Will US Liquefied Natural Gas be able to compete with the Russian gas markets in the long term?

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Summary - Conclusion

Even if the massive arrival of US LNG on the markets over the next few years will fundamentally change the configuration of world gas supply, a distinction must nonetheless be made between the short term and the long term, and between the European and Asian markets.

On the European markets, only the US LNG produced by existing installations can currently be valued at a cost similar to that of Russian gas (between USD 5-6/MBTU) imported by pipeline. However, it will prove difficult for LNG from installations that have not yet been built (USD 8/MBTU) to compete with Russian gas. In theory, if oil prices increase to around USD 70/bbl, gas prices will automatically increase, making American LNG competitive. In view of the production costs, however, the Russians can easily grant their European clients discounts relative to the indexed contract prices. This spot market strategy already applies to two-thirds of the volumes produced. In economic terms, the Russians therefore have major levers, both short-term, by imposing prices lower than the indexed prices, and longer-term, by deterring investment decisions on future LNG trains. As proof, US exports of LNG to Europe in 2016 and 2017 accounted for less than 10% of total US LNG exports. Nevertheless, behind the scenes of this price war, the Europeans do not want to jeopardize their energy security by over-reliance on the Russian gas supply. The difficulties in launching the *Nord Stream 2* project show that in spite of proven competitiveness and significant levers on margins, geopolitical problems make the Russian gas strategy vulnerable.

The situation is very different on the Asian markets, as onshore pipeline infrastructures are non-existent. The projects for creating the West entry (*Altai* gas pipeline) and the East entry (development of the Chayanda and Kovykta fields, *Power of Siberia* pipeline) to the Chinese network, will require heavy investments, generating a gas price of USD 9/MBTU, almost equivalent to that of US LNG which, thanks to the early opening of the Panama Canal, now has access to the Asian markets.

The competition between Russian gas and US LNG should therefore be fought out on the Asian markets and not on the European markets.

Finally, the competition between the Russians and the Americans will make it incredibly difficult to develop unconventional resources in Europe and in China. In view of the geological and climatic difficulties (in China) and the socio-political concerns (in Europe), developing these indigenous resources would cost between USD 12-15/MBTU[1]. Unless the developments are partly subsidized by the States for political reasons, shale gas has no real economic future in the medium term in China and in Europe.

Introduction : the US shale gas revolution. A play in three acts

The United States is the world's leading consumer and historically, also the main gas producer. US remained gas independent until the end of the 1980s. In the early 1990s however, after a steady increase in consumption and the stagnation of its domestic production, the US began to import gas and in less than 10 years, its gas dependence rose to 15%. At the beginning of the 2000s, all the observers agreed that US dependence would continue to grow over the following decade, spelling massive imports of Liquefied Natural Gas. So, in the early 2000s, the US authorities decided to build regasification terminals in the Gulf of Mexico and along the Atlantic coast. With the steep drop in production and the forecast of massive LNG imports, gas prices across the Atlantic rocketed, practically doubling between 2000 and 2007 (**Figure 1**). This growth inevitably made coal more competitive and had negative consequences on US GHG emissions. But this first act is in fact pure fiction!

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[1] Ph.A. Charlez et P. Baylocq (2013) "The Shale Oil and Gas Debate" Editions Technip.

The second act began in the early 1980s in northern Texas. In total anonymity, an unknown independent company called Mitchell Energy[2] was exploring the gas contained in the Barnett formation. The geological formation was not a conventional reservoir but a source (shale) rock. Although the Barnett formation contains huge amount of gas, it could not be produced cost-effectively using conventional extraction methods owing to the shale rock's very low permeability – hence the term "*shale gas*".

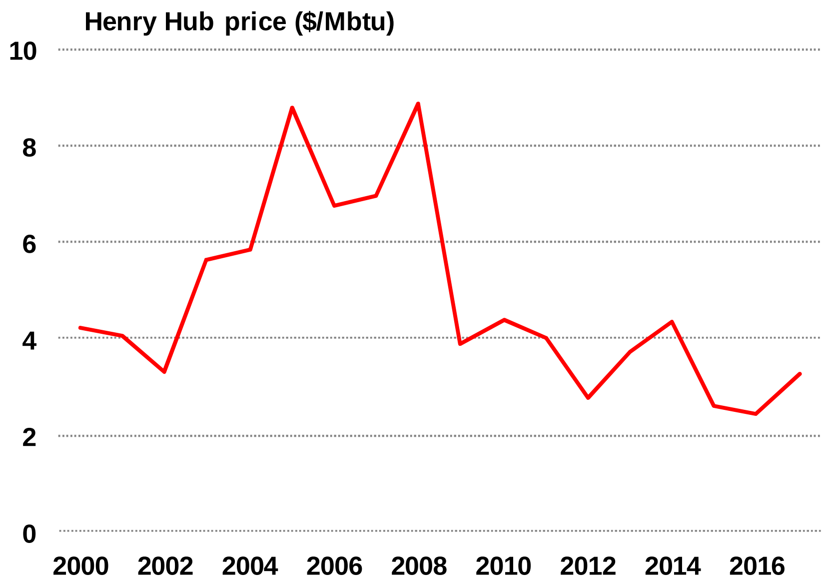

Figure 1 – Henry Hub price
(Data source: BP Statistical review)

After extensive research, it was ultimately another independent company, Devon (which bought out Mitchell Energy in the meantime) who developed the right technology. It was by no means a technological breakthrough, as it simply involved combining two mature technologies: horizontal wells and hydraulic fracturing, used in the industry for the very first time in… 1947. The idea was a stroke of genius as, contrary to all expectations, it enabled the United States to give spectacular kick-start to its waning gas production. After the Barnett formation, the Haynesville field (Texas and Louisiana) and then the giant Marcellus formation (Ohio, Pennsylvania) were developed at breathtaking speed.

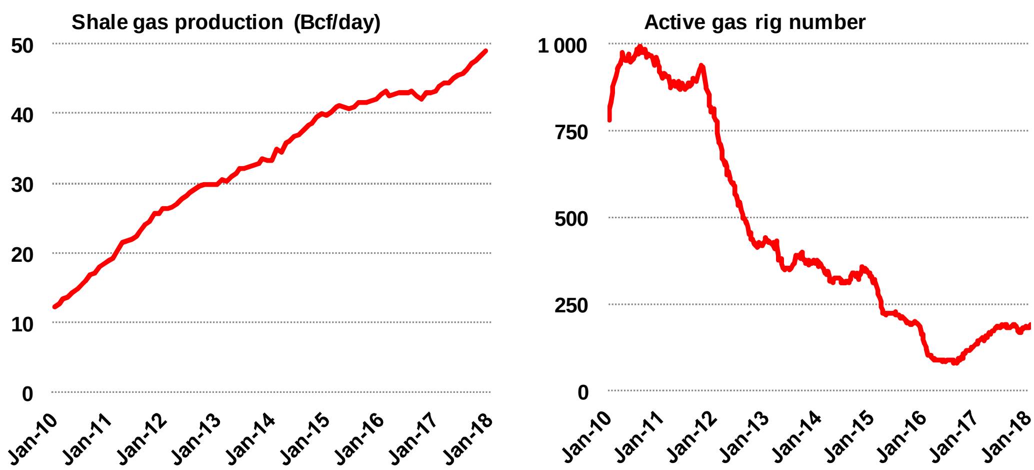

Figure 2 – US shale gas production
Number of operating drilling rigs (gas)

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[2]http://www.theenergycollective.com/jimpierobon/257691/george-p-mitchell-founder-shale-gas-here-s-how-he-and-his-team-did-it

Henry Hub price
(Data source: EIA, Baker Hughes)

Thanks to the shale gas revolution, the Americans regained not only their gas independence, but also their place as leading gas producer ahead of the Russians in just under a decade. The growth in production was remarkable. Inexistent in 2006, it reached 12 Bcf/day in 2010 and 49 Bcf/day by the end of 2017 (**Figure 2**). And despite a new drop in prices in 2012 and 2017, and a marked decrease in activity production continued to rise. This amazing resilience[3,4] can be explained by the massive well portfolio, the spectacular improvement in operational performance, the tremendous progress made in well completion and in the identification of sweet spots. At the end of 2017, shale gas production therefore represented 66% of US gas production.

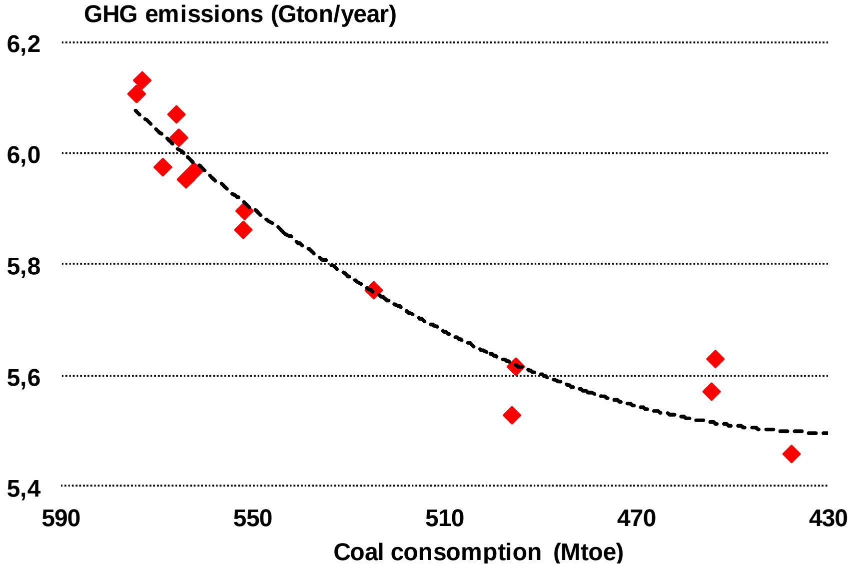


Figure 3 – Evolution of US GHG emissions vs coal consumption
(Data source: BP statistical review 2017)

This wave of cheap gas buoyed up the US economy, creating over two million jobs in heavy, high-energy consumption industries such as steel, glass-making, cement works and petrochemicals. The low price of gas also led the land of Uncle Sam to displace electricity generation from coal to gas, which had become much more competitive. Many coal-fired power stations were shut down, with the knock-on effect of reducing the demand for coal and therefore causing prices to collapse. This displacement had a very positive impact on US greenhouse gas emissions, which were reduced of 13% between 2007 and 2017 (**Figure 3**).

[3] Ph. A. Charlez & P. Delfiner (2016) "A Model for Evaluating the Commerciality of an Unconventional Factory Development Outside of North America" SPE Economics & management. SPE 179735

[4] Ph. A. Charlez & P. Delfiner (2016) "Resilience of the US shale production to the collapse of Oil & Gas prices" Unconventional Resources Technology Conference San Antonio, August 1-3, 2016

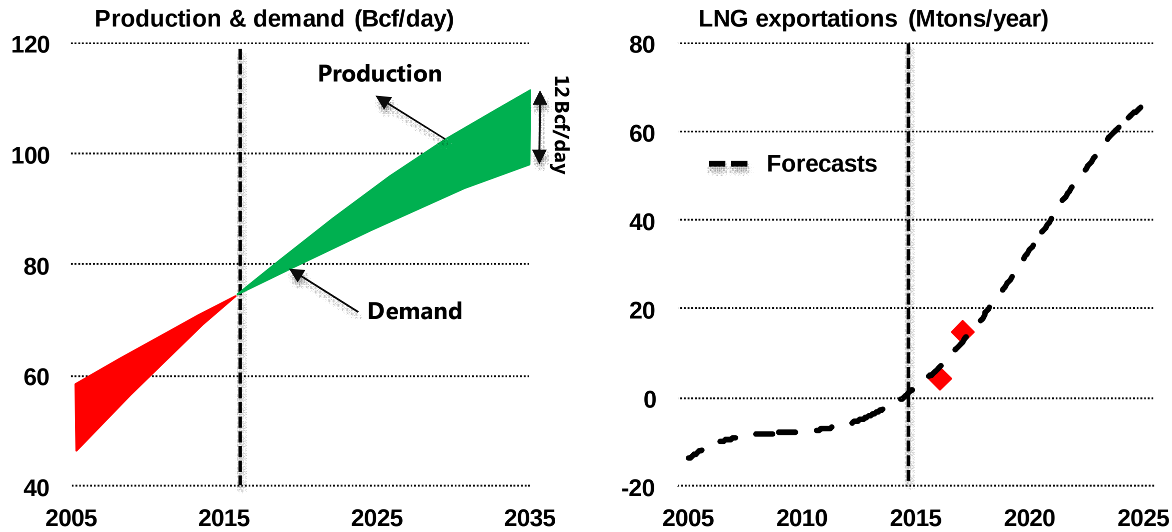


Figure 4 – US natural gas production and demand
LNG export potential up to 2035
(Data source: IHS CERA & EIA)

But the story does not end there, and the third act is already in full swing. Where the United States was set to become a major LNG importer, it was actually the opposite scenario that occurred. After a heated debate between producers in favor of exporting gas surplus (from 2 Bcf/day in 2020 to 12 Bcf/day in 2035 - **Figure 4**) and consumers in fear of a price increase that would jeopardize the new-found competitiveness, the US authorities finally decided in favor of the producers.

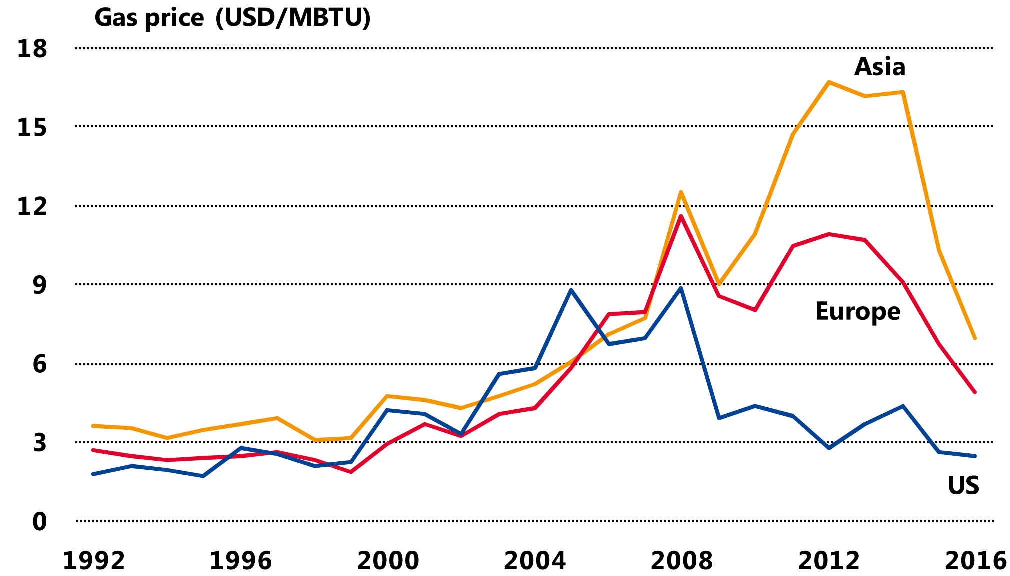
They authorized the conversion of the newly-built re-gasification terminals into liquefaction units. In the context of an LNG market that foresees world production of around 500 million tons by 2030 (compared with 256 million tons in 2016[5]), the US liquefaction capacity should exceed 60 million tons by 2025, and reach 80 million tons at the beginning of the following decade (**Figure 4**).

The first LNG shipment from the Sabine Pass liquefaction unit (operated by Chenière[6]) was exported to Brazil in March 2016, whereas the first European delivery was offloaded in Portugal at the end of April 2016. The export of US LNG, produced essentially on the Atlantic Coast and in the Gulf of Mexico, to the Asian markets was to be made much easier by the early opening (2016) of the Panama Canal to large LNG carriers[7]. As show in **Figure 4**, the 2016 (4,5 Mt) and 2017 (15 Mt) are in line with respect to the forecasts.

What is the economic efficiency of US LNG in the short and medium term?

Does US LNG actually have the potential to create a world gas market and merge regional market prices[8], as some opinion-makers might suggest? Even if the LNG market is rocketing, the volumes exported in 2016 represented less than 10% of global consumption, whereas the regional exchanges via gas pipelines represented 20%, and indigenous consumption 70%[9]. Inherently a commodity that is preferably consumed in a perimeter relatively close to its extraction site, gas is still a long way away from a single world market. Just like its peers, under no circumstances can US LNG bank on a spot market. US LNG export projects have very attractive advantages compared to their competitors (much lower CAPEX, price indexed on the Henry Hub and not on oil prices, tolling contracts[10], no destination clause[11]). However, they cannot escape the rules of regional European and Asian markets, built on long-term oil-indexed contracts (**Figure 5**).

[5] BP Statistical Review 2017
[6] http://www.cheniere.com/terminals/sabine-pass/
[7] http://www.wk-transport-logistique.fr/actualites/detail/83285/canal-de-panama-la-concertation-avance-pour-les-nouveaux-peages.html
[8] http://www.lantenne.com/Les-exportations-americaines-de-GNL-pourraient-aboutir-a-un-marche-mondial_a15892.html
[9] BP Energy outlook 2017
[10] Reservation of a liquefaction capacity at a set rate of around USD 3/MBTU and not at that of the standard retail price
[11] Buyers can resell the shipment on the market of their choice without any restrictions



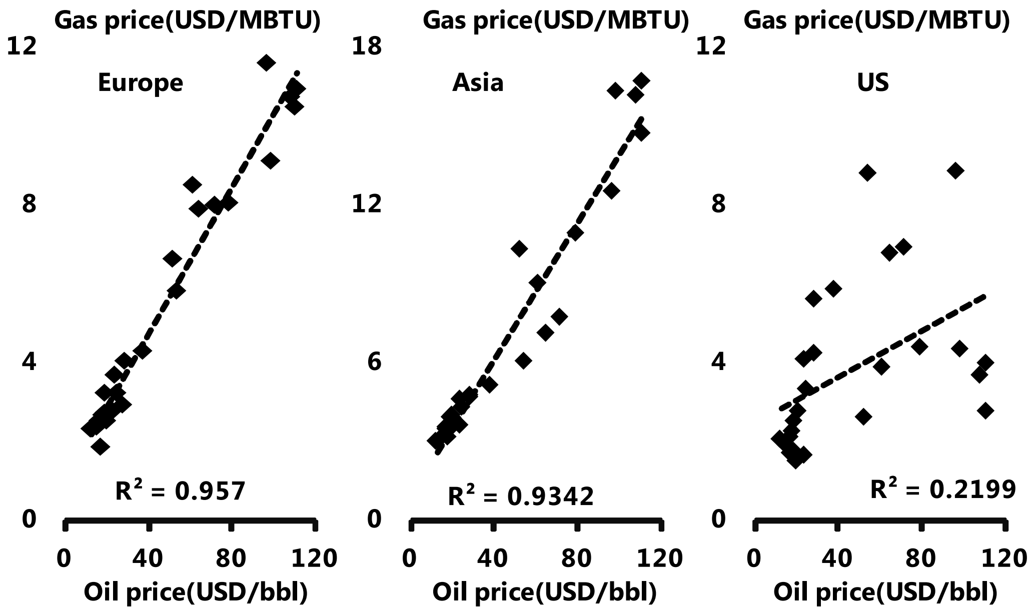
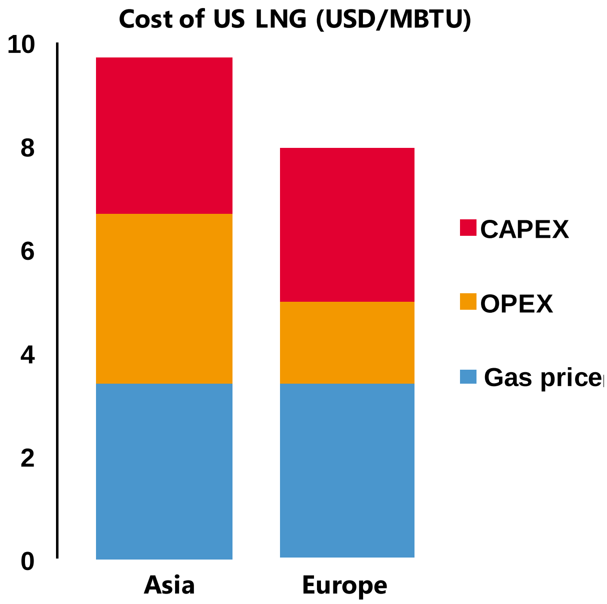


Figure 5 - Evolution of gas prices on the three world markets
Correlation between gas and oil prices
Left: Europe, Center: Asia, Right: United States
(Data source: BP outlook 2016)

Although the potential export capacity approved by the FERC[12] is just over 100 million tons per year[13], it is crucial to differentiate between the degree of cost-effectiveness of operational units that already have the required infrastructures, and for which investments have been all but amortized (20 million tons per year), units under construction (40 other million tons per year), for which sales contracts have already been negotiated, and long-term projects, for which investments have not yet been decided on (another 40 million tons per year). Since the fall of 2014, the drop in oil prices has had an automatic knock-on effect on the price of gas on both the European and Asian markets. Between 2014 and 2016, the price of gas in Europe dropped on average (**Figure 5**) from USD 11/MBTU to USD 6/MBTU, whereas in Asia, LNG that was negotiated at over USD 15/MBTU in 2014, plummeted

[12] Federal Energy & Regulation Commission
[13] S. Cornot-Gandolphe (2016) « Les exportations américaines de gaz naturel. De nouvelles règles du jeu sur l'échiquier européen » Etudes de l'IFRI. June 2016.

to under USD 7/MBTU (**Figure 6**) in 2016. This new configuration fundamentally modified the degree of cost-effectiveness of future US LNG export projects.



Oil USD/bbl	Europe Gas USD/MBTU	Asia Gas USD/MBTU
110	11,2	15,3
50	5,6	7,5
30	3,8	4,9

Figure 6 – Comparison of the average cost of "long-term"[14] US LNG delivered in Europe and in Asia at regional gas prices
(Data sources: BP energy outlook 2016 & ColumbiaUEnergy SIPA)

For operational projects, or those under construction, for which most investments have already been made, the extent of cost-effectiveness depends on the marginal costs alone (gas price + OPEX covering transportation and regasification - **Figure 6**); these are, on average, around USD 5/MBTU in Europe and USD 6.7/MBTU in Asia[15]. With respect to the data in **Figure 5**, US LNG therefore generates profit margins for an oil price of around USD 45. For new projects, however, whose economic efficiency must be evaluated in view of the total costs (gas price + OPEX + CAPEX), the price of the barrel would have to exceed USD 70 for LNG suppliers to generate profit margins. In other words, given the current crude oil prices, the cost of new US LNG projects is currently higher than the European and Asian gas prices, which explains why the start-up of new projects has been deferred. In the medium term, the potential production capacity should therefore be limited to projects that are already under way, i.e. 60 million tons per year.

US LNG: a threat to, or an opportunity for Russian gas in Europe?
Ranked second gas producer and third oil producer, Russia relies essentially on a cash-flow economy where the GDP (but also the currency) evolves with the ebb and flow of oil prices (**Figure 7)**. Growth or recession depend essentially on the cash flow generated (or not) by its hydrocarbon revenues, so Russia is therefore particularly concerned by protecting its gas markets.

[14] 'Long-term' refers to new LNG projects for which investments have not yet been sanctioned
[15] T. Mitrova (2016) "International challenges of the Russian hydrocarbon sector in the current context". IFRI September 20, 2016

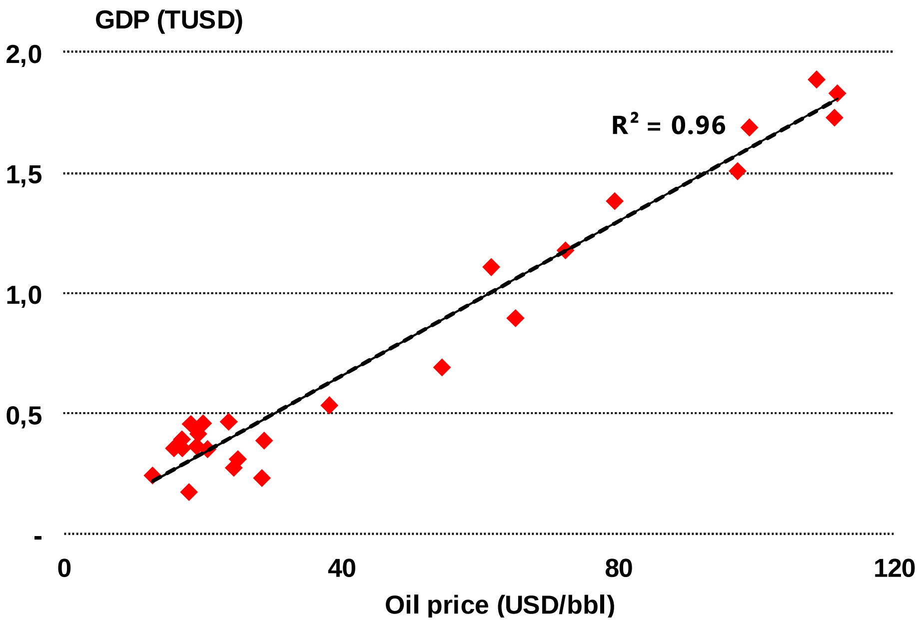


Figure 7 – GDP of the Russian Federation against oil prices
(Data source: BP energy outlook 2015 and the World Bank)

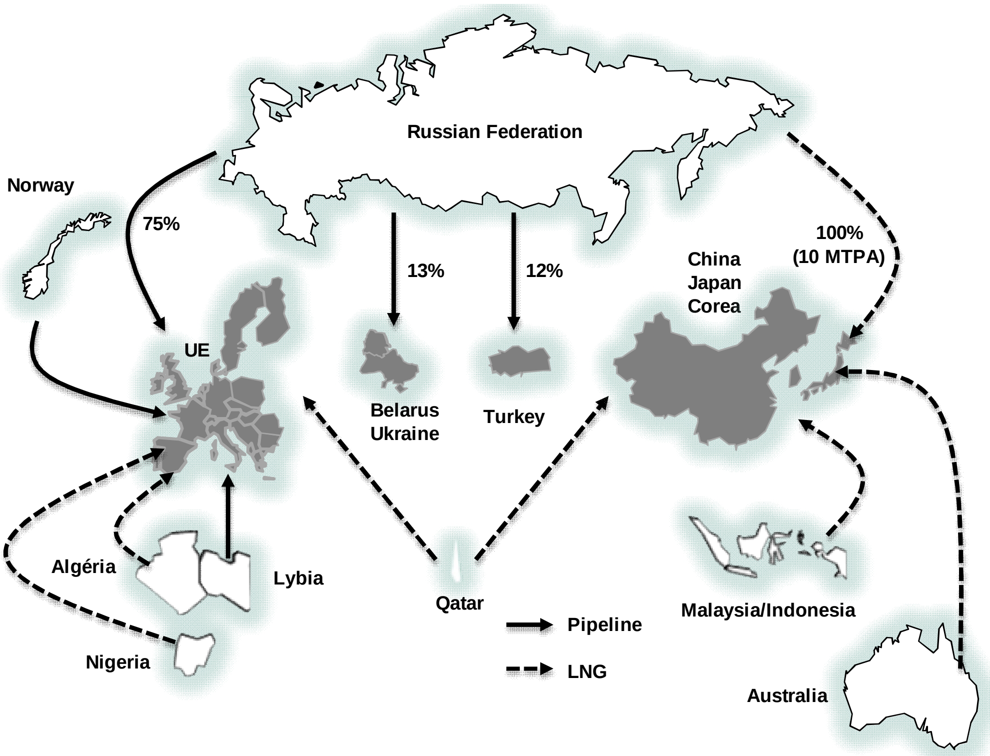


Figure 8 – Gas exchanges with Europe and with Southeast Asia in 2014
(Data source: BP statistical review 2017)

In 2016, Russia produced 55.9 Bcf/day, and exported by gas pipeline one third of it, i.e. 18,2 Bcf/day[16], to three main clients (**Figure 8**): the European Union (75%), the former Soviet Republics (the Ukraine and Belarus - 13%) and Turkey (12%). The Russians' main competitors on the European market are Norway, Algeria and, to a lesser extent, Nigeria and Libya. Russia, however, is a second order LNG producer with just 10 MTPA, exported to Japan from the Sakhalin Island.

[16] BP Energy outlook

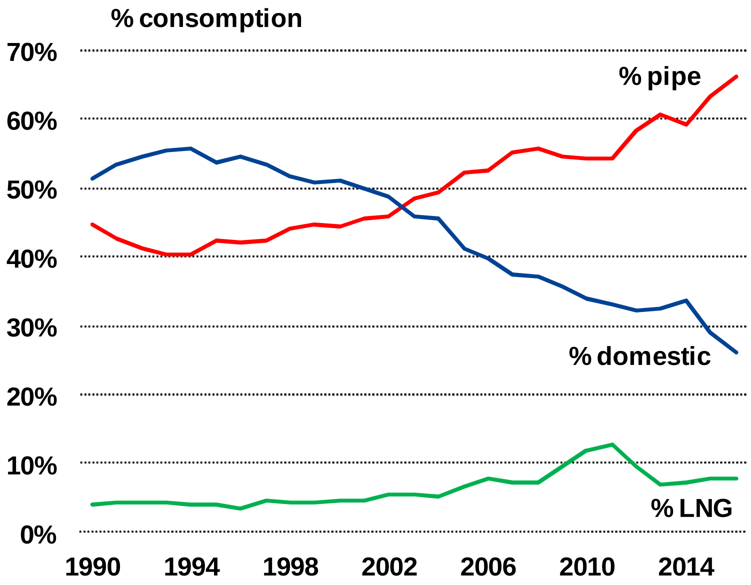


Figure 9 – European natural gas consumption, production and imports
(Data source: Eurostats & BP statistical review 2017)

Due to high prices indexed on those of oil, a marked drop in electricity demand and a low economic growth, European gas consumption has decreased by over 15% in six years, from 47.6 Bcf/day in 2010 to 41 Bcf/day in 2016. However due to a continuous drop of its domestic production (North Sea and Netherlands) gas importation have strongly increased. But, this increase was from pipe and from Russia (**Figure 9**) whereas the part of LNG has remained marginal since representing only in 2016 8% of the European global consumption.

Could however, the collapse of oil prices that pulled those of gas down with it[17] could give new impetus to the European LNG market in the medium term. Could this new situation catalyze US LNG consumption and pose a threat to Russian deliveries? Conversely, could Russia impact the US gas strategy in the medium term?

Compared with most of its competitors, Russian gas enjoys undeniable competitive advantages: very low production costs of less than USD 1/MBTU, heavy devaluation of the Ruble[18] and marginal transportation costs owing to the existing gas pipeline network. When transit rights are added to that, the average long-term cost is around USD 5/MBTU which makes Russian gas competitive as from USD 43/bbl (**Figure 10**).

In other words, with oil prices as they stand, only US LNG from existing liquefaction plants (breakeven point at USD 5.5/MBTU and USD 45/bbl) can compete with the Russian gas delivered to Europe. However, the analysis confirms that US LNG from liquefaction plants in the project phase can be competitive on the European market only if there is a significant uplift in the price of oil, to take it above USD 70/bbl. Moreover, even if Gazprom, whose model is intrinsically based on long-term contracts, does not look favorably on the liberalization of European markets[19], the Russian group has economic margins that are significant enough to protect its European markets. In particular, it can break with certain restrictive clauses[20] by granting reductions to its European clients compared with the contractual prices indexed on barrel prices. This strategy is already extensively applied on a considerable share of the volumes delivered by gas pipeline, two thirds (**Figure 10**) of which are currently related to a spot market (GOG – Gas On Gas competition) removed from oil prices. Conversely, the European LNG market is still dominated by the OPE (Oil Price Escalation)

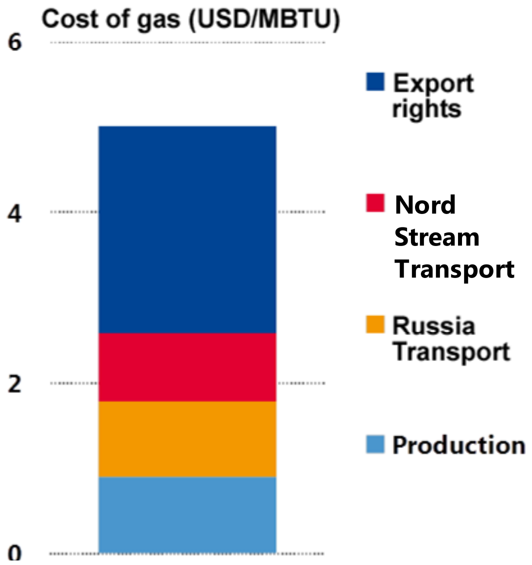
[17] In June 2012, after the Fukushima disaster, Indonesian LNG rose to USD 19.4/MBTU. In September 2016, it was being negotiated at USD 7/MBTU. http://www.indexmundi.com/fr/matieres-premieres/?marchandise=gaz-naturel-liquefie-indonesie&mois=120

[18] 30 Rubles per Dollar in 2010 to 60 Rubles per Dollar in 2016.

[19] MC Aoun and S. Cornot-Gandolphe (2015) "L'Europe du Gaz à la recherché de son âge d'or" Les Etudes IFRI, October 2015

[20] Long-term contracts are revised every three years

mechanism indexed on oil prices. Economically speaking, the Russians therefore have major levers to impose a price war on US LNG and counteract its entry into the European markets, both in the short term, by imposing prices lower than the indexed prices, and in the longer term, by deterring investment decisions.



Price formation mechanism	LNG	Gas pipeline
Oil indexation	60%	32%
Spot market	40%	64%
Bilateral agreement	0%	4%

Figure 10 – Average cost of Russian gas delivered in Europe
Price formation mechanisms in Europe
(Data source: ColumbiaUEnergy SIPA and IGU[21])

In the wings of this latent price competition however, the Europeans do not want to jeopardize their energy security by amplifying their gas dependence on Russia. The 2014 conflict between Russia and the Ukraine is particularly present in the collective European mind. Insofar as, at the time, more than half of the gas destined for Europe transited via the Ukraine through the historical *Brotherhood* pipeline[22], Moscow automatically cut off half the European supplies.

The European strategy therefore aims to reduce as far as possible Russian gas imports through the *Brotherhood* or even through the *Yamal* (which crosses Belarus), and preferably use the *Nord Stream,*[23] brought into service in 2012 (**Figure 11**), which starts in the Gulf of Finland and runs directly toward Germany across the Baltic Sea. Since 2014, the *Brotherhood* has been carrying only 44% of Russian gas and the *Yamal* 23%, whereas the *Nord Stream* carries 33%[24]. To free itself even more from the risks related to the former Soviet Republics (the Ukraine but also Belarus) the Russian and German authorities want to double the *Nord Stream 1* by creating a second gas pipeline (the *Nord Stream 2*) following exactly the same route for a cost of between 8 and 10 B€. The *Nord Stream* 1&2 would therefore carry 56% of the European supplies, marginalizing the *Brotherhood*, which would then convey only 24% of the exported volumes[25].

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[21] http://www.igu.org/sites/default/files/node-news_item-field_file/IGU_WholeSaleGasPrice_Survey0509_2016.pdf
[22] The Brotherhood pipeline was opened for service in 1967. It runs from Russia to Slovakia, after crossing the Ukraine from north to south http://www.gazpromexport.ru/en/projects/transportation/
[23] The Nord Stream was opened for service in 2012. http://www.gazpromexport.ru/en/projects/transportation/
[24] ENTSO-G Transparency Platform
[25] T. Gustafson, L. Ruseckas, S. Blakey, A. Galtsova(2016) "*Nord Stream 2. Will it still be built?*" Strategic report HIS CERA

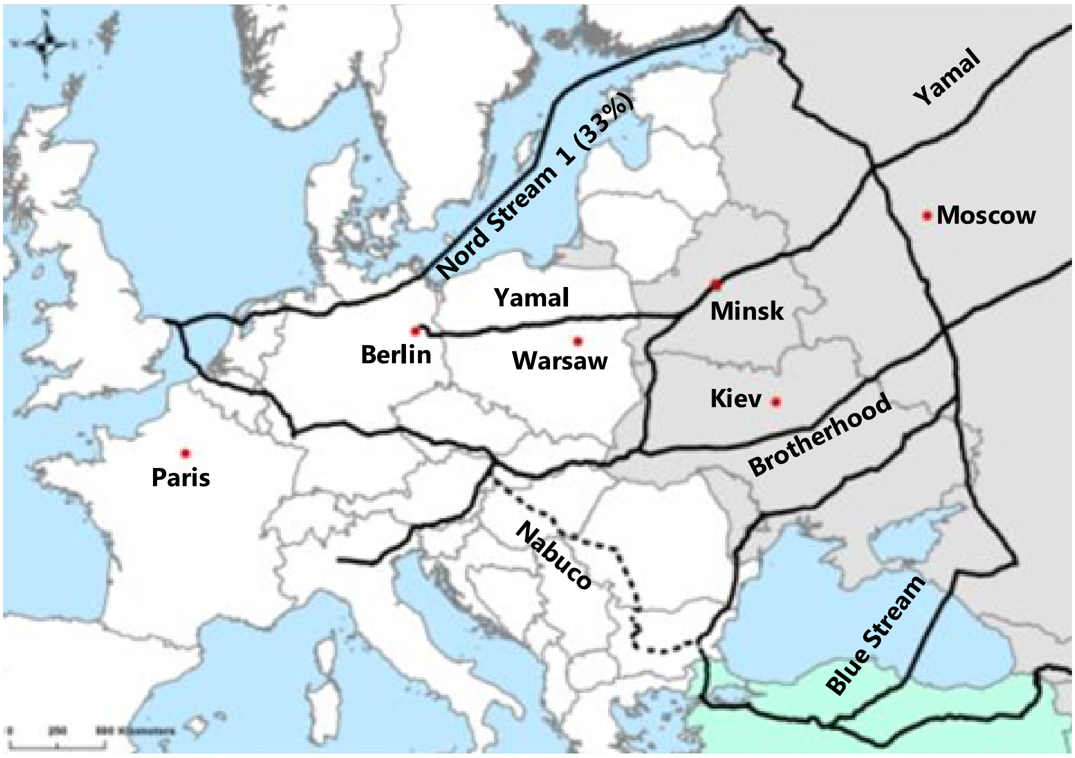

Figure 11 – Main European gas routes
(Data source: IHS CERA)

International gas pipeline	Country	Current	Nord Stream 2
	Russia	5.3	5
Yamal	Poland	0.4	0.4
	Belarus	0.3	0.2
Brotherhood	Ukraine	3.2	1.8
	Slova - RT	1.3	0.7
Nord Stream	Baltic	1.1	1.9
Total		11.6	10.0
Yamal/NS/Brotherhood current 23%/33%/44%			
Yamal/NS/Brotherhood NS2 20%/56%/24%			

Figure 12- Global cost of transportation (in BUSD based on 150 Bm^3 per year) in the current configuration and if the *Nord Stream* were doubled.
(*Data source: IHS CERA*)

In economic terms, the cost of transportation via the *Nord Stream* (USD 1.5/MBTU) is half that of the *Brotherhood* (1,000 km less, no transit rights in the Ukraine, or in Slovakia or the Czech Republic – USD 3/MBTU) since the Ukraine unilaterally decided to double its transit rights. In the current configuration, and based on an annual export of 150 Bm^3 (13 Bcf/day), global export costs would drop by 15%, which would reduce the German invoice while making Russian gas even more competitive relative to US LNG (**Figure 12**). But the Ukraine and, to a lesser extent, Slovakia and the Czech Republic would see their transit rights significantly reduced. By-passing the *Brotherhood* could cost the Ukraine up to USD 2 billion per year in the long term, an impossible shortfall for a country whose financial resources have already been bled dry. The idea of doubling the *Nord Stream* is therefore far from being widely endorsed by the European Counties. While the Russian and German authorities enthusiastically support the project, the Ukrainians, Slovaks, Czechs, Polish as well as the Baltic countries are opposed to it, as they consider it will automatically reinforce the Union's energy dependence on Russia. According to its critics, it would be in contradiction with the Union's energy security policy based, among other things, on the diversification of supplies.

In spite of a the agreement signed in April 2017 between Gazprom (50%) and 5 European Companies (French Engie, British/Dutch Shell, Germans Uniper & Wintershall and Austrian OMV each 10%), the project has yet to be approved by the States of which the gas pipeline will cross the territorial waters as well as the European Commission.

This example shows that, in spite of proven competitiveness and significant levers on margins, geopolitical problems make the Russian gas strategy vulnerable against the potential US LNG market, and also against new Middle East resources from Iran, Israel and Egypt following the discovery of giant fields in the east Mediterranean.

It is therefore logical that Russia is also turning to the Asian markets to find new outlets.

Competition on the Asian markets
Russian gas exports to Asia tentatively began in 2009 with the opening of the Sakhalin liquefaction plant and the shipment of LNG to Japan (**Figure 14**). The capacity (10 MTPA) is still very small compared with that gas pipeline. They represent just 8% of exports and 2.5% of total production (**Figure 13**). Moreover, they remain marginal in an LNG market dominated by Qatar, Indonesia, Malaysia and even Australia, whose liquefaction capacities are set to increase significantly (GNLG[26], Ichtys[27]) in the coming years. Russia should significantly step up its LNG production, in particular with the start-up of a large liquefaction plant on the Yamal peninsula[28]

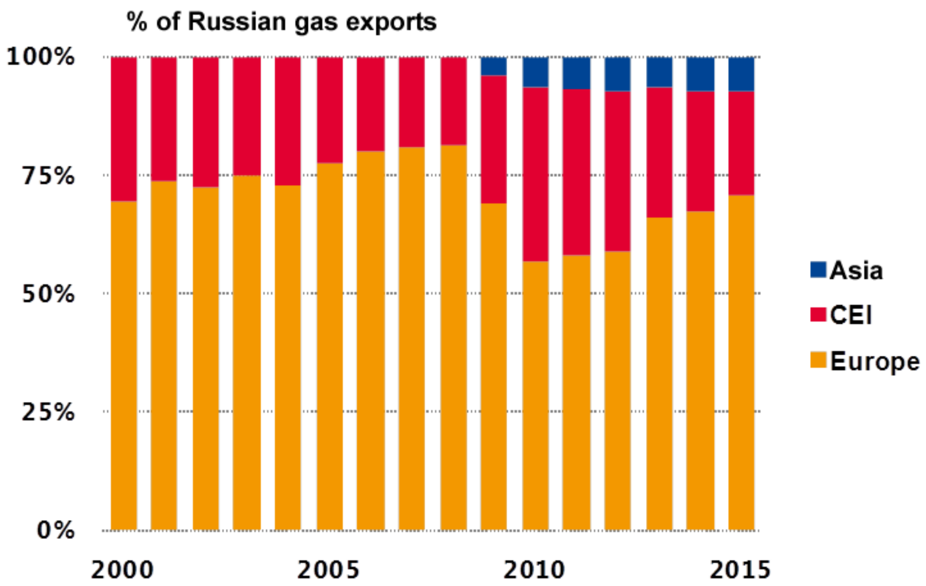

Figure 13 – Russian gas exports to Europe, the CEI and Southeast Asia (as percentages)
(Data source: Rosstat CDU Tek)

However, the competitiveness of Russian gas in Southeast Asia, China in particular, will depend essentially on the development of gas fields located in East Siberia (Chayanda and Kovytkta – 6 Bcf/day) and on the construction of two gas pipeline network in order to supply China (**Figure 14**) Russia need to implement two pipe lines. One from the East ("*Power of Siberia*" project) will link Chayanda and Kovykta to the Sakhalin network and the Vladivostok terminal. From the West the "*Altai*" pipeline project will connect the Chinese network to the fields located in western Siberia (Yamal peninsula and Urengoy).

[26] www.santosglng.com
[27] www.inpex.com.au/our-projects/ichthys-lng-project
[28] http://www.russieinfo.com/russie-yamal-lng-un-projet-pionnier-l%E2%80%99extremite-du-monde-2016-04-13

Figure 14 – Russian gas transportation project to Southeast Asia "Power of Siberia" and "Altai" projects
(Data source: Gazprom[29])

These projects were confirmed on May 21, 2014 when Gazprom and the Chinese giant CNPC[30,31] signed a contract for USD 400 billion over 30 years. In terms of capacity, Russia should deliver to China more than 3 Tcf/year of natural gas. It should heavily displace from coal (China produces and consumes half of the world's coal resources and emits 30% of global greenhouse gases) to gas the Chinese power generation. However, the corresponding investments, to exceed USD 50 billion, will lead[32] to a gas price of around USD 9/MBTU, almost equivalent to that of US LNG (**Figure 6**) which, thanks to the early opening of the Panama Canal, now has access to the Asian markets.

The competition between Russian gas and US LNG should therefore be fought out more on the Asian markets and not on the European markets. Finally, a noteworthy point is that the project has a variant[33], consisting in connecting the western network to the future eastern network via an extra pipeline, which would run from *Prokokovo* to the future *Power of Siberia* pipeline (**Figure 14**). It would provide greater flexibility for both markets, but would considerably increase the cost by USD 20 billion. For the time being, doubts still persist as to the cost-effectiveness of this alternative.

[29] http://www.gazprom.com/f/posts/61/907574/2014-06-26-map-sila-sib-en.jpg
[30] http://www.lemonde.fr/planete/article/2014/05/21/gaz-mega-accord-entre-la-chine-et-la-russie_4422950_3244.html
[31] https://fr.sputniknews.com/infographies/20140522201292992/
[32] Credit Suisse (2016) "Global LNG sector", ASE analysis, Oxford Institute for energy study
[33] Accenture Strategy (October 2016) "Strategic choices for Russia's gas development"