Global Gas/LNG Research

# LNG SUPPLY OUTLOOK 2016 TO 2030

## By Andy Flower[1]

### Executive Summary and Commentary

As shown by Andy Flower in *LNG Supply and Outlook 2016 to 2030*, a research paper commissioned by CEE as part of our Global Gas/LNG Research, global liquefied natural gas (LNG) supply is set to grow quite dynamically over the next few years from the 248 million tonnes produced and delivered in 2015.

Overall, by 2030, if all known proposed projects come to realization, global capacity would reach 1,000 mtpa, "much more than any realistic assessment of what will be needed as noted in the report".

**Summary: Global Liquefaction Capacity to 2030 (mtpa)**

| | In Operation | Under Construction | Proposed |
|---|---|---|---|
| Qatar | 77.5 | - | - |
| Australia | 46.0 | 40.2 | - |
| USA | 4.9 | 59.7 | 248.0 |
| Canada | - | - | 333.0 |
| Russia | 10.6 | 16.5 | 30.0 |
| East Africa | - | - | 70.0 |
| Rest of Middle East | 23.4 | - | - |
| Rest of Pacific Basin | 70.8 | 6.3 | 20.0 |
| Rest of Atlantic Basin | 88.9 | 1.2 | 20.0 |
| **Total** | **322.1*** | **123.9** | **721.0** |

*Source: A. Flower, LNG Supply Outlook 2016 to 2030, as presented May 31, 2016 in Houston, CEE Think Day on global LNG and China/India gas demand. *24.1 mtpa of capacity in Yemen, Egypt and Angola are offline as of this compilation (see full paper for discussion on these locations).*

[1] Report commissioned by the Bureau of Economic Geology's Center for Energy Economics as part of CEE's in depth review of natural gas demand in key countries and world regions. Other publications forthcoming included a detailed case study and cross-country comparison of China and India. This summary and commentary was prepared by CEE global gas/LNG principal investigator Dr. Michelle Michot Foss with Andy Flower, Dr. Gürcan Gülen, CEE senior energy economist and research scientist and Guy Dayvault, Energy Deal Solutions, a peer reviewer for the full report.

While global LNG output was essentially unchanged from 2011 to 2014, and increased by only 2.7% in 2015, many facilities now under construction will begin operating during the coming five years. These new projects will increase global LNG supply capacity to 385 million tonnes per annum (mtpa), which is an increase of some 55%, or 137 mtpa, over 2015 actual production volumes.

The full paper provides a country-by-country discussion of new LNG supply volumes both under construction and being proposed. The paper includes a summary of supply capacity by country in three categories (Appendix 3) including:

- Capacity as of April 2016;
- Capacity currently under construction:
- Capacity planned and proposed; and
- Comments on status of the various facilities.

The current global LNG supply capability tabulated in Appendix 3 of 322 mtpa exceeds 2015 production for a combination of reasons.

- By far the most important reason is a shortage of natural gas supplies to plants. In many cases this is because governments are prioritizing their domestic markets over exports (for example in Algeria, Egypt, Oman and Indonesia). Declining gas reserves and production are a factor in Trinidad and Indonesia whereas in Nigeria the shortfall has been because of sabotage to pipelines – insurgents sabotaging pipelines and theft of condensate via illegal pipeline taps.
- Unscheduled maintenance (such as at Norway's Snohvit and Angola's LNG).
- New LNG capacity commissioned during the first quarter of 2016 (e.g., Sabine Pass, Gorgon and Australia-Pacific LNG in Queensland) was in build-up mode.
- Capacity that was idle during 2015 for various reasons (e.g., Angola for repairs; Egypt for insufficient upstream gas availability and Yemen[2]).

The global LNG liquefaction fleet operated in 2015 at an aggregate 89% utilization factor when considering the plants operational for the full year. That 2015 utilization factor would be only 83% if we also include the idle capacity in Angola, Egypt, and Yemen.[3]

*LNG Supply Outlook 2016 to 2030* focuses on large-scale LNG supply for export by conventional ocean going LNG Carriers (LNGC). The most common LNG Carriers have a cargo capacity of between 130,000 and 180,000 cubic meters of LNG, which is approximately equivalent to between 3 and 4 BCF of vaporized gas depending on the LNG heat content and cargo size. At the extremes, the global LNGC fleet includes vessels as large as 266,000 cubic meters for certain trade routes originating in Qatar and vessels as small as 1,100 cubic meters for certain coastal

[2] Yemen was closed because of the Civil War. In earlier years there had been interruptions to supply of gas because of pipeline sabotage.

[3] The capacities of liquefaction plants normally take into account routine maintenance – trains are typically taken off-line once every three years for around one month. Thus, for example, while the Pluto project in Australia has a capacity of 4.7 mtpa operating 24 hours per day, 365 days per year, Woodside quotes its capacity as 4.3 mtpa to take into account scheduled shut-downs.

and inland waterway trade.[4] A few unique segments of global LNG supply are beyond the scope of this paper.

- Recent development of LNG shipment using pressurized International Standards Organization (ISO) intermodal containers (such as in the Caribbean region, and Hawaii).
- Peak-shaving LNG production in North America, Europe, Asia, Australia and South America for load balancing by local gas distribution companies.[5]
- Small-scale domestic LNG production (in China, Canada, US and elsewhere).[6]

*LNG Supply Outlook 2016 to 2030* includes discussion of future LNG demand, including high and low scenarios, generally in line with other organizations. Rather than an exhaustive treatment of demand trends and forecasts, this paper was commissioned by CEE to provide context for CEE's detailed case studies of natural gas consumption and forward paths among key markets and regions. *LNG Supply Outlook 2016 to 2030* incorporates an expectation of sufficient global supply until the 2021 to 2023 time frame. Subsequent demand for imported LNG is expected to exceed supply from plants now in operation and under construction. Historically, like other large scale capital investments, the practical reality of LNG facilities is that once capital is spent to build and commission LNG plants, the short run marginal cost of operation is very low and nearly always less than the export price of LNG. This economic reality, combined with limited global storage of LNG (as a cryogenic liquid requiring storage competence to minus 256°F), has resulted in LNG cargoes always finding customers. In recent years with the further development of short term LNG trade, the price of "spot" cargoes has served to balance supply and demand.

Extensive work over the years has been undertaken by CEE researchers to document, analyze and better understand the large, dynamic US and North American continental marketplace.[7] *LNG Supply Outlook 2016 to 2030* provides considerable detail on the status of widely anticipated North American export projects. Several of these are conversions of brownfield, LNG import terminals in the Lower 48 states of the US, with substantial import capacity built when LNG imports were expected to be needed to balance US supply-demand. Developers and proponents of US export projects clearly were lured by very low prices in recent years at the main Henry Hub trading location, as sample supply from domestic production (including new unconventional plays) flowed into a market impacted first by deep recession in 2009 and later by a very warm winter during 2011-2012. While gas producers initially targeted methane rich locations, in response to high and volatile Henry Hub prices from 2001-2007. Since that time "methane yield" has come primarily from drilling targeting higher value liquids – black oil, most

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[4] The Pioneer Knutsen, which trades in Scandinavia has a capacity pf 1,100 cubic meters.

[5] US and Canadian gas utilities and pipelines have traditionally operated satellite liquefaction and storage facilities for seasonal peak natural gas use. Gas pipeline and distribution operators in other locations have followed similar strategies.

[6] For instance, China uses domestic LNG for marine and road transport. China has 20 to 30 plants which liquefy gas (in some cases minemouth coal bed methane or CBM) for distribution to industrial sites by road tanker. Norway has a 0.3 mtpa plant which supplies LNG for small communities along the Norwegian coast and for delivery to small receiving terminals elsewhere in Scandinavia. LNG and associated refueling locations are emerging to serve regional trucking needs. As a transportation fuel, LNG must compete with ultra-low and low sulfur diesel.

[7] See http://www.beg.utexas.edu/energyecon/GlobalGas-LNG/ for publications highlights from CEE's decades of natural gas value chain research in the US, North America and worldwide.

desired, and condensates and "wet gas" as well as non-associated, ethane rich gas acreage that yield that commodity and suites of other natural gas liquids (NGLs).

At present, and for the foreseeable future, the US oil and gas producer segment will be challenged by lower oil and NGLs prices, with the latter especially volatile as operators seek to preserve or enhance value through exports in a rapidly shifting commodity price and trade environment. As of this writing, US dry gas production, the principle, pipeline-delivered feed gas for liquefaction, has plateaued and begun to trend down. With liquids prices less supportive of drilling and production, Henry Hub and associated netbacks will have to provide suitable incentives for re-deployment of capital to gas-targeted investments. Meanwhile, the historically low Henry Hub index during the past eight years has been a boon to gas use by US customers.[8] Gas demand for power generation has reached record highs of 37 to 40 billion cubic feet per day (Bcfd) during summer 2016 and gas now constitutes about 35% of dispatched generation from just over 12% in 2001 – in a power industry that has seen flat to declining demand since the 2009 recession. The principle loser at the power burnertip has been coal; switching between coal and gas remains a feature of the US power landscape, deeply disadvantaging the US coal industry. Industrial demand for natural gas – the array of molecules from methane through the natural gasolines – has grown and is expected to increase further as some $90 billion in petrochemical and other gas driven investments come online beginning in 2017. Finally, North America has long been its own best marketplace, with gas-on-gas competition providing the commercial basis for the deepest physical and financial trading location in the world. An ever expanding, integrating gas pipeline grid has facilitated incursion of US Lower 48 production into Eastern Canada markets, as Western Sedimentary Basin declines set in, and especially to Mexico where gas imports have zoomed more than five times since 2005. These patterns and trends suggest that, at some point, any international customer of US gas supply must be willing to pay considerably more than customers within North America.

In *LNG Supply Outlook 2016-2030* author Andy Flower also addresses other North American proposed projects, namely Western Canada and Alaska. These, and other, projects will be burdened by current market conditions, with several years of softer LNG prices as a result of both ample capacity relative to demand, global economic conditions and the lower trajectory for oil prices. Not explored in this paper, but well-understood as a pronounced project development risk in Canada, are the difficulties in procuring rights-of-way from First Nations landholders and absorbing the high costs of very long distances for gas pipelines to feed Western Canada export facilities.

International LNG supply and trade reflect shifting patterns of natural gas use around the world. For example, new LNG import infrastructure began operating recently in locations such as Pakistan and Jordan. Active developments are underway to initiate or increase LNG trade to markets such as the Caribbean, Uruguay, Ghana, South Africa, Colombia, Bahrain, UAE, Myanmar (in part to supply to Thailand), Vietnam, Bangladesh, Hong Kong, and the Philippines. Projects are taking on increasingly mixed approaches, including marine-based solutions. For instance, two more floating storage and regasification units (FSRUs) are being progressed in Pakistan and Golar LNG/Golar Power plans to provide an FSRU to supply LNG for power

[8] CEE's ongoing analyses of US power and industrial gas demand can be accessed at our research blog, http://www.beg.utexas.edu/energyecon/thnkcrnr.php.

generation in Sergipe, Brazil. Some of the shifting patterns reflect changes to established trade flows. Natural gas demand growth in Chile includes exports of vaporized LNG via pipeline to Argentina; until ructions in gas supply contracts in recent years, Argentina had been supplier to Chile through the GasAndes pipeline. CEE currently is completing work on potential gas demand growth in China and India which will bear numerous implications for international LNG trade. Recent lower prices for LNG along with the push for commercial flexibility outlined in *LNG Supply Outlook 2016 to 2030* could stimulate growth in demand for natural gas and imported LNG but these huge markets are nothing if not complex.

In contrast, LNG demand reductions are occurring in the long-established, core markets of Japan and Korea. Japan's imports alone were down by 3.5 million tonnes (mt) in 2015 and a further 2.3 mt during the first half of 2016. Korea's LNG imports declined by 4 mt in 2014 and 2.9 mt in 2015 (with a further 0.6 mt drop during first half 2016). A significant factor that will affect LNG trade is the eventual resumption of nuclear power generation by the Japanese fleet. Progress has been very slow. Cost and pace of construction at some nuclear power plants (NPPs), given the requirements for "hardening" Japan's nuclear energy bases following the horrific March 11, 2011 ("3/11") earthquake and tsunami, have been major factors. Restoration of the NPP fleet also has been encumbered by local and national opposition. Only the Sendai 1 and 2 nuclear units (Kyushu Electric Power Company or EPCO, unaffected by 3/11) are in operation. Takahama units 3 and 4, operated by Kansai EPCO, had been in restart but a district court ordered a halt, unresolved as of this writing.[9] The Ikata-3 unit owned by Shikoku EPCO is due to restart August 2016. Several other nuclear power bases are in various stages of retrofits and regulatory reviews for resumption of operations. Meanwhile, more critical to this paper and the global LNG industry, Japan's energy situation has changed considerably. The slow pace of economic activity; the extent of economic "outages" associated with parts of the country impacted by 3/11 (offset by investment in recovery and repair); aggressive demand side management efforts; and, not least, the cost of energy procurement (LNG, oil, coal) as the NPP fleet was taken offline have all weighed heavily on the country and affected energy outlooks and views considerably.

As noted in CEE's research prospectus (Appendix 4 of *LNG Supply Outlook 2016 to 2030*), the status of nuclear power generation in Japan, the largest LNG market in the world, is a key variable. LNG demand for Japan is expected to contract in the near future as portions of the nuclear fleet resume operation. However, longer term, Japan's demand for gas could well be affected by difficulties in relicensing existing, much less licensing new, nuclear generation units. Moreover, Japan's experience has rippled, and will continue to ripple, through the worldwide LNG picture in two significant ways. The first comes in ramifications for LNG capacity expansions in response to the post-3/11 wave of supply contracting by Japanese utilities. LNG projects in the development queue with start dates beyond 2020 may find viability in a post-nuclear picture for Japan. Japan's situation, and decisions, may well affect those in other countries where nuclear presents a potential constraint to increased market share for gas. LNG projects that were rolled out in response to the post-3/11 wave are being affected by the down-shifting economic and energy picture in Japan as well as by other global factors that have contributed to

[9] The Otsu district court ordered a temporary injunction based on concerns regarding both technical issues (adequate protection against surface ground movements) and validity of the new regulatory standards. A Shiga Prefecture-based anti-nuclear group filed a lawsuit in the same court targeting potential drinking water safety in the region, a claim rebutted by Kansai EPCO.

the mismatch between LNG capacity, as mapped out in the paper, and gas demand in critical importing countries.

The second significant impact from the Japanese experience are the fundamental modifications in LNG supply contracting and pricing as outlined in *LNG Supply Outlook 2016 to 2030.* Japanese utilities, holders of a large number of LNG supply and purchase agreements (SPAs) worldwide, are among the many customers seeking greater flexibility in destinations, resale of contracted cargoes, alternative pricing formulas and more open and transparent market operations, not least of which would be gas and LNG hubs that could support LNG physical and derivatives trading in the Asia-Pacific region. The search for commercial options by Japanese utilities, many of whom face substantial penalties and other costs if they deviate from contract provisions, may well hasten the long expected restructuring of the global LNG commercial scene.[10]

To that end, *LNG Supply Outlook 2016 to 2030* contributes toward the myriad discussions and debates on how LNG commerce is likely to be shaped in the future. However, constraints and caveats are fully recognized. Author Andy Flower notes that about 60% of LNG supply added between 2015 and 2020 could be likely to be traded on a short term or spot basis, and thus "flexible" to variations in the marketplace. He suggests that US (with the considerations stated in this summary), Qatar and Australia could be the main sources of flexible supply. However, he notes the following:

> *"The challenge of meeting buyers' requirements for flexibility will be greater for these projects since security of long-term off-take is likely to remain a requirement of boards of directors approving investment and, in cases of project financing, the bankers. The easiest of the requirements to meet will be destination flexibility, especially where a contract is on an FOB basis, but diversions under a DES contract should be possible provided there are protections in the contract to avoid the seller having to invest in additional shipping capacity. Buyers already argue that, when project shareholders purchase output from their own projects to market as portfolio LNG, they are given destination flexibility so why shouldn't they have the same rights."*

A world of resource abundance is also one that presents supreme tests of endurance for producers and project developers. The CEE research team and our extended, international research and collegial networks will continue to monitor market dynamics going forward. It is worth closing this summary with the main conclusion drawn by Andy Flowers.

> *Demand will grow as new markets emerge and with output from some operating projects constrained by declining natural gas supply, leading to a requirement for new LNG sources. Just over 700 mtpa of new capacity has been proposed by sponsors to fill the gap between demand and supply which is expected eventually to emerge. Three quarters of the proposed projects are in*

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[10] Beyond the reference in *LNG Supply Outlook 2016 to 2030* to actions by Japan's Ministry of Economy, Trade and Industry (METI), CEE is undertaking a deeper look at prospective Asia, and other regional, gas and LNG trading and commercial trends. The CEE research team also is looking more closely at Japan's nuclear situation and nuclear energy developments elsewhere, including in the US. Contact CEE for more details.

*North America as companies see the opportunity to take advantage of low natural gas prices resulting from the shale gas revolution. The proposed capacity is well in excess of any likely requirement before 2030, which means that many of the projects face long delays and abandonment. The successful projects will be those that can make an offer to buyers and off-takers that meets their changing requirements which include lower prices, flexibility and shorter-term contracts. Reducing costs to a level that ensures economic viability will be essential in a low price environment that the industry faces in the medium to longer-term.*

**Access the full report, LNG Supply Outlook 2016 to 2030 at [http://www.beg.utexas.edu/energyecon/GlobalGas-LNG/](http://www.beg.utexas.edu/energyecon/GlobalGas-LNG/). For details please contact CEE.**

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