Overlooked Environmental Improvements From U.S. Liquefied Natural Gas Exports

BY THOMAS N. RUSSO

Much of the discussion about liquefied natural gas (LNG) centers on growing U.S. exports, which are largely responsible for creating an LNG spot market and decoupling prices from oil. We often overlook or take for granted the environmental improvements that will occur in developing countries that import LNG or countries that choose not to develop their shale gas resources.

Greater demand for LNG is limited due to its higher price. Landed LNG prices exceed pipeline gas in North America ($2.90 per million Btu's) and Russia ($6.00–$7.00 per million Btu's). See Exhibit 1. In the last six months, prices in North Asia have been flirting with an almost $12-per-million-Btu price level in winter and have risen again during the summer. This increase may be due to rising global oil prices, on which many long-term LNG contracts are based.

Note: Prices are the monthly average of the weekly landed prices for the listed month. Landed prices are based on a netback calculation.

Exhibit 1

U.S. LNG exports are an underlying reason why LNG is becoming a global commodity just like oil.

The U.S. LNG industry still relies on long-term contracts, but sales and purchase agreements (SPAs) offer greater flexibility and don't have destination clauses. More important, the SPAs are tied to the price of natural gas at the NYMEX natural gas futures contract at Henry Hub; the agreements are not tied to oil prices. Many U.S. LNG companies are emphasizing reduced costs. Some companies, like Tellurian Inc., are encouraging purchasers to make equity investments in their company that would allow the buyers to lift LNG at the proposed Driftwood LNG export terminal in the U.S. Gulf Coast for $3.50 per million Btu's. That's good news for European countries that are reliant on Russian pipeline gas and Asian buyers that are exposed to very high LNG prices. See Exhibit 2.

The need to establish an LNG benchmark based on natural gas at the Henry Hub, rather than on oil, is also gaining traction. Lower LNG prices based on the former will encourage more widespread use of LNG and accelerate the replacement of highly polluting coal and oil. On July 10, 2018, CME Group and liquefaction/export pioneer Cheniere Energy Inc. announced an agreement in which CME Group will develop a Henry Hub–indexed LNG futures contract with physical delivery to the Sabine Pass terminal on the U.S. Gulf Coast.[1] Additionally, the Intercontinental Exchange launched an LNG futures contract for the U.S. Gulf Coast in March 2017. CME's new LNG futures contract could further erode pricing of LNG cargos based on the price of oil, a basis

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See footnotes at end of text.

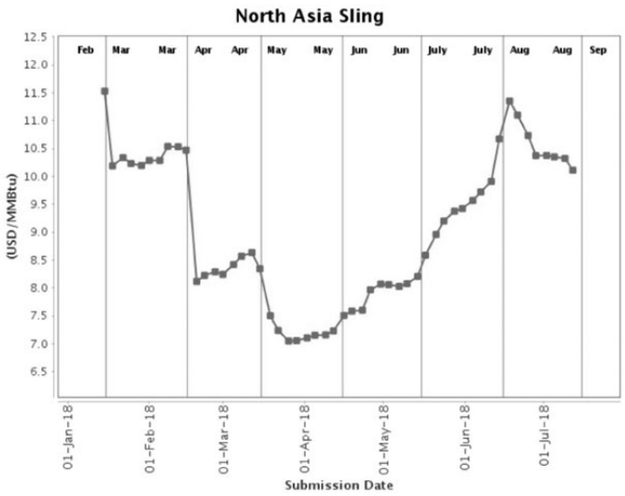

Exhibit 2

often used by the major LNG exporters like Qatar, Australia, and Russia. However, the success of CME's LNG futures contract will depend on whether or not LNG sellers and buyers, trading houses, and financial institutions use the futures contract and its liquidity.

Aside from giving LNG purchasers a tool to manage their risks, these new LNG futures contracts may result in lower LNG prices overall, which will encourage the use of LNG in the power sector, for residential heating, and as a marine bunker fuel.

Environmental Concerns and Government Mandates Drive LNG Imports

Natural gas is the cleanest of the fossil fuels.

Many developing countries have chronic air pollution problems, because these countries burn coal and fuel oil to generate electricity and for heating purposes. The use of diesel and gasoline in the trans-

portation sector also contributes to air pollution. While LNG is much more expensive than pipeline gas, the governments of many importing countries are requiring existing power generators and others to switch from coal and fuel oil to cleaner-burning gas. Also, Japan and Germany are relying less on nuclear power and have little choice in the immediate future except to use gas-fired power plants to integrate growing solar and wind energy into their electric grids.

China

China has diversified its pipeline gas and LNG suppliers to include buying U.S. LNG.

Beijing aims to lift gas to supply 15 percent of its total energy demand by 2030, more than double the 6 percent in 2017. Chinese hotels, hospitals, and factories were forced to swap their coal-fired boilers for gas ones in 2017 as Beijing pushes to wean the country off coal.[2] This has created thousands of new standalone gas customers thirsty for the clean fuel. The demand for gas is being met by LNG trucking firms who deliver LNG within a 310-mile radius of the natural gas base in Tangshan, east of Beijing. Trucking LNG will play a critical role in keeping the world's most populous nation fueled as a winter fuel while China embarks on an experiment to heat homes in nearly 30 northern cities with gas.

China is not relying solely on LNG or natural gas to solve its air pollution problems. Beijing is also pushing electric cars as a preferred mode of transportation, with the country aiming to sell 2 million electric vehicles (EVs) by 2020 and attain an internal-combustion-engine-to-EV ratio of 1:1 by 2030. China is also well ahead when it comes to electrifying its mass transit. China had about 99 percent of the 385,000 electric buses on the roads worldwide in 2017, accounting for 17 percent of the country's entire fleet. Every five weeks, Chinese cities add 9,500 of the zero-emissions transporters—the equivalent of London's entire working fleet of electric buses, according to *Bloomberg New Energy Finance.*

In July 2018, Tesla announced a preliminary agreement with Chinese authorities to build a solely owned facility in Shanghai dubbed "Gi- gafactory 3." The planned facility is expected to begin producing EVs roughly two years after its construction begins and to ramp to a 500,000-vehicle-per-year production rate in two to three years. Some analysts may think that the electrification of China's transportation system is bad news for natural gas and LNG imports. That idea is not entirely true. The rise of EVs will increase electricity demand and the need for dispatchable gas-fired power plants until utility-scale electric storage batteries gain market share.

Until then, Chinese LNG imports can be expected to fill the gap between China's growing shale gas production and demand for natural gas for power, heating, and industrial purposes.

Mexico

Under former President Enrique Peña Nieto, Mexico is following in the United States' footsteps in greening its electric power sector and addressing air pollution by importing inexpensive and abundant U.S. pipeline gas and LNG at its regasification terminals in Altamira and Manzanilla.

While Mexico's new president-elect, Andrés Manuél López Obrador (often referred to as AMLO), would prefer Mexico to be self-sufficient, as a former mayor of Mexico City, he probably has a greater appreciation of how air pollution can affect the lives and health of common people than most leaders. I believe he will still rely on inexpensive U.S. natural gas pipeline imports, which average between $2.45 and $3.53 per million Btu's at the U.S./Mexico border,[3] assuming the North American Free Trade Agreement is renegotiated. In the future, AMLO will want to develop Mexico's own shale gas reserves and use associated gas from offshore oil fields.

The government expects 9.2 gigawatts of new natural gas–fired plants in the next four years, which will displace higher-polluting fossil fuels. The government also plans to oversee the Pajaritos Floating & Storage Regasification Unit, which will enable the government to alleviate supply constraints in southeast Mexico caused by a lack of U.S. pipeline imports and a sharp decline in PEMEX offshore associated gas.

India

Like China and Mexico, India is also trying to wean its power sector off coal to reduce chronic air pollution problems in its major cities. I believe India will stay the course and embark on an aggressive infrastructure program to build regasification terminals, pipelines, and distribution lines to get the gas to customers.

Trade Disputes and Natural Gas/LNG Exports

Thus far, the imposition of higher U.S. tariffs has not affected imports of U.S. LNG in the European Union, China, Mexico, or India, nor have tariffs affected U.S. pipeline gas exports to Mexico or Canada.

That could all change when it comes to national honor and the geopolitics at play between the United States and its trading partners. LNG-importing countries could simply purchase LNG from other suppliers. While U.S. LNG exports are sought by global buyers for diversification reasons, there is fierce competition from LNG producers in Russia, Qatar, Australia, Malaysia, and Indonesian. New LNG exports from Mozambique and the Middle East and additional capacity from Nigeria may disadvantage U.S. LNG exporters further if trade disputes spill over into energy.

If a full-scale trade war erupts that includes U.S. LNG and results in higher U.S. LNG prices, some LNG-importing countries that have shale gas reserves may opt to accelerate development to mitigate supply and

price risks. That could include replicating U.S. shale gas production.

Plan B: China and Mexico Replicate U.S. Shale Gas Production—Correct Economics?

According to the *BP Energy Outlook*, by 2040 China will be the second-largest shale gas producer, after the United States, growing to 22 billion cubic feet per day by 2040. However, demand for natural gas in China is to grow by 194 percent during the same period, while coal demand is to decline slightly (down 18 percent). Renewables, including wind and biofuels, will grow rapidly, by 789 percent. Nuclear and hydropower are to grow by 574 percent and 32 percent, respectively. See Exhibit 3.

1 Asia and Oceania Share of world TRR: 28 per cent. Number of countries under review: 11 Comment: Together, China and Australia, accounted for three quarters of TRR in the region.	**2 North America** Share of world TRR: 23 per cent Number of countries under review: 3 Comment: The United States and Canada are commercial shale gas producing countries and respectively accounted for 36 and 33 per cent of regional TRR. Mexico represented 31 per cent of regional TRR, with nascent exploration activities.
3 Latin America and the Caribbean Share of world TRR: 19 per cent Number of countries under review: 8 Comment: Argentina is the main shale gas reservoir in the region, with 56 per cent of regional TRR, followed by Brazil (17 per cent) and the Bolivarian Republic of Venezuela (12 per cent).	**4 Africa** Share of world TRR: 19 per cent Number of countries under review: 7 Comment: With 69 per cent of TRR in Africa, North Africa appears to hold the largest share of TRR on the continent. Algeria accounts for more than half of TRR in Africa. South Africa also holds large resources, with 28 per cent of regional TRR. Countries in sub-Saharan Africa are almost excluded from the sample, with the exception of Chad, with 3.2 per cent of regional TRR.
5 European Union Share of world TRR: 6 per cent Number of countries under review: 11 Comment: France and Poland appear to hold most shares of regional TRR, with 30 per cent each. Poland and the United Kingdom of Great Britain and Northern Ireland (5.5 per cent) have taken steps towards the future production of shale gas. France decided to ban hydraulic fracturing in July 2011 (law No. 2011–835).	**6 Eastern Europe** Share of world TRR: 6 per cent Number of countries under review: 3 Comment: The Russian Federation ranks first within the group, with a share of about two thirds of regional TRR, followed by Ukraine (29 per cent).

Source: UNCTAD secretariat, based on EIA.

Exhibit 3

According to the Mexico Institute, more than 50 percent of Mexico's energy comes from fossil fuels, with the transportation sector consuming 45 percent. Electricity has grown by half since 2000, and energy demand has increased by more than 25 percent. Mexico's energy outlook is impressive. More than 50 percent will come from offshore oil fields. Mexico estimates that $93 billion will be invested over the next 35 years offshore. By 2040, greater than one-half of the country's energy will come from offshore oil fields, including associated natural gas. Mexico's General Law on Climate Change requires emissions to be below 50 percent by 2050. Thus, more than one-half of power generation will be from renewables.

While it may be tempting for both China and Mexico to replicate U.S. shale gas, there are significant policy, monetary, and environmental costs that would be incurred, besides the economic feasibility of such a program. The U.S. model is unlikely to be directly replicable in other countries, according to a new report by the United Nations Conference on Trade and Development (UNCTAD).4

By importing pipeline gas and LNG, Mexico and China are saving considerably on shale gas infrastructure investments in drilling/fracking, gathering, processing, and storage. In addition, they don't have to deal with the associated environmental effects from the aforementioned activities. However, if LNG prices rise further for one reason or another, China and Mexico will have no choice but to accelerate development of their shale gas to make steady progress in meeting their air pollution reduction goals.

The United States produces approximately 80 billion cubic feet per day of natural gas from gas wells and oil wells. The capital expenditures (CAPEX) to accomplish this along the entire oil and gas supply chain amounted to $184.5 billion in 2018. Upstream costs are the lion's share of the investment at $132.5 billion. Even though the United States already has an extensive natural gas and oil pipeline network of 300,000 miles and 79,000 crude oil pipelines, CAPEX in natural gas pipelines increased by 144 percent. See Exhibit 4.

As China expands its shale gas development to offset its dependency on higher-priced LNG imports, China will be required to increase its CAPEX in drilling, gathering, processing, pipeline transmission, and distribution. China will also have to regulate upstream and midstream activities associated with hydraulic fracking and horizontal drilling and ensure that the supply chains for water, proppants, and chemicals are adequate to support drilling. Water is especially important, because unconventional gas wells require 15.5 liters per million Btu's, twice the amount of water used by conventional gas wells in extraction and processing.[5]

	2018 million $	Change change, %	2017 million $	Change change, %	2016 million $
Exploration-production					
Drilling-exploration	111,180	9.0	102,000	37.8	74,000
Production	21,124	9.0	19,380	37.8	14,060
OCS lease bonus	200	65.3	121	-32.0	178
Subtotal	**132,504**	**9.1**	**121,501**	**38**	**88,238**
Other					
Refining and marketing	13,860	5.0	13,200	0.8	13,100
Petrochemicals	8,667	7.0	8,100	5.2	7,700
Crude and products pipelines	2,676	15.0	2,327	-89.5	22,130
Natural gas pipelines	18,751	144.0	7,685	18.7	6,475
Other transportation	4,300	19.4	3,600	2.9	3,500
Miscellaneous	3,750	25.0	3,000	25.0	2,400
Subtotal	**52,003**	**37.2**	**37,911**	**-31.5**	**55,305**
TOTAL	**184,507**	**15.7**	**159,412**	**11.1**	**143,543**

Exhibit 4

In addition, China will probably have to expand its gathering, processing, and pipeline transmission system to accommodate increased production. Depending on the natural gas liquids content of the gas, China may have to build additional fractionation plants and pipelines to send the more-pure products to

petrochemical plants.

All of the activities associated with accelerating shale gas production require regulation to protect the environment and the public from methane leaks, explosions, and other impacts associated with the construction of pipelines and their operation. Annual budgets and staffing levels at the Federal Energy Regulatory Commission (FERC) and Pipeline & Hazardous Materials Safety Administration (PHMSA) provide some insight on the costs of regulating the midstream activities such as pipeline, storage, and LNG terminal construction and operation. FERC's 2019 fiscal year budget request is $70 million for its natural gas program, including enforcement staff. PHMSA's 2019 fiscal year budget request is $119 million to oversee the safety of over 2.6 million miles of pipelines and storage facilities in the United States. China would require at least a similar effort.

The above costs seem small compared to the required CAPEX to expand shale gas production. Costs are relatively low in the United States, because the oil and gas industry takes an active role in ensuring that the safety and operations of infrastructure and drilling do not violate existing laws and regulations. That role includes working with environmental groups like the Environmental Defense Fund to reduce methane leaks and flaring of natural gas.

The oil and gas industry in the United States is privatized and completely separated from government agencies that regulate the industry. In China, government-owned companies would be making the CAPEX investments and conducting the activities. In Mexico, it is likely that government-owned companies like Petróleos Mexicanos would be heavily involved in shale gas expansion. I believe China's and Mexico's environmental agencies will find it challenging to adequately protect the environment and safety from shale gas development along the entire natural gas supply chain.

By relying on U.S. LNG imports and pipeline gas, China and Mexico are assured that the gas has been extracted and transported with the appropriate level of environmental and safety oversight.

Better Economics To Import Rather Than Duplicate Effort

In conclusion, the value of U.S. LNG imports not only offsets the additional CAPEX needed to replicate U.S. shale gas production, but also reflects a high degree of environmental protection. Also, if U.S. LNG prices can be further reduced, they may delay accelerated shale gas production in China, Mexico, and other countries and quicken the adoption of gas to replace coal and oil.

The UNCTAD report on shale gas contains valuable information that countries will need to consider before developing their shale gas reserves or even attempting to replicate the U.S. shale gas experience. However, I don't believe China and Mexico will be dissuaded from trying to accelerate their shale gas production and ultimately replicate the U.S. shale gas production if the price of their pipeline gas or LNG imports continue to rise and air pollution adversely affects the health of their citizens.

Foonotes

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[3] NGI's Mexico Gas Price Index, July 16, 2018, Vol. 2, No. 12.

[4] UNCTAD. (2018). Commodities at a glance: Special issue on shale gas, No. 9; p. 48. Retrieved from http://unctad.org/en/PublicationsLibrary/suc2017d10_en.pdf.

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