



White Paper

An America First Future for LNG Exports

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Shareables

- Short-term and flexible LNG (liquefied natural gas) contracts without destination clauses are expected to increase in the future.
- U.S. natural gas markets will be increasingly linked to global markets through LNG exports.
- U.S. LNG exports will play a significant role in global LNG pricing and will accelerate the de-linking of LNG contracts from oil prices.

Executive Summary

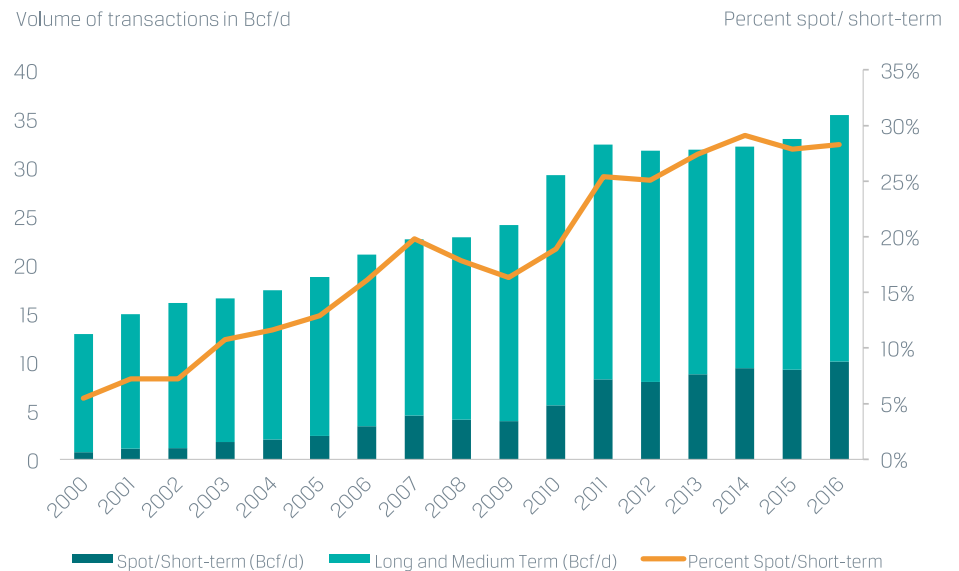
The United States is playing a major role in transforming the global LNG markets as it marches towards becoming the third largest LNG exporting nation in the world. In the near term, LNG supply is projected to increase more quickly than global demand, leading to an oversupply scenario through early 2020s. This buyer's market will lead to depressed prices and an increase in short-term trade. U.S. export terminals will likely set the global LNG price in this period based on variable costs, acting as marginal suppliers in the global LNG market. Recently, South Korea and China which are currently the world's second and third largest LNG importers have shown increased interest in U.S. LNG and natural gas, aided by policy initiatives of their respective governments. The U.S. can also play a role in increasing liquidity of global LNG trade and enhancing supply security for other countries. Future LNG exports may vary significantly depending on several factors; however, some scenarios such as weather-related demand increases are advantageous to U.S. exporters. It is important to analyze the impacts of growth in this sector under different market conditions to understand the implications on domestic natural gas markets.



Global LNG Trade is Trending Towards Short-Term and Flexible Contracts

The share of spot and short-term cargos (of duration less than 4 years) in the global LNG market is trending upward, from about 16% of shipments in 2010 to over 28% in 2016, as shown in Exhibit 1. Increases in the LNG shipping fleet and regasification capacity over the past few years supported the recent shift towards short-term LNG cargos. ICF expects this trend to continue as more LNG export capacity comes online globally.

EXHIBIT 1: WORLD LNG TRADE BY CONTRACT DURATION, 2000–2016



Source: GIIGNL, *The LNG Industry in 2016 and earlier years*

Global LNG export capacity is projected to increase 32% over 2016 levels to about 61 Bcf/d (450 MTPA) by 2020 as approved and under-construction projects come online. Believing the market is oversupplied, buyers will likely resist signing long-term contracts until they believe the market has rebalanced and prices have bottomed out. In July 2017, State-owned Qatar Petroleum has announced plans to increase its LNG production by over 20% by mid-2020s, which might result in an over-supplied competitive market.¹ They may also be able to avoid rigid contracts with high Take-or-Pay levels. For example, in a move to push for flexible contracts from LNG producers, Korea Gas Corp, Japan's JERA, and China National Offshore Oil Corp, which together account for about one-third of global LNG demand, signed a memorandum of understanding in March 2017 to cooperate in the joint procurement of LNG. Moreover, Malaysia's state energy firm, Petronas, is exploring short-term LNG contracts and smaller cargo sizes to capture new demand in an oversupplied LNG market.

¹ EIA Natural Gas Weekly Update, <https://www.eia.gov/naturalgas/weekly/>

As long as buyers expect spot prices to drop, ICF expects that shorter duration (5–15 years), flexible LNG contracts without destination clauses will be more prevalent and that significant demand will remain uncontracted. Short-term trade will thus increase considerably to reach 40–50% of the global trade by 2020. Based on Department of Energy data, from February 2016 through April 2017 spot cargos accounted for about 32% of total U.S. LNG exports.²

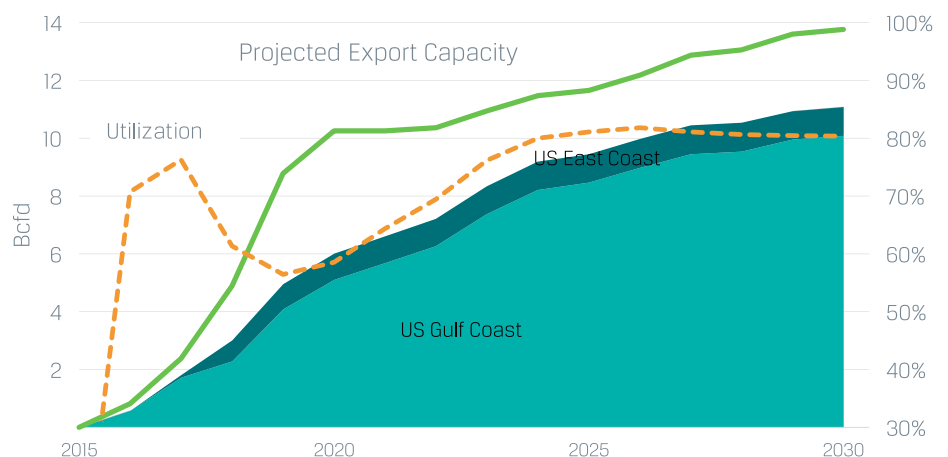
U.S. Natural Gas Markets will be Increasingly Linked to Global Markets Through LNG Exports

In 2016 global LNG imports increased by around 7.5% to about 36 Bcfd (263.6 million tons). LNG demand growth in China, Egypt, India, Pakistan, and Jordan offset the decline in LNG demand from Japan. This increase in demand was met by new supplies coming from Australian LNG projects and the start of the first two trains at Sabine Pass in the U.S.

World LNG demand is projected to almost double by 2030 to reach 64 Bcfd,³ and the U.S. is well-positioned to capture a significant share of the contestable global LNG market. U.S. LNG terminals are supported by a highly competitive domestic natural gas market that will limit feed-stock price increases and potentially lower capital costs compared to integrated LNG facilities in other countries. ICF expects U.S. LNG exports to account for more than 16% of global demand by 2030.

As global supply-demand balance tightens and utilization at existing LNG terminals approaches 80%, ICF anticipates a second wave of LNG terminal build outs between 2023 and 2030, including about 3.5 Bcfd of new capacity on the U.S. Gulf Coast.⁴ Despite their advantages, the over-supplied global LNG market will cause U.S. export terminals to average about 60% utilization through 2020, and rise to about 80% by 2025, as shown in Exhibit 2.

EXHIBIT 2: US LNG EXPORT VOLUMES VERSUS CAPACITY



Source: ICF Gas Market Model

¹ LNG Monthly (YTD – through April 2017), <http://energy.gov/fe/listings/lng-reports>

² 4.5% per annum demand growth from 2016 through 2030.

³ ICF's Q2 2017 forecast

LNG export projections may vary significantly depending on factors like oil prices, economic growth, international pipeline trade, and market share of natural gas versus other fuels. Lower domestic natural gas prices or more expensive international LNG supplies could result in a "high case" scenario in which U.S. LNG exports grow throughout the forecast period. In addition, weather will continue to affect seasonal LNG demand globally, presenting U.S. suppliers an option to leverage their vast gas supply resources and robust pipeline network to ramp up their feed-gas deliveries and meet the demand more quickly than other integrated LNG facilities around the world. Last winter, for instance, LNG exports from Sabine Pass benefitted from higher spot prices in Asia due to cold weather and unscheduled maintenance outages of LNG terminals in Australia and Angola. The U.S. can thereby act as a global storage or buffer facility to meet swings in LNG demand caused by cold weather, global supply outages or policy changes related to supply diversity, energy security or international disputes.

U.S. LNG Exports Will Play a Significant Role in Global LNG Pricing

Weak oil prices and low growth in the global economy forced down LNG market prices in 2016. Prices are expected to experience additional downward pressure in 2017 and 2018 as about 11.5 Bcfd (85 MTPA) of new LNG export capacity is projected to come online, resulting in a significantly oversupplied market. Despite growing demand, new export capacity in Australia and the U.S. combined with potential supplies from East Africa and Canada will continue to place pressure on global LNG prices; the market will remain over-supplied until approximately 2022.

The projected increase in U.S. LNG export capacity and competition among LNG sellers will likely result in de-linking of the long-term oil-indexed LNG contracts and promote competitive trading. LNG exports of more than one hundred cargoes from Sabine Pass are already indexed to the natural gas price at Henry Hub. As more U.S. LNG export facilities come online, the amount of global LNG trade indexed to gas prices will increase, thereby transforming the terms of pricing in contracts.

Outlook for Global LNG Markets and Pricing

Over the next fifteen years, ICF expects global LNG markets to transition through several distinct market periods driven by different supply and demand factors as well as pricing setting mechanisms.

Currently, global LNG markets are over-supplied, favor LNG buyers, and will see increasing exports from new U.S. LNG export terminals. Under this dynamic, pricing, in particular spot-pricing, will trend to the lowest cost incremental sources of supply. Given the low utilization levels projected for U.S. LNG terminals over the next five years, ICF expects LNG prices will remain near the marginal cost of a shipment from the U.S. Gulf Coast to market destinations.



By the early 2020s, the global LNG market is expected to tighten as it experiences new demand growth and a slow-down of new terminal builds. Under this dynamic, incremental supply will be needed to meet new demand, shifting the power back toward project developers that will require secure contracts to commission new facilities. ICF expects the U.S. to again play an outsized role in the global LNG market as brownfield U.S. LNG projects (expansions at the existing terminals) will likely be among the lowest cost options for new export capacity.

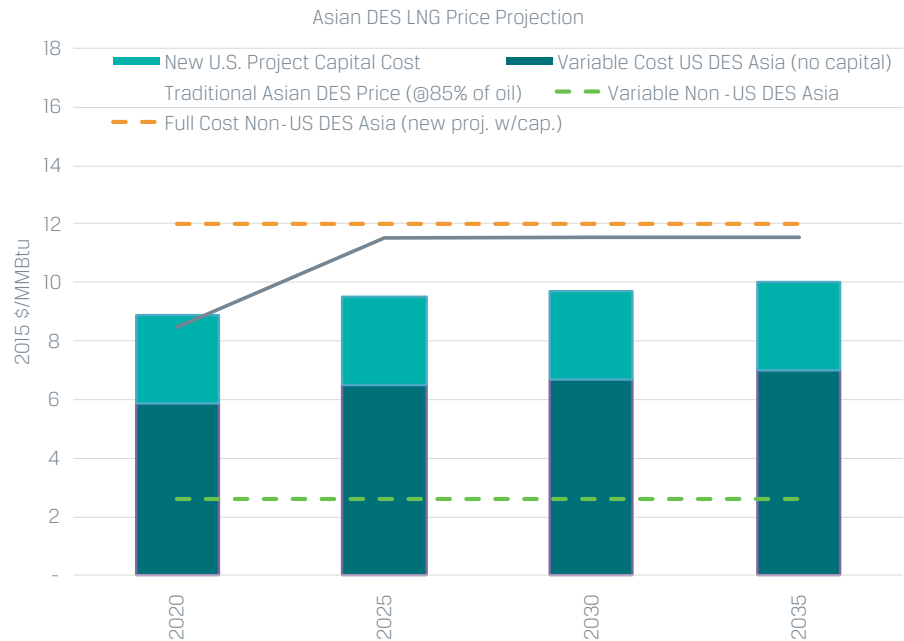
During this market tightening period, the price for newly contracted supplies should be high enough to justify final investment decisions on proposed LNG terminals. As LNG supply tightens due to rising demand, prices are expected to rise and sellers will likely regain their negotiating power, triggering a second wave of investments in LNG export terminals.

Over the long-term, incremental LNG supplies will be needed from a variety of supply areas; the global LNG price will be influenced by the cost of new greenfield LNG supply projects outside of traditional low-cost LNG centers. ICF estimates the free-on-board (FOB) LNG price required for a typical, moderate-cost integrated LNG project to be about \$1900/tpa, or about US \$7.40/MMBtu (US \$6.30/MMBtu after the benefit of associated liquids). Projects in the Middle East and East Africa would require delivered ex ship (DES) prices in Asia of roughly \$8/MMBtu to be economical. ICF's estimate for a high-cost LNG project is about \$3,000/tpa, which would be equivalent to an example Australian project that translates to a FOB price about \$10/MMBtu or more after liquids credits, and would require DES prices in Asia of roughly \$11-\$12/MMBtu to be the marginal supply.

Exhibit 3 highlights projected DES LNG prices in Asia given ICF's forecasted global oil prices and U.S. natural gas prices. The bar represents the full cost of U.S. Gulf Coast exports to Asia: the purple portion represents the variable cost of shipment and the blue portion represents the terminal fee of around \$3 per MMBtu. An over-supplied market, global spot and short-term LNG prices should range near the variable cost of exports from the U.S. Gulf Coast, with an upper limit set by the full cycle costs.

However, once new liquefaction capacity is needed in the market transition period and in the market tightening period, LNG prices should increase enough to incentivize new investments. Initially, ICF expects LNG prices to trend to the upper end of the range of full cycle costs for a new U.S. LNG facility, but as the market continues to tighten, LNG prices must rise further to incent development of LNG supplies outside of lower-cost supply areas.

EXHIBIT 3: ICF FORECAST OF DELIVERED EX SHIP (DES) PRICES IN ASIA



Source: ICF

1. Pricing set by the variable costs of existing suppliers.
2. Minimum price set by variable costs of existing suppliers. Max price by U.S. full cost for new plants.
3. New liquefaction capacity must be added so full cost recovery of marginal plant must take place

While liquefaction capacity is over-supplied, until the early 2020's, spot and short-term prices in a competitive market are expected to be set by variable costs—slightly less than \$3/MMBtu for established LNG suppliers with dedicated feedstock supplies such as Qatar. These prices are far below full cost recovery prices, and long-term contracts are expected to settle at significant premiums, mainly to compensate suppliers for the higher prices that are expected to prevail once the market comes into balance. On the other hand, when a market balance is achieved and spot and short-term prices rise closer to the full cost of new plants, the premium for long-term contracts are expected to be smaller.

It is important to note that the base case LNG price forecast shown in Exhibit 3 implies that, given ICF's oil price assumption, new Asian contract prices will be substantially below the historical, oil-linked average benchmark of 85% of oil price on a Btu basis. This suggests that as these traditional oil-linked contracts expire and are re-negotiated, their prices will be reduced to match the prevailing new contract price levels.





A Future for LNG Exports

The wave of LNG terminals that recently came online and the new terminals that are expected to open in the near future will likely result in an oversupplied global LNG market until 2022.

Moreover, expiration of long-term contracts and LNG on LNG competition have created a favorable environment for buyers. However, as LNG demand grows, new floating LNG re-gasification terminals are built, and more countries start importing LNG, suppliers will likely gain back their advantage. New LNG export terminals will be needed to meet the demand starting 2023.

With highly competitive natural gas markets and potentially lower capital costs compared to integrated LNG facilities in other countries, the U.S. has the potential to become the leading exporter of LNG in the world, even if a fraction of the several proposed LNG export terminals are built after 2022. The U.S. will play a major role in increasing liquidity of global LNG trade and enhancing supply security for other countries. However, the projected LNG exports may vary significantly depending on several factors like oil prices, economic growth, international pipeline trade, and market share of natural gas versus other fuels.

About ICF

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About the Authors

Srirama Palagummi has nine years of experience in the energy industry with a strong background in natural gas markets, regulatory analyses, data management, and power sector modeling. He has participated in several studies for private clients for valuation of energy infrastructure assets. He analyzes and forecasts the North American natural gas market using ICF's Gas Market Model (GMM) for developing ICF's Quarterly Natural Gas Strategic Outlook, and helps in the design of alternate gas market scenarios for ICF's public and private sector clients. He also assisted EPA's Clean Air Markets Division in several rulemakings like Proposed Clean Power Plan, Cross State Air Pollution Rule (CSAPR) and Mercury and Air Toxics Standards (MATS), by performing policy runs to analyze the impacts of electric power sector emissions under different Command & Control and Cap & Trade policy scenarios using ICF's Integrated Planning Model (IPM).



processes; and synthetic fuels and end market uses.

Harry Vidas is a recognized authority on energy markets and forecasting. He leads a team of geologists, engineers, and economists to analyze North American and world natural gas and oil supply, transportation, and end use. Mr. Vidas has directed projects related to international oil and natural gas supply, gas processing, and LNG production; shipping, pipeline transmission, underground storage, gas-to-liquids



natural gas liquids markets, infrastructure assessments, regulatory impacts on Upstream developments, and strategic analysis of investments. He holds a BS in Management Science from UCSD and a MBA in Global Finance from Thunderbird School of Global Management.

Eric Kuhle is a manager with ICF's Energy Advisory Group who works on projects related to NGL and Natural Gas Markets. He has over 9 years of experience in energy related research and consulting and most recently worked at Halliburton's Production Enhancement group in strategy and planning before joining ICF in 2016. Mr. Kuhle has expertise covering the forecasting of natural gas and

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