gas according to professor Jan de Jaeger from the Utrecht university.

A number of the following remarks on shale gas activities in the European countries are based on the final report on unconventional gas in Europe of November 8, 2011 prepared by the law firm Philippe & Partners for the Directorate –General for Energy of the European Commission. Compared with North America, the regions in Europe with the required geological conditions for shale gas are scarce[13]. This is linked to the composition of the subsurface.

In Poland, shale gas deposits are located in the zone stretching from the north-west to the south-west of the country. Most areas of potential interest have already been covered with prospection/exploration authorization and currently are at the phase of seismic surveys. Only few projects have entered the drilling phase. Cost is of course an issue. It is reported that drilling a well for shale gas in Poland is three times more expensive than in the US given the absence of competitive service industry and because of the deposits characteristics. Shale gas explorations are so far less successful than expected.

In Germany, exploration projects are being carried out in the states of North Rhine Westphalia, Lower Saxony, Baden-Würtemberg, Saxony-Anhalt and Thüringen[14]. Studies of the environmental impact of shale gas exploration/prospection are being conducted. Until a decision is taken on shale gas operations based on such studies, shale gas activities are suspended inter alia in North Rhein Westphalia. Implementation and supervision of relevant permits is indeed the competence of the Länder.

In France, three "permis d'exploitation" were granted in March 2010 but drilling is suspended since February 2011 for all shale gas projects. It was decided that the *Conseil Général de l'Industrie, de l'Energie et des Technologies* as well as the *Conseil Général de l'Environnement et du Développement durable* would investigate the economical, social and environmental impact of shale gas activities.

In Sweden, only minor shale gas projects are ongoing. They all have been initiated recently. A review of the applicable legislation is under consideration. The Sweedish government will soon decide to investigate the communication and transparency mechanisms the Minerals' Act foresees towards the concerned municipalities and landowners.

In all member States of the EU surveyed by Philippe & Partners for the DG Energy of the EU, the grant of authorizations and permits is for the time being governed by the general legislation for prospection, exploration and production of hydrocarbons. An analysis conducted by the European Commission on regulation of hydraulic fracking for shale gas extraction concludes that new legislation is not needed for shale gas drilling[15].

A 2012 draft report for the EU parliament environment committee drawn up by Boguslaw Sonik also concludes that existing laws governing drilling for conventional gas are adequate. On the other hand, the oil industry companies insist on the fact that the process of extracting shale gas has already been used for other types of rocks for decades and the protests against it arise from misinformation.

D | Environmental concerns

The questions are: could shale gas development stall because of environmental concerns? Are the most cited harmful effects of shale gas production real problems?

[13] Jan de Jaeger, professor of geology at the university of Utrecht. Before this assignment, he worked as exploration geologist for Shell.

[14] Exploratory drilling in Germany and Sweden has so far been unsuccessful.

[15] Regulation 2006/1907/EC concerning the registration, evaluation, authorization and restriction of chemicals, establishing an European Chemicals Agency (REACH), is applicable to the use of fracturing fluid which consists of a mixture of chemical substances, provided that the thresholds for registration are fulfilled. All scrutinised Member States foresee sanctions in case of non-compliance with REACH.

1 | Visual nuisance

The number of drilling pads of each shale gas drilling site could go up to 20 to 30. However the same drilling rig is used for drilling all the wells within a site and is thus moved from one pad to the next one. The drilling time depends on the number, length and configuration of the horizontal borings; it takes several weeks for each pad. When the drilling operation of a site is completed, the drilling rig is removed to another drilling area.

Moreover multiple laterals can be bored from the same well pad so that a bigger part of the shale can be accessed from one location, which limits the surface disturbance. It means that a vertical well can be connected to several horizontal wells, up to 2 to 3 km long. This multiple laterals technique also reduces the truck traffic transporting the water to fill a pond from where the water is injected into the well. The shale gas exploitation development can thus be planned to mitigate the footprint on the landscape. When the deposit is exhausted, the land is reclaimed.

The major visual impact is a matter of a few years, much less than wind farms for instance.

2 | Ground water contamination

Ground water contamination does not directly come from injecting fracking chemicals deep into shale rock formations because they are located well below water aquifers. The fractures at the extraction level are relatively small (up to 100 m).They cannot propagate much further because there is not enough energy.

However contamination could come from poorly constructed injection pipelines or pipelines taking the waste water and chemicals to the processing facilities. To avoid leakages, in particular at the level of the water table, vertical wells are sealed with multilayered steel and concrete to a depth of up to about thousand meters to prevent fluids, chemicals or gas from seeping into the groundwater.

In a nutshell, if the work is undertaken with the necessary care the groundwater should not be contaminated. The environmental risk is no greater than in conventional oil and gas production according to professor Jan de Jaeger.

3 | Uncontrolled methane releases

An analysis by Howarth et al. (April 2011) of the well to consumer life-cycle of fracked natural gas concluded that 3.6 to 7.9% of the methane produced by a well will be leaked in the atmosphere during the well's lifetime. However numerous studies have pointed out critical flaws with that paper and/or come to completely different conclusion. In January 2012, Howarth's own colleagues at Cornell university, Lawrence Cathles et al., responded with their own peer reviewed assessments, noting that the Howarth's paper was seriously flawed because it significantly overestimates the fugitive emissions associated with unconventional gas extraction, undervalues the contribution of "green" technologies to reducing these emissions to a level approaching that of conventional gas and so on.

Lawrence Cathles concludes that "shale gas has a GHG footprint that is half, perhaps a third that of coal. There are significant challenges in terms of local environmental problems [...]. We have seen that we can solve these problems with existing technologies. If this is done, it will increase the cost of production by 10-15% in some cases, but the investments will still be profitable. So the message is: if gas producers want to see a golden age of gas, they have to apply golden rules to their extraction technologies"[16]. GHG emission from shale gas extraction is only 2 to 3% higher than that from conventional natural gas production.

4 | Water consumption

In the US, "the drilling and hydraulic fracturing of a horizontal shale gas well may typically require 2 to 4 million gallons of water (about 7,600 to 15,000 cm)[17]. It should be noted that the volume of water need may vary substantially between wells. In addition the volume of water needed appears to be decreasing as technologies and methods improve over time [...]. While the water volumes needed to drill and stimulate shale gas wells are large,

[16] Alex Forbes, *European Energy Review*, November 14, 2011.

[17] Apparently total water consumption per well may go up to 20,000 cm.

they generally represent a small percentage of the total water resource use in the shale gas basin. Calculations indicate that water use ranges from less than 0.1% to 0.8% by basin. This volume is small in terms of the overall surface water budget for an area; however operators need this water when drilling activity is occurring , requiring that the water be procured over a relatively short period of time […]. One alternative that states and operators are pursuing is to make use of seasonal changes in river flow to capture water when surface water flows are greatest [or] to store water withdrawals obtained during periods of high flow [...]. States, local governments and shale gas operators seek to manage produced water in a way that protects surface and ground water resources… By pursuing the pollution prevention hierarchy of "Reduce, Re-use and Recycle" these groups are examining both traditional and innovative approaches to managing shale gas produced water."[18]

Operators are more and more recycling the fracking water by returning a large fraction of it to the surface and after treatment, using it in the next well.

5 | Earthquake hazards

There are concerns that the injection of large amounts of fluid into gas shales could trigger earthquakes. Actually the experience accumulated so far tends to indicate that it is not the fracturing process itself that triggers significant earthquakes, but it is what occurs during the production phase that could be a cause for concern. Indeed in some cases, the volume of waste water is so large that recycling is not economical. Instead the waste water is returned to the surface and then injected deep underground into disposal wells storing fluids from many fracking wells. In view of the volume so injected, enough energy could be generated to trigger an earthquake.

Indeed the earth is pervasively fractured and faulted. Natural stresses put faults and fractures close to failures. According to Bill Leith[19], when injecting big volumes of water at high pressure into the rocks, the sides of the faults are pushed apart which allows the fault to slip more easily than without large quantities of high pressurized water. There is a correlation between the volume of fluid injected and the earthquake magnitude.

The hydro-fracture itself (fracking process) releasing much less energy than the one of the big volumes of waste water under high pressure, could induce earthquake of a magnitude less than 2, which is not a safety concern. Dr Cliff Frohlich[20] suggests that "for the most part, earthquakes related to injection don't get larger than the natural earthquakes in an area".

2 | The European gas market

As a rule in Europe, security of supply has been historically met through long-term (20 years or more) gas contracts between gas producers and buyers. Such agreements include a "take or pay" clause or in other words buyers must take the minimum agreed volumes of gas or if they don't, they must pay for it. Long-term gas contracts are considered as securing sufficient cash flows for investments in gas production and infrastructure projects, like pipelines including cross-border connections and LNG terminals. It is seen as a way of sharing the risks between gas sellers and buyers.

However the European gas market is undergoing a deep change. With a temporary reduction in gas demand due to economic downturn in 2009, strong US gas production resulting from technological breakthroughs in extracting gas from shale, the increase in LNG imports available for Europe and lack of powerful cartels, lower priced spot supplies are increasingly undermining long-term contracts that have traditionally dominated the market.

[18] *Modern shale gas, development in the United states: a primer*, US department of Energy, April 2009.

[19] Bill Leith is a seismologist and served as Chief of the USGS Special Geologic Studies Group.

[20] Associate Director and Senior Research Scientist at the Institute of Geophysics , University of Texas, Austin.

A | European hubs

There is a number of gas wholesale markets (hubs) in Europe. The most liquid one with churn ratios[21] of about 15 in 2010, is the British National Balancing Point (NBP). Altogether, there are 8 North-West European gas hubs, including:

- NBP (UK), TTF (the Netherlands);
- ZEE (Belgium), CEGH (Baumgarten, Austria), GPL (Gaspool, Germany);
- NEG (Germany), PEG (France), PSV (Italy).

The most successful hubs are NBP and TTF (Title Transfer Facility) while Gaspool and CEGH offer future possibilities, NEG and PSV are facing uncertainties of development, NEG is emerging and ZEE volumes are falling and offers poor liquidity[22].

B | Gas target model

The EU and Member States are working on transforming the European gas markets into a single liberalised market. The first step to make this great change possible was the legislation, called 'the third package", put in place in 2009 by the Commission. The independent national energy regulators were given the task to supply the details of the new market structure. The regulators which unofficially cooperate in the Council of European Energy Regulators (CEER) and officially in the Agency for the Cooperation of Energy Regulators (ACER), felt also the need to provide a vision of the future market structure which was eventually known as the "Gas Target Model".

It was in December 2011 that CEER established its target model for European gas markets. The Gas Target Model (GTM) sets out the vision for the European gas market in 2014 and beyond, based on the input from the Florence School of Regulation and from consultants. CEER's vision of a sustainable internal gas market is based on a core objective of enabling performing wholesale markets where they do not exist yet. Furthermore, markets need to be connected closely to move forward to an integrated market. The Gas Target Model hopes to deliver:

- Efficient use of existing infrastructures;
- Well-functioning wholesale markets in all of Europe;
- Connected functioning wholesale markets in all of Europe;
- Secure supply patterns that ensure gas flowing to Europe;
- Ensuring that economic investments take place.

National Regulatory Authorities (NRAs) will assess market liquidity and the degree of market integration in the framework of the regional initiatives. Where necessary for creating functioning wholesale markets, NPAs will explore measures to improve market liquidity and the degree of market integration.

The markets are organised in the form of "entry-exit zones" where shippers have to pay for entering the zone and delivering the gas at its final destination or at an exit point, but not for the distance the gas travels. In addition, the zones will be connected to each other in a way that stimulates competitive cross-bordering trading. Thus the various market zones will be more or less integrated into a single market.

Unlike Gazprom's view, Walter Boltz, CEER Vice-President and Vice-Chair of ACER's board of regulators, is convinced that the new European market will become more attractive for outside suppliers who are faced with large investments. Indeed with this new gas market, instead of being limited to single countries, suppliers can sell in the whole European market which is connected and transparent and which everyone can access on an equal basis.

However Walter Boltz concedes that the market will be more short-term oriented. "This means that you cannot expect shippers to commit themselves to long term investments in cross-border pipelines. We are looking at different investment incentives. I think the outcome will be that regulators will increasingly decide on capacity that needs to be built. This means that a large share of the costs will be socialised."

[21] Total volume of gas traded compared to the volume of gas consumed, a good measure of a given market's liquidity and depth.

[22] Patrick Heather, Senior research fellow, OIES Gas Research Programme, Presentation at Florence, March 21, 2011.

C | The Russian case

The Gazprom's contractual approach is hardly sustainable in Europe. Indeed, overall demand for gas is down in Europe for the time being while new gas sources are significantly up.The shale gas boom in the US has freed up large quantities of LNG that are fuelling the European spot markets. Consequently spot prices are structurally lower than Gazprom's oil-indexed prices. In particular, the UK NBP (National balancing Point) became an attractive alternative to oil indexed contracts.

This new situation leads to "renegotiations of the oil indexed prices in the long-term gas contracts in favour of a more gas-on-gas pricing. However more need to be done for European gas wholesale gas markets to be sufficiently liquid sending reliable price signals. Any Gas Target Model will need to provide a regulatory framework that secure supplies in the long, medium and short term, which means making Europe attractive for gas import also in the future and taking into account seasonal and short-term fluctuations in gas demand. A competitive wholesale market will need to be efficient, thereby delivering gas to where it is valued most whilst providing shippers with right incentives to secure supplies to European consumers"[23].

D | Long term contracts and oil indexation

But what about security of supply? Will the excess gas from the US and other producing countries with big gas reserves, be exported to Europe or to Asia where prices are more attractive? Will European hubs still be fuelled in the future with cheap gas? India and China along with South Asian buyers (Indonesia, Singapore, Vietnam and Thailand) will sustain the growth of planned LNG re-gasification capacity during the coming years. "Several of these countries are planning to construct floating LNG re-gasification facilities and charter floating LNG re-gasification vessels for a quick, low cost and flexible option to meet peaking or sudden increases in gas demand. The total planned capacity addition by new LNG importers in South Asia will account for 31% of the total planned LNG capacity of Asia Pacific by 2016"[24].

All those countries offer to gas exporters much better prices than European countries do. Hence, even though gas prices are down at the hubs, some long term contracts are still to be expected in the future. Overall demand grows substantially and long-term contracts give the security badly needed.

Gertjan Lankhorst[25] notes that in the Dutch market, where long-term contracts had virtually disappeared, energy company Eneco has recently entered into new long-term contracts with several suppliers.

On the other hand, it does not seem likely that the link between oil and gas prices will entirely disappear. Indeed big oil companies produce more and more gas. If oil prices are higher, they will direct more of their resources to oil and less to gas. They are also investing in gas to liquid operation.

What about financial institutions getting more and more involved in the gas market with the growing importance of spot trading? Although they contribute to enhancing the liquidity of the market and to growing convergence of gas prices in Europe, wouldn't the involvement of banks lead to speculations jeopardizing the very objectives of gas trading.

E | Bargaining position of gas buyers

Another issue concerns the European competition policy. Because of the competition principle, European gas companies are not allowed to join efforts to negotiate gas contracts with big gas producers like Gazprom. It is a kind of cartel which is not allowed by the European law. However such joined approach is a very efficient way to obtain good prices all the more so that gas has a direct impact on gas power generation and hence on the energy cost for industry.

Preventing gas companies from building up common purchases leads to weakening the competitive position of

[23] CEER, *Vision for an European Gas Target Model*, Conclusions paper, December 1, 2011.

[24] GlobalData, April 2012.

[25] CEO of Dutch gas trading company GasTerra and Vice-President of gas industry association EUROGAS.

European companies buying electricity from gas and to increase the cost of power balancing required by the intermittent renewable energy. Hence the rule of ensuring competition within the EU borders has a pernicious effect, in this particular case, on competitive gas prices and consequently on the competitive position of the European industry on foreign markets.

On the other hand the very fact that the EU bans collective purchasing agreement makes the lobbying position of the Commission towards gas suppliers such as Uzbekhistan and Turkmenistan, weaker. Indeed, at the end of the day, the gas companies will have to negotiate the gas contracts and not the Commission.

F | Incentives

Because of increasing renewable energy and progressive phase out of nuclear power the security of electricity supply being not possible without gas in the coming decades, the right signal should be given to invest in gas infrastructures, domestic gas production where possible and power generation from gas. It is indeed not logical to develop renewable energy at great expense and not to provide incentives to promote a mix of gas resources and routes as well as gas power plants all the more so that the profitability of such investments are a cause for concern.

In that respect, the Commissioner in charge of energy appears to be adapting his policy on the strategies of the Commissioners in charge of environment and climate and hence neglecting to some extent his real job.

3 | Gas/LNG transport

Transport modes and routes have diversified. Until the early 2000s, most European imports came via pipelines. Since then Europe has been importing more and more liquefied natural gas (LNG) which are transported by sea. In Europe, LNG is delivered to terminals in the Channel and the Mediterranean Sea.

Since 2002, LNG from Nigeria, Egypt, Trinidad or Qatar has accounted for a great deal of the EU gas imports, bringing the share of LNG in EU gas imports to more than 20% in 2007[26]. Global LNG trade currently accounts for 30% of the world wide natural gas trade. Russia remains a very important gas supplier. However, it is facing challenges to maintain its current supply level from the three "super-giant" west Siberian gas fields, now in decline. To compensate for this decline, Gazprom depends on the development of the Yamal peninsula (in north-west Siberia) gas fields. These latter are expected to come on stream in 2015. This suggests that imports of non-Russian gas will have to increase even faster to allow for continued growth in consumption.

It should also be taken into account that the potential for import expansion from Norway is limited and rising internal consumption will limit export growth from Algeria. On the other hand LNG imports are not necessarily the solution to the possible scarcity of European gas supply. Indeed the LNG market is becoming increasingly integrated. Contracts have become more flexible and cargoes, even contracted ones, tend to go where the spot price is highest. Gas short buyers, especially in Asia, are bidding up the prices. However this has not prevented Poland to build a LNG terminal on the Baltic coast, enabling gas import from Qatar.

The trend in the global gas market is towards greater liquidity of supply, supported, to a great extent, by the production of non-conventional gases such as shale gas. Production tends to increase worldwide. Maybe, at some point in time, Europe will be able to tap its own shale gas fields.

As far as piped gas is concerned, there are seven alternative projects of delivering Caspian gas to Europe via Turkey or the Black Sea. The problem is that all these projects rely partially on Azeri gas, some of them crossing Turkey which could be "another Ukraine", gas availability is limited and all promoters have to hurry up because of the fierce competition between pipe projects but also between LNG and pipes. This is a typical first-come, first-served game.

[26] BP, *Statistical Review of World Energy*, 2007.

A | Nabucco

The 3,900 km pipeline project of an estimated cost of EUR12 billion, designed to bring Caspian gas to a hub outside Vienna, is backed by the EU Commission as an element of the EU's strategy for security of supply. Six companies are involved in the investment scheme: RWE (Germany)[27], OMV (Austria), Botas (Turkey), Transgas (Romania), Bulgargaz and Mol (Hungary) whereas three financial institutions should be sharing half of the total investment: EBRP, EIB and IFC[28]. None of the participants is a gas producer which is a weak point of the project. The gas resource could come from Azerbaïdjan[29], Turkmenistan and from Irak (see below).

The first stage of the project would have a capacity of 10 bcm, fed from Shah Deniz-2. To meet its target capacity of 31 bcm, talks were held with Turkmenistan, where one of the world's largest gas fields are located. In this context, on September 12, 2011, the European Commission announced that the EU 27 Member States had given it a mandate to negotiate with Azerbaïdjan and Turkmenistan[30].

There are many challenges ahead: the rival projects, the funding, the discoveries of more and more non-conventional gas reserves, the continuing financial and economical crisis, the availability of gas to fill the pipeline. About this latter issue, in addition to the potential 10 bcm from Shah Deniz, another 20 bcm is required to secure the profitability of the project. Turkmenistan is not very likely to fill the gap for geopolitical reasons. What about the Kurdish region where huge reserves have been discovered? To make a deal with Kurdistan feasible, the Kurds should "resolve their dispute with Iraq central government over the absence of a revenue-sharing law… This would provide a firm legal basis for the allocation of gas proceeds and a regulatory framework for contracts and investment"[31].

For all those reasons the construction of the Nabucco project is very unlikely to be implemented under its current structure.

B | Nabucco West

Nabucco West would transport gas from the Turkey/Bulgaria border to the Baumgarten gas hub in Austria via Bulgaria, Romania and Hungary. It is a short version of the initial Nabucco project, with a 1,300 km, 48 inch, pipeline , a capacity of 16 bcm/year and a technical capacity of up to 23 bcm/year. This proposal is supported by all six shareholders of the Nabucco project and by the Intergovernmental Agreement (IGA) signed in July 2009.

C | South Stream gas pipeline

The South Stream project, estimated at EUR 16 billion, was designed to diversify the Russian gas export routes. It will comprise a 900 km offshore section running under the Black Sea to transport 63 bcm of gas via Turkey to countries of southern and central Europe.. Intergovernmental agreements were signed with Greece, Bulgaria, Serbia, Croatia, Slovenia, Hungary, and Austria in order to implement the on-shore gas pipeline section. The South Stream consortium includes Gazprom (50%), ENI (20%), EDF and Wintershall (15% each).

In fall 2009, Gazprom signed a gas purchase contract with Azeri's GNKAR using the European pricing formula with no limitation in volume. The price is reported to be USD 200/1000 cm at the Azeri-Russian border. Taking into account expenses on transit, gas is expected to be sold in Europe at more than USD 320/1000cm.

Gazprom is said,for what it is worth, that it does not intend to buy Azeri gas to ship it through the South stream pipeline. Instead the Russian gas that costs USD 50 to 60/1000 cm, can be pumped into the South Stream. The Azeri gas will be delivered to Russia and distributed in the country's southern regions saving logistical expenses.

[27] In 2012, RWE publicly voiced concern about the project and MOL is following suit.

[28] EBRD : European Bank for Reconstruction ans Development. EIB : European Investment Bank. IFC: International Finance Corporation.

[29] The Shah Deniz field has proven recoverable gas reserves of 1.2 trillion cbm with considerable upside potential. The field was developed in two phases with the 1st one already delivering 6.8 bcm annually to Turkey and 3.2 bcm into local markets of Azerbaïdjan and Georgia. Gas volumes from the second phase are expected to be 17.6 bcm/year.

[30] Other gas projects with Turkmenistan are more advanced. A gas pipeline liking Turkmenistan to China went on stream recently. Turkmenistan also hopes to export gas to Pakistan and India.

[31] *European Energy Review*, June 6, 2011.

Gazprom decided to speed up considerably the implementation of the South Stream gas project. The construction will begin as early as December 2012 instead of in 2013 as previously scheduled. However if Russia succeeds in solving the Ukrainian problem, is the South Stream pipe still necessary all the more so that the concerned European countries are in a position to stall their project by refusing to deliver the required pipe layout permits?

D | Trans-Adriatic-Pipeline (TAP)

The TAP pipeline would transport 10bcm/year of gas from Komotrini (near the border between Turkey and Greece) to Italy, through Albania and the Adriatic Sea. The consortium includes Statoil, Eon and the Swiss energy utility EGL. Statoil and Eon are among Europe's most experienced pipeline construction management and pipeline operators. Statoil, the Norwegian major, is developing Shah Deniz alongside BP.

The advantage of this project over Nabucco is its reduced investment requirements because it is more modest in scope and connects to existing pipelines in Turkey and because it can be sourced entirely from Shah Deniz-2 because of its capacity of only 10 bcm and without any political sensitive outbreak to other supplier countries.

Albania which has gained a lot of stability since it became a NATO member in 2009, had signalled that it will do its utmost to cooperate with the TAP consortium when it comes to planning and constructing the pipeline through Albania.

E | Turkey-Greece-Italy pipeline (ITGI)

The consortium includes DESFA, the Greek state natural gas TSO that will construct the pipeline, DEPA and EDISON that do not represent credible buyers and have not the capacity to deliver the infrastructure.

F | South-East European pipeline (SEEP)

The project proposed by BP in 2011, is a newcomer in the group of competing projects. It appears to be a restructured and less expensive version of Nabucco, utilizing some of the existing inter-connectors in south-eastern Europe. As a result, only 1,300 km of new pipelines would be required.

This project offers the possibility to supply gas to Bulgaria, Romania, Hungary and potentially Croatia. Another advantage that SEEP shares with TAP is that both pipeline capacities can be increased by compressors from its original capacity of 10 bcm in the future. However , unlike TAP, SEEP is for the time being more of a concept. Many of the details are still not available such as a detailed feasibility study or concrete cost estimates.

"Between 2008 and 2010, long distance pipeline gas (LDPG) lost a total of 10 bcm while imports of liquefied gas rose to 11 bcm in 2009 and 18 bcm in 2010. The oversupply of LNG is due to a decrease of global gas demand during the recession, a lack of US gas import demand because of the unconventional gas take-off and new LNG capacity that came on-stream in Qatar. Undoubtedly, 2015 will be a turning point for global gas markets, especially in Europe. The industry's status quo is about to be disrupted, with both a worldwide surplus and a plunge in prices expected [...].The gas import infrastructure is undergoing massive expansion in both pipeline gas and LNG. A conservative assessment of import infrastructure projects either under construction or in the planning stages reveals a 65% increase in pipeline capacity and more double the LNG import capacity by 2020. We believe overcapacity will reach 77 bcm by 2020, even in a conservative scenario [...]. As a consequence, we expect more competition between pipelines and LNG import terminals [...]. This will benefit spot LNG in periods of oversupply [...]. In Europe, we predict higher demand for LNG over this decade, from around 80 bcm to 113 bcm, an increase of 42%"[32].

[32] A.T. Kearney, *The future of the European gas supply*, April 2012.

G | Tanap

In June 26, 2012, Azerbaïdjan's President Ilham Aliyev and Turkish Prime Minister Recep Tayyip Erdogan signed the Intergovernmental Agreement on the Trans-Anatolia Gas Pipeline (Tanap) project. Another two documents were also signed the same day. Azerbaïdjan, via Socar, intends to sell 29% of its 80% share of Tanap to oil and gas companies operating gas fields in Azerbaïdjan, thus holding a majority stake of 51%. Botas Turkish gas pipeline company holds 15% of the shares and Turkish Petroleum 5%.

Tanap is designed as a scalable pipeline. Its capacity will be scaled up to 16 bcm/y by 2020, 23 bcm/y by 2023 and 31 bcm/y by 2026. Start of construction is planned late 2013 or early 2014 and first flow in 2018 (when Shah Deniz phase 2 production is due on stream).

The cost of the project is estimated at USD 7 billion out of which USD 1.8 billion are to be covered by Tanap's shareholders proportionately to their stakes in the project. Most of the remainder is to be raised through bank loans.

However the route from the end of this pipe (Turkish border) to Europe is still a pending issue. There are two possibilities: or the Nabucco West pipe to northern Europe, or the Tap pipeline to Italy. The decision will depend on economic considerations and shareholders priorities.

4 | Gas storage

Natural gas storage is traditionally required for:

- adjusting supply and demand;
- optimizing transmission and production infrastructures;
- ensuring security of supply:
    - mitigating risks in case of supply shortage;
    - complying with public obligations.

However the development of the gas market lead to new requirements linked to:

- coordination between different means of power production (intermittent/thermal);
- arbitrage between spot market and long term contract;

There are several ways of storing gas: underground, as LNG, or in pipelines.

A | Underground gas storage

It is the more important type of gas reservoir. Gas can be stored underground in:

- depleted oil or gas caverns;
- aquifer reservoirs;
- depleted salt caverns.

Depleted gas caverns and aquifers are the most suitable facilities for seasonal storage i.e. for balancing seasonal gas demand fluctuations since they offer large storage volumes and are more cost-efficient than other storage options, such as salt caverns. Traditionally, natural gas companies inject their production underground during the off-peak summer months to meet peak consumption during the winter.

Salt caverns are instead frequently used to balance daily and hourly demand fluctuations or unforeseen supply disruptions. This type of storage facility is often called "peak-shaver". They are smaller in volume than seasonal storage facilities and allow, thanks to less resistance, quick extraction of gas. Their investment costs are higher (about twice as expensive) but their operating costs much lower than depleted deposits storage.

B | LNG storage tanks

LNG storage tanks offer a number of advantages over underground reservoirs. As a liquid at approximately –163°C, it occupies about 600 times less space than gas stored underground and it provides quick delivery at very short notice because LNG storage facilities are generally located close to the market and can be trucked to customers. Such facilities are however more expensive to build and maintain than new underground storage facilities.

C | Pipeline capacity

Gas can be temporarily stored in the pipeline itself through a process called line packing. This is done by storing more gas in the pipeline under increased pressure. During period of high demand, greater quantities of gas can be withdrawn from the pipeline. Line packing is usually performed during off-peak times to meet the next day's peaking demands. This method however only provides a temporary short-term substitute for traditional underground storage.

D | Gasholders

Gas can be stored above-ground in tanks at district pressure so that they can provide extra gas very quickly at peak times.

The recommended storage ratio versus consumption is 20%. In Europe out of 530 billion cm/year consumption the current storage capacity is about 80 billion cm including investments under construction. Germany has the largest storage capacity of about 20 bcm followed by Italy with near 15 bcm and France with around 12 bcm. Altogether the EU27's storage capacity is close to 84 bcm. The Wingas storage facility at Rehden in Northern Germany-the biggest one in Western Europe- has a working gas volume of more than 4 bcm and occupies around 8 km^2 of space underground. It represents about a fifth of the entire storage capacity in Germany.

Although gas storing plays a crucial role in ensuring the EU's security of supply, the Commission warned that gas warehousing can also seriously distort the market. In order to ensure that storage capacity is used efficiently and does not impose unreasonable costs on consumers, all provisions of the EU legislation must be respected, in particular the third party access to gas storage facilities.

It is the responsibility of the Member States to ensure that the use of storage for production operations is not abused by local producers through the creation of de facto priority access to storage.

5 | Conclusions

The increasing share of renewables in the EU power generation requiring more and more gas-fired power plants to compensate for intermittent electricity production, the replacement of coal-fired power stations, the partial switch from nuclear to gas in Europe's power sector in the aftermath of the 2011 Fukushima disaster in Japan, the expected reduction in newly built nuclear power plants which will be partially offset by combined cycle gas power production, the penetration of natural gas in road transport, although at a slow pace for the time being, will lead to an increase in annual gas consumption.

Natural gas deposits are vast and widely dispersed geographically. This fuel offers environmental benefits compared with other fossil fuels.

It appears from the European Roadmap 2050, that by 2050, gas consumption in EU27 will be 800 TWh, i.e. more gas than today. If the CCS (carbon capture and storage) technology is mastered by that time, this figure could still be higher. This could be an incentive for the gas industry to get involved in CCS development investments.

As gas fired power plants are unavoidable to the penetration of intermittent energy such as wind and solar power [33] – this view being shared by all stakeholders and not only by the gas industry – shouldn't incentives be offered to this type of power generation like the subsidies to renewables?

A | Non-conventional gas revolution

Some years ago, a game-changer emerged: non-conventional gas.

The development of this gas is overturning the market. Its reserves are massive and well distributed worldwide with the biggest deposits in China, the US and Argentina although the volumes estimates are still uncertain.

"Unconventional gas may hold the key to expanding the long term role of gas in the global energy mix. Already the unconventional gas revolution has reshaped the market in the US and lastingly affected global markets. Over the last decade, substantial LNG re-gasification capacity was built in anticipation of the US becoming a large importer. However the unexpected and substantial rise in domestic gas production during that period, particularly from shale gas, has reduced import needs, leaving these facilities underutilized and freeing up LNG for other markets (notably Asia and Europe). The situation has changed so quickly that proposals to export from North America are now being seriously advanced …The life cycle emissions of shale gas production have come under scrutiny… total emissions from production are only slightly higher than for conventional gas and both water and climate impacts can be mitigated using existing techniques"[34].

However in Europe, it is more expensive to exploit shale gas than in the US because of deeper and more complex geological structures, stricter environmental legislation and higher density of population.

B | Environmental concerns

The question is: could shale gas development stall because of environmental concerns? Are the most cited harmful effects of shale gas production such as visual nuisance, ground water contamination, uncontrolled methane releases, water consumption or earthquake hazards, real problems?

The experience shows that these consequential effects can be adequately addressed with existing technologies, of course at a cost, but without affecting the profitability of the projects to such a point that investments are deterred. "If gas producers want to see a golden age of gas, they have to apply golden rules to their extraction technologies".

C | European policy

EU's gas dependence is going to worsen in the future if non-conventional gas is not part of the game. In that respect it is unfortunate that most European governments have decided to suspend non-conventional gas exploration, Poland being an appreciable exception.

Dependence on foreign gas is however a central issue in the EU's internal debates about its relationship with exporters. There are different strategies among EU's Member States. The national differences would not matter too much if there were a single European gas market. But the reality is that Europe's gas market is fragmented along national lines. As a rule, there is not sufficient cross-border trading within the EU, and when supply disruptions occur, there is very little reallocation of supply between regional markets. The result is that Russian gas has become an extremely divisive issue in European policies.

In this respect the mandate given to the Commission by the EU27 Member States to negotiate with Azerbaïdjan and Turkmenistan on the Trans-Caspian pipeline system appears more as a way to keep alive the Nabucco pipeline than a credible negotiation mission given the different approaches of EU's Member States which at the end of the

[33] However the moto of the supporters of renewable energy is « Renewables drive, gas supports », in other words no dash for gas, whereas the gas industry is investing for the long term.

[34] IEA, *World Energy Outlook 2011*.

day will be the decision makers with their gas companies.

Actually the real issue is whether the Nabucco project will ever be implemented. It does not only face opposition from Gazprom but EU's Member States are also divided about the opportunity to achieve this difficult and costly project all the more so that there are less expensive and more credible alternatives.

D | New contractual and pricing approaches

With the current reduction in gas demand due to the 2009 economic downturn, the strong US gas production resulting from technological breakthroughs in extracting gas from shale, the increase in LNG availability and lack of powerful cartels, lower priced spot supplies are increasingly undermining long-term contracts that have traditionally dominated the market.

Spot prices are structurally lower than Gazprom's oil-indexed prices. In particular, the UK NBP (National Balancing Point) became an attractive alternative to oil indexed contracts.

In this context, Gazprom's contractual approach is hardly sustainable in Europe. This new situation leads to renegotiations of the oil indexed prices in the long-term gas contracts in favour of a more gas-on-gas pricing or other forms of pricing closer to the market's reality.

This is the case of a number of European gas companies, some of them having filed a legal action against Gazprom to revise the terms of their gas purchase contract, in particular the oil-indexation clause.

Such renegotiations of contracts reflect the shift towards a buyer's market. In this context, what about cartels of gas buyers? Is it economically justified, for the sake of the competition principle, to prevent European gas companies from joining efforts to negotiate contracts with big gas producers?

Now the question is: will the excess of gas from the US or from other gas producers with big reserves, be exported to Europe or to Asia where prices are more attractive? Hence even though gas prices are down at the European hubs, long-term contracts are not expected to completely disappear in the future. Worldwide demand will continue to grow and long-term contracts give the security of supply. In the same way, it does not seem likely that the link between oil and gas prices will entirely vanish because, inter alia, of big oil companies. Indeed they produce more and more gas. If oil prices are higher, they will direct more of their resources to oil than to gas.

At last but not least "because of shale gas revolution there are now huge investor uncertainties at all stages of the gas value chain. Whether to invest in gas production-conventional or otherwise? Whether to invest in new pipelines, LNG plants and storage? Whether to invest in long-term supply contracts? All of these uncertainties are likely to lower future investment levels. There already signs of gas export projects being cancelled or postponed.[35]"

Jean-Pierre SCHAEKEN WILLEMAERS

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