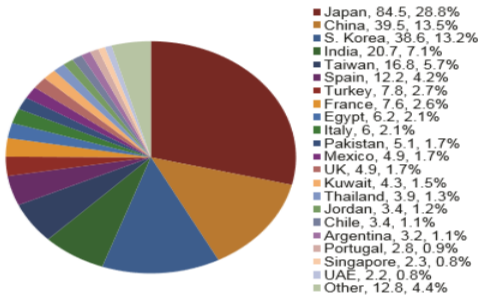
TO: Professor Pinho
FROM: LNG Group (Cyprian Christian, Dexter Ndengabaganizi, Blair Lui, Saleem Nasir, and Valentin Worm)
DATE: October 18, 2018
SUBJECT: Natural Gas and LNG

The demand for primary energy is ever-growing. As the world struggles with complexities of developing new sources of energy it is clear that fossil fuels will continue to play a dominant role for the foreseeable future. Currently, the fastest growing hydrocarbon is natural gas as a result of recent technologies that have bolstered the production capabilities of the resource. As a result, natural gas has become a popular alternative and complement to conventional energy sources, such as crude oil and coal.

The resource's popularity has grown for several reasons. First, environmentalists propose that natural gas could serve as a cleaner bridge fuel between the dominant fossil fuels of today and the renewable fuels of tomorrow. The main consumption of natural gas is as a source for electrical generation and its popularity is increasing because it burns cleaner than oil and coal, and produces less greenhouse gases. Therefore, these features allow natural gas the potential ability to emerge as a critical transition fuel that could help to combat global warming. Second, the abundance of natural gas has led to lower and competitive prices. For example, The United States "shale revolution" has stimulated tremendous production of oil and natural gas and has led to record-low natural gas prices and profoundly affected the energy economy. This revolution was the outcome of technological advances in the oil and natural gas industry that is most attributed to the ability to perform a combination of hydraulic fracturing and horizontal drilling. Therefore, shale gas possibly provides a lower-carbon fuel source economical enough to dethrone coal, which is currently the primary and most carbon intensive electricity source in the United States. Third, the emergence of Liquefied Natural Gas (LNG) has made transportation of natural gas long distances possible, though it still a capital intensive process.

An Increase in LNG Global Trade in 2017

Figure 3.7. LNG Imports and Market Share by Country (in MTPA)



Note: Number legend represents total imports in MT, followed by market share %. "Other" includes countries with imports less than 2.0 MT (by order of size): United States, Brazil, Malaysia, Poland, Greece, Belgium, Dominican Republic, Puerto Rico, Lithuania, Netherlands, Israel, Canada, Malta, Jamaica, and Colombia. Sources: IHS Markit, IGU

The main importer of LNG is Japan due to the shutdown of their nuclear power plants after the infamous Fukushima disaster. The largest following importers are China, South Korea, India and Taiwan, followed by the. In 2017 imports grew 12 percent and the growth mainly came from China and South Korea. In China, the energy demand is growing and environmental issues have led to downsizing the role of coal in the energy mix. In South Korea, the increase is linked to the decommissioning of some power plants. Increases in European LNG consumption were mainly seasonal due to temporary plant power shut downs and an unusually cold winter. (Sources: IHS, Markit, IGU)

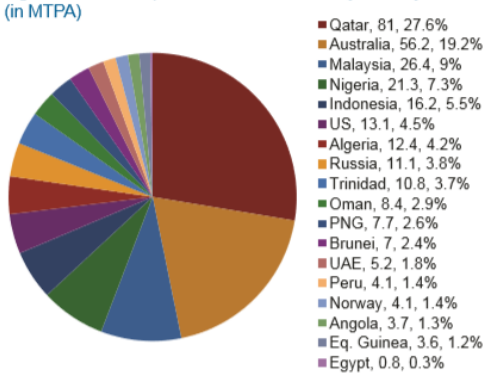
The main exporter of LNG is Qatar with a significant lead ahead of the next largest imported, Australia. It is important to delineate the difference between main exporters of LNG compared to the greatest natural gas exporters, such as Russia, Norway and Canada who are the biggest producers and exporters of natural gas n the world via pipeline. We count only 18 exporters of LNG. The increase in demand was

mainly supported by a corresponding increase in the supply of LNG driven by Australian and U project reinforcement.

2018 World LNG Report - International Gas Union

https://www.igu.org/sites/default/files/node-document-field.../IGU_LNG_2018_0.pdf

Figure 3.2: LNG Exports and Market Share by Country (in MTPA)

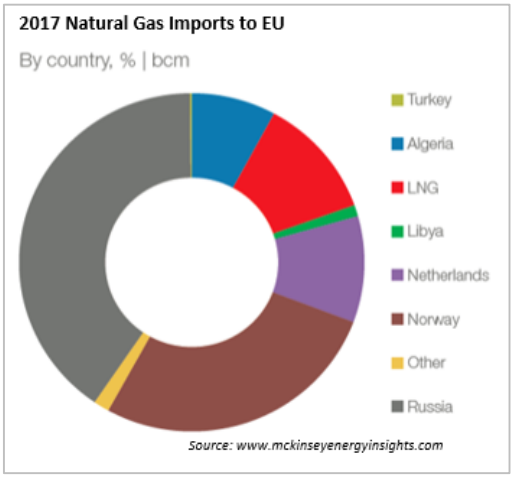


Note: Numbers in the legend represent total 2017 exports in MT, followed by market share. Source: IHS Markit, IGU

The European Natural Gas Market

The European market, specifically the 28-member European Union is currently experiencing structural changes with regards to its energy mix. A prime example is Germany (the largest consumer of energy in EU) phasing out nuclear plants and coal plants while investing in renewables. This move has been prompted by concerns over the Fukushima nuclear incident, as well as Germany's commitment to reducing its carbon footprint in compliance with the Paris Climate Agreement. During this structural change, Germany will remain dependent on natural gas for coming years.

Import Mix



With regard to natural gas, the European Union is an import-based market. In 2017 the market was 408.7bcm with the majority of imported gas coming via pipeline from Russia (40%), Norway (27%), the Netherlands (10%), and Algeria (8%).[1]**LNG**

LNG plays a minor role, only accounting for 12% of the share.[2] In fact, LNG imports to Europe decreased 13% this year due to a more attractive Asian spot market (primarily driven by China).[3] The main source of LNG is Qatar, which is currently giving the United States' LNG market tough competition through lower prices.

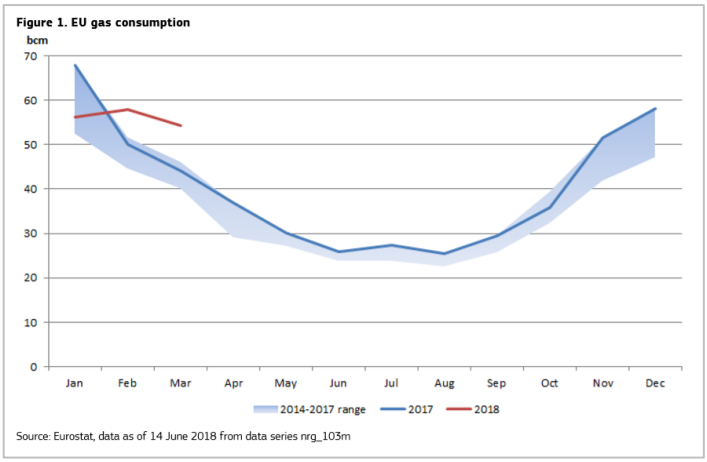
Consumption Pattern

The growth of gas consumption in Europe has been slow. This can be explained by the increase in the efficiency of consumption and increasing share of renewables. Figure 1 shows the range of consumption between 2014 and 2017.

Pipeline Projects

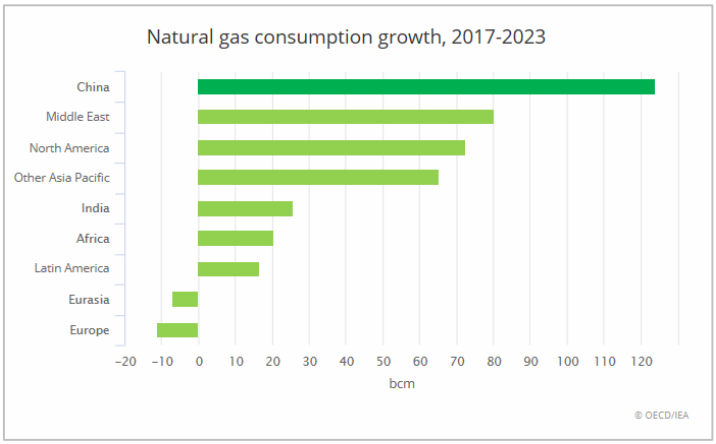
[1] "The 2017 European Gas Market in 10 Charts." McKinsey Energy Insights. Accessed October 14, 2018. https://www.mckinseyenergyinsights.com/insights/the-2017-european-gas-market-in-10-charts/.
[2] Ibid.
[3] "Quarterly Report on European Gas Markets." European Commission. Accessed October 14, 2018. https://ec.europa.eu/energy/sites/ener/files/documents/quarterly_report_on_european_gas_markets_q1_2018.pdf.

The proposed Nord Stream 2 pipeline from Russia to Germany, if materialized, will double the flow of gas from Russia by 2019.[4] For Russia, this route via the Baltic sea helps to avoid supplying gas via Ukraine due to political tensions.



Other major pipeline projects include the 'Trans-Adriatic Pipeline' (TAP) from Greece to Albania. This project as of Oct 2018 is 76% complete.[5] The TAP will be connected to the Trans-Anatolian Natural Gas Pipeline (TANAP) pipeline that will bring gas from Azerbaijan to Greece via Turkey.[6] TANAP was inaugurated this year (2018) and has had strong support from both the EU and the United States as a means to reduce dependence on Russian gas.[7]

Challenges



EU gas production will halve by 2040 as per the IEA, increasing imported gas share to 84% from 71% in 2016, hence possibly increasing the dependence on Russia.[8] At the same time, the growth of renewables is replacing gas over time; the European Commission has a set target of 27% for renewables in energy consumption by 2020.[9] Lastly, higher prices in Asia make countries such as China an attractive market for LNG exports instead of Europe. However, this will not affect Russian supply to Europe.

Forecasts

European gas demand rose in 2016, thanks to low gas prices and coal plant retirements, but forecasts predict that European gas demand will stay flat out to 2023 as per the IEA.[10] Future import

[4] "Europe Tries to Lead the Way on Clean Energy." The Economist. March 15, 2018. Accessed October 14, 2018. https://www.economist.com/special-report/2018/03/15/europe-tries-to-lead-the-way-on-clean-energy.
[5] "TAP at a Glance." TAP. October 14, 2018. Accessed October 14, 2018. https://www.tap-ag.com/the-pipeline.
[6] "TRANS ANATOLIAN NATURAL GAS PIPELINE PROJECT." TANAP. Accessed October 14, 2018. https://www.tanap.com/tanap-project/why-tanap/.
[7] Ibid.
[8] "Gas 2017: Analysis and Forecast till 2022." International Energy Agency. Accessed October 14, 2018. https://www.iea.org/Textbase/npsum/gas2017MRSsum.pdf.
[9] Ibid.
[10] Ibid.

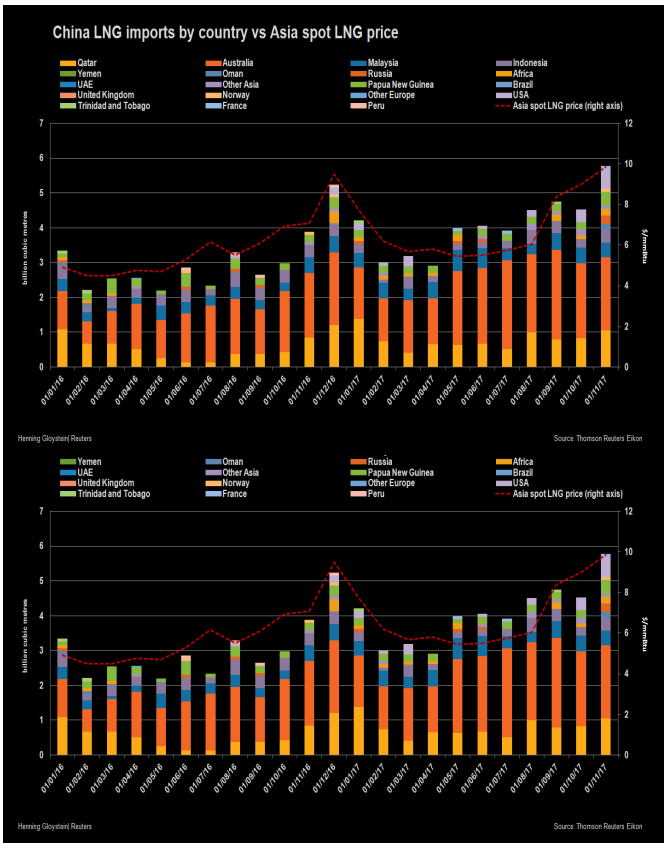
demand is expected to be met by TANAP and TAP pipelines (operational in next 5 years), hence the limited market for LNG.

The Chinese Natural Gas Market

In 2017, China's LNG demand grew by 15%, comprising 33% of the global LNG increase. This surge of LNG demand is mainly driven by a determined policy effort to improve the air quality through coal and gas boiler conversion in the residential and industrial sectors. Natural gas became a key energy to support Chinese government's efforts in fighting air pollution.

Origins: As energy experts, David Sandalow, Akos Losz, and Sheng Yan wrote as a apart of research at the from the Center on Global Energy Policy at Columbia University, "In winter 2013, a long period of particularly severe air pollution in China garnered widespread attention and was labeled an 'airpocalypse'. This experience led the Chinese government to dramatically increase the priority it gave to fighting air pollution."[11]

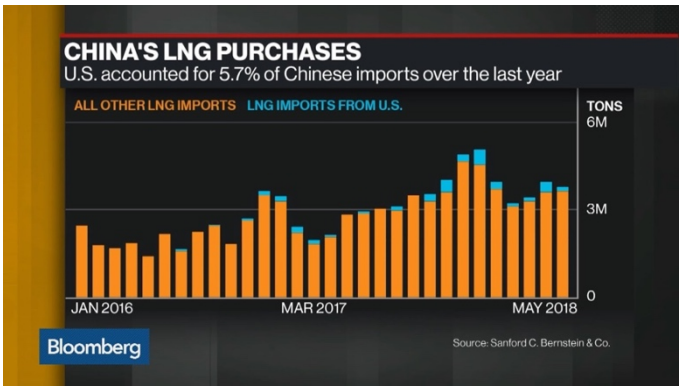
Target: In December 2016, the Chinese government enacted the 13th five-year plan, which determines China's future five-year goal in every sector. In the energy development sector, Chinese national energy administration aim to meet seven renewable energy targets by the end of 2020. Because every sector of China's economy is backed by strong policy support from the 13th five-year plan, it brings an increasing role to natural gas, which is defined as a clean energy source.



Market: On the domestic side, China's demand of natural gas grows at an average of 8% per year through the forecast period. On the global side, China will rise as the top importer of both piped gas and LNG, overcoming Japan and South Korea who are in second and third place respectively. China, Japan, and South Korea in total imported 55% of the total LNG supply in 2017 and 72% of the total LNG sold last year.

On China's imported LNG destination side, we see China has been significantly diversifying its import sources from a variety of countries; its primary importers are Qatar, Australia, and Russia. There is a positive correlation between China's LNG import amount and Asia's Spot LNG price. If the demand and price correlation trend continues, we will see LNG shift from a buyer's market to seller's market in the near future.

[11] David Sandalow, Akos Losz, Sheng Yan, "Natural Gas Giant Awakens: China's Quest for Blue Skies Shapes Global Markets". Columbia Center on Global Energy Policy, June 27, 2018.



U.S.-China Tariff War

Due to the trade war between the United States and China, China's retaliation toward US tariffs might include the US LNG exports to China. According to Reuters News, China set a 10% tariff on new US export LNG terminals.[12] The *Wall Street Journal* implicates the tariff might be within the 10% 25% range, which will impose spillover effects to the whole market.[13] What are the implications of this on the future of China's LNG market?

According to Akos Losz, "Since China is a huge player in the LNG market, if China is going to impose tariffs on the LNG market, there will be minimal marginal changes to the current LNG price, but it will bring more difficulties in the United States finding markets in future."[14] After all, China consists of a huge proportion of the global LNG market. So in the future, it will be harder for the United States and China to cooperate on new and/orr long term project.

It is important to note that the United States will have the highest growth of LNG production in future' retaliation on LNG exports will bring huge disadvantages to US LNG prices in a highly competitive LNG deal negotiation. According to Akos, "There is no fixed spot price of LNG, it's all about the negotiation of price back and force between nations."[15] As we can see from this chart, currently US exports are only 5% of China's LNG import market. So that means, for those who are concerned about the China-US tariff war, LNG deals will not have an immediate influence, the future impact on new deals and long term projects will be greater.

Conclusion

In the short to mid-term, the future of natural gas and LNG as a share of the global energy market only looks poised to become more robust. The fact there are no real resource constraints on the production of natural gas, it's lower carbon output compared to traditional energy resources, and the technological revolution in LNG refinement that has plummeted production costs has made it increasingly attractive as a fuel source to countries across the world. The natural gas frenzy in the United States and Australia, as well as the much discussed natural gas "renaissance" in Europe has turned the global energy landscape on its head for many interested parties.

There may be slightly overambitious hype surrounding these changes though as the most prominent exporters such as Qatar (LNG) and Russia (pipelined natural gas) will remain unchanged, solidifying their role as power players in the market and beyond. The sudden outsized increase in demand of LNG from China also threatens to change the dynamics of the energy markets even more so, especially if the United States decides to engage them in a contentious trade war. In the end however, the future of LNG

[12] Scott DiSavino, Sabina Zawadzki, "China LNG tariff casts shadow over new U.S. export terminals". Reuters Business News, September 18th, 2018. Web Access: https://www.reuters.com/article/us-usa-trade-china-lng/china-lng-tariff-casts-shadow-over-new-u-s-export-terminals-idUSKCN1LY27T

[13] Georgi Kantchev, Christopher M. Matthews, "China tariffs threatens U.S. Liquified Natural Gas Boom", Wall Street Journal, September 18th, 2018. Web Access: https://www.wsj.com/articles/china-tariff-threatens-u-s-liquefied-natural-gas-boom-1537302659

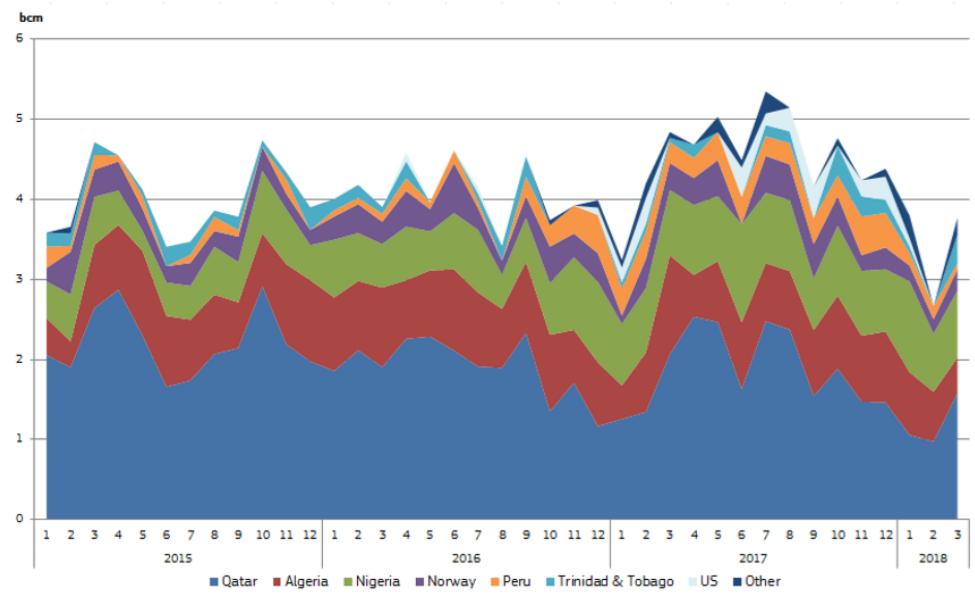
[14] Akos Losz, conversation with Natural Gas Group, October 3rd, 2018.

[15] Ibid.

will depend on its response to the growth of renewable energy. The continuing advances in battery storage and renewable technologies has dramatically lowered the price and production of these alternatives. If this trend continues, natural gas and LNG may eventually find themselves pushed out the market.

Appendix

Figure 11. LNG imports to the EU by supplier



Source: Commission calculations based on tanker movements reported by Thomson Reuters
Imports coming from other EU Member States (reexports) are excluded
"Other" includes Angola, Brazil, Egypt, Equatorial Guinea, Oman, Russia, Singapore and the United Arab Emirates