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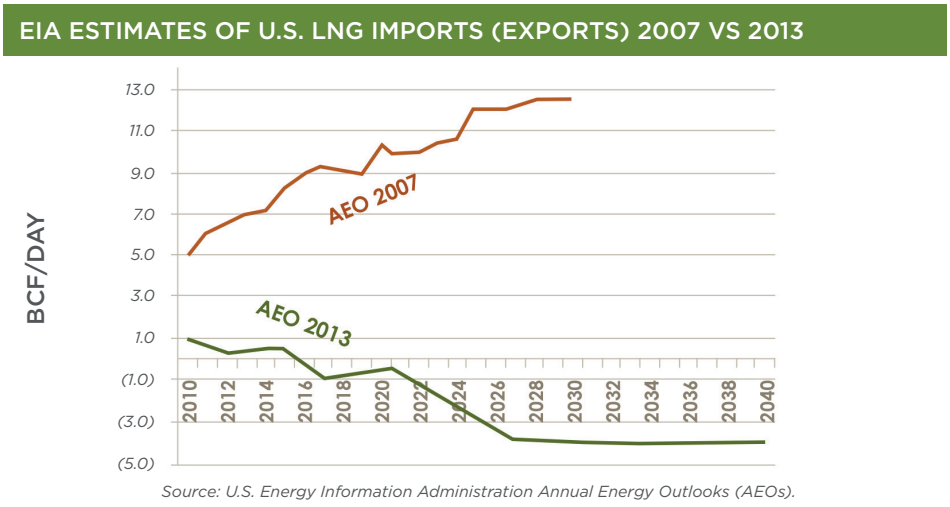
CONSTRUCTION

SUCCESS IN LNG EXPORTS WILL REQUIRE SUCCESS IN EXECUTION (CONSTRCUTION, THAT IS)

In the June issue of "NG Market Notes," Navigant's Gordon Pickering and Jeff Van Horne explored the massive wave of liquefied natural gas (LNG) export applications from the U.S., and the process and theories being used at the Department of Energy (DOE) to decide when and how to consider the applications. The recent approval of the Freeport LNG project bodes well for some reliance on market forces to keep supply and demand in balance at reasonable prices.

The challenge has been that the volume proposed for unrestricted export to other nations, whether or not they have a free trade agreement with the U.S., now totals 29 billion cubic feet per day (bcfd) from just the Lower 48, adding up to nearly half of the total current U.S. market for natural gas. Various comments have been filed expressing alarm at the impact that sort of volume of exports could have on domestic markets. What an argument to be having — six years ago, the U.S. was actively involved in figuring out how to out-compete Asian markets for exporting-nation LNG supplies. Now we are actively involved in figuring out how to out-compete other exporting nations for Asian markets. As recognized by the Energy Information Administration (EIA), the nation has gone from an expectation of very large import volumes[1] to substantial net exports,[2] shown in Figure 1.

Figure 1. The Natural Gas Turnaround



Source: U.S. Energy Information Administration Annual Energy Outlooks (AEOs).

1. The 2007 Annual Energy Outlook.
2. The 2013 Annual Energy Outlook.

Still, there is no doubt that 29 bcfd is a large volume. As Gordon Pickering and Jeff Van Horne pointed out, it is safe to rely upon global competition to keep the actual volume within reasonable levels. How do we know? Without performing a major econometric analysis, the probable competitive balance for the U.S. can be estimated from practical con-siderations. First, what is the expansion market for LNG from new projects, in excess of the production from existing facilities and those already under construction? At LNG17 in April, a major global analyst of natural gas and LNG markets estimated that expansion volume at 160 million metric tons per year (MTPA), through 2025. That estimate is also equal to similar estimates made by two of the largest traders and project developers. So, how does 160 MTPA relate to the 29 bcfd proposed to be exported from the Lower 48? Well, at the global average load factor for LNG liquefaction facilities of 80 percent, 29 bcfd of capacity is 160 MTPA of actual LNG movement. In other words, the applications pending at DOE propose to capture 100 percent of all the growth in world LNG markets for the next couple of decades.

Is that realistic? No, it is not. Major new LNG exports are planned throughout the world, from Australia, Indonesia, East Africa, the Eastern Mediterranean, Western Canada, and Alaska. Each of these countries is closer to Asia than the U.S. Gulf Coast, and a couple of them are closer to Europe. However, to offset these geographic disadvan-tages, U.S. supplies have the advantages of attractive and transparent markets, of a large, sophisticated industry in terms of infrastructure and work force, and of a diversi-fying supply to add competition to global markets. So it is reasonable to expect the U.S. to get more than a ratable share of the global market — say, 25 percent. That would suggest that no more than 8 bcfd of U.S. new-plant capacity will find a stable home in global markets.

The basic follow-up question is, of course, which 8 bcfd? Of that volume, 1.4 bcfd for Freeport has already been approved, leaving less than 7 bcfd of probable new projects from the Lower 48. Should DOE try to pick the projects? As articulated in the June article, the market and ability to execute are much more likely better selectors of successful projects.

There are several factors involved in successfully completing one of these multibillion-dollar facilities, such as: gaining a firm market commitment; securing an adequate supply and upstream pipeline capacity; securing financing; and, of course, clearing all necessary regulatory and siting hurdles. After all the above-mentioned factors have been satisfied, project owners must then plan, design, and construct the facility, which is not a small matter. Stories of massive cost overruns in Australia have pervaded the industry, and just given the sheer number of facilities likely to be attempted worldwide, construction challenges are now a fact of life. Thus, this issue of "NG Market Notes" invites Navigant's Global Construction Practice to share some insights on the current obstacles developers are facing and the lessons learned when constructing LNG facilities. Navigant's construction experts are globally recognized for their significant experience and skill in the management of construction risks and processes around these types of facilities in many regions of the world.

– Navigant's Natural Gas Team

...AND HERE IS WHAT THE CONSTRUCTION EXPERTS HAVE TO SAY

While the number of applications and permits for U.S. and Canadian-based LNG export facilities has been accelerating throughout the past year, most of the projects in the region remain in the very early, planning stages. However, throughout the rest of the world, many such projects are well into construction and/or are operating. Navigant's Global Construction Practice has been involved in many of these projects, and has identified several unique design and construction challenges and risks that have been encountered by these international LNG export facilities, which will likely be faced by sponsors of such projects in the U.S. and Canada. In addition, we have identified some best practices that can be utilized to limit or control the effects of such risks.

UNIQUE CHALLENGES AND SIGNIFICANT RISKS

In the course of Navigant's involvement in LNG export facilities outside of the U.S., we have observed the following issues:

- Remote, Undeveloped Project Locations
- Limited Pool of Potential Contractors Competent in Mega-Projects
- Overheated Markets and Impact on Supply/Costs
- Construction of Marine Facilities
- First-of-a-Kind Aspects of the Process
- Contractor Delays and Claims

Each of these risks and challenges is discussed in detail below.

- **Remote, Undeveloped Project Locations** — In the U.S. and throughout much of the world, oil and gas project owners and sponsors are accustomed to developing new capacity either through the expansion of existing facilities or new construction in existing industrial complexes. However, many of the major LNG facilities currently under construction throughout the world are located in extremely remote areas. These areas are considered undeveloped in terms of basic transportation infrastructure, industrial infrastructure, and support services. Navigant expects that many of the LNG

export facilities planned for the U.S. will reflect the same, judging from the location of initial filings (e.g., Jordan Cove LNG Project, as well as projects proposed for British Columbia.

The majority of these site locations often lack the basic infrastructure needed to construct and operate such facilities. Existing roads, bridges, port facilities, and electric generation facilities in such areas are generally not sufficient to support the needs of the construction project or the follow-on operations. Therefore, other facilities have to be constructed just to allow the construction of the project to begin. For example, several major LNG export facilities are currently being developed along the western coastline of Australia. Owners have had to allow for significant time and expenditures for up-front development activities to design and build the basic transportation infrastructure and even living quarters for construction and operations personnel before any construction of the process portions of the project can begin. Meaning that a project that could be constructed in three years for US$3 billion, could take up to five years and US$5 billion.

Accordingly, when U.S. owners and developers get their projects underway in similarly remote areas, they will have to include in their planning the added time and cost to construct the many facilities that will be needed to support the construction and operation of the plant, including separation tanks, pipelines, roads, receiving facilities, emergency (fire and health) facilities, and facilities for housing and subsistence of workers and their families. These substantial investments will increase the cost per unit of output, as well as add to both the length and complexity of the projects.

- Additionally, mobilizing equipment, manpower, materials, and other requisite resources needed to build infrastructure projects in underdeveloped site locations can significantly increase the risk of budget overruns and considerably extend construction schedules. The global shortage of skilled local labor is of particular concern. A large skilled labor force is necessary to complete the project on time and with appropriate quality levels. But for recent projects constructed in Australia and Angola, the supply of skilled craft labor has been a challenge due to: limited existing personnel in remote areas; lack of interest in relocating to such areas; many projects competing for scarce resources; and/or restrictions on importing foreign labor. For example, there are oil and gas projects in northern Alberta for which craftsmen are being flown in from all over Canada and the U.S. because of limited manpower and competing projects.
- **Limited Pool of Potential Contractors Competent in Mega-Projects** — Most LNG and major development projects in the oil and gas industry now represent mega-projects, costing several billion dollars and requiring three to six years to design and construct. However, the population of contractors capable of performing such mega-projects has not kept pace with the rapid growth in projects. As a result, there are a limited number of qualified contractors with the resources and expertise to take on an LNG export facility. Given the high risk and the large cost of such projects, it is unlikely that the number of qualified engineer-procure-construct (EPC) contractors will grow substantially in North America or Western Europe.
- **Overheated Markets and Impact on Supply/Costs** — Back in 2006–2008, when China was bringing a new coal-fired power plant online every week, India and Brazil were embarking on major construction programs, and many other international energy companies were expanding capacity, the combination of a highly active international market and an overheated local market created very difficult and costly conditions for the purchase of process equipment and bulk commodities. For example, in Australia, where several major LNG facilities are currently under construction and the general construction market is very active, privately funded engineering construction[3] volume in 2011 was 33 percent higher than 2010 levels, and then grew an additional 37 percent from 2011 to 2012.[4]

  In addition to this general run-up in the prices of construction inputs, during periods of heavy global industrial construction activity, the prices for key commodities needed for oil and gas facilities can experience extreme inflationary pressures. Steel for the construction of structures and tanks, steel for the manufacture of piping, copper for electrical cable, and more exotic materials for specialty piping and process equipment, can become relatively scarce and extremely expensive, due to competition from international development of other process facilities, power facilities, pipelines, etc.

  Perhaps of greater concern than the inflationary price effects are potential extensions to the length of the procurement period, due to overloaded suppliers. Navigant has been involved in many projects in which lead times for steel, pipe materials, manufactured pipe, and manufactured equipment grew from an anticipated six months after release of design to 12 months or more. These unanticipated setbacks can drastically affect the dates of first product delivery, and correspondingly, the return on the capital investment. And, this problem is further exacerbated when the project is in a remote location, making material deliveries even more difficult.

3. Engineering Construction Activity addresses all construction excluding residential buildings and non-residential buildings (e.g., warehouses, offices, etc.).
4. Australian Bureau of Statistics, Table 8762.0, Engineering Construction Activity.

- **Construction of Marine Facilities** — By their very nature, LNG facilities require the design and construction of extensive marine facilities. This includes not only the loading terminal, but also the unloading areas to be used during construction, as well as the dredging of harbors necessary for these activities. And, it goes without saying that the construction of marine facilities is a very risky and potentially problematic undertaking, due to the general unpredictability of ocean conditions. Changes in tides, hurricanes, typhoons, and other unexpected underwater conditions are all major risks for marine projects to which many oil and gas owners are not accustomed. There have been substantial delays to the construction of projects in Australia and Latin America due to such conditions, and Navigant expects that the development of future LNG projects in the U.S. will encounter similar issues.
- **First-of-a-Kind Aspects of the Process** — During the construction of recent projects throughout the world, Navigant has observed several instances of technological approaches that have been developed in relation to different types of industrial facilities that are adapted for use on LNG facilities (e.g., power plants). While such improvements represent accepted technologies and can result in improved performance of the facility, there are risks inherent in the design, manufacture and application of such technologies in a first-of-a-kind manner in LNG facilities. Such risks can include extended manufacturing/testing processes to adapt the equipment/process to the LNG environment, installation problems, and/or an extended debugging or commissioning period due to the first-of-a-kind nature.
- **Contractor Delays and Claims** — Construction delays and claims are not new or unique risks particular to LNG facilities. Quite the opposite, construction delays and contractor claims have been common occurrences for centuries. However, certain characteristics of oil and gas projects in general, and LNG facilities in particular, make such projects particularly vulnerable to claims and delays. In fact, a leading source of information in the industrial construction market, "Industrial Info Resources," reported that only 34 percent of the respondents in its study had delivered construction projects within 25 percent of the approved budget and only 32 percent reported completing their projects on time.[5] Navigant's global construction practice's mitigation of risk[6] report indicated that only 16 percent of the survey respondents reported completing their projects on the original schedule. Accordingly, in the best of circumstances, it is difficult to complete these large, complex industrial projects without experiencing delays.

  Due to the increases in the size of projects and the number of project participants, owners have been taking increasingly larger roles (with attendant increases in responsibility), including sometimes taking overall responsibility for the project schedule, contracting directly with suppliers and installation contractors, etc. However, with such an increase in responsibilities comes an increased risk of claims.

  Additionally, several of the risk factors described in previous sections of this article cause increased exposure to delays and claims, including remote, undeveloped project locations and related infrastructure construction, extensive marine facilities, and new technologies.

BEST PRACTICES FOR ADDRESSING THESE RISKS AND CHALLENGES

As typically occurs in the energy industry, as new opportunities give rise to new types of risks and challenges, practices and approaches are identified and adopted to address and control those risks and challenges. Some of the approaches that have been adopted to help address the issues identified in the previous section include:

- **Evolving Project Delivery Models** — The delivery model for the project, including the different parties involved, their respective roles and responsibilities, the form of contract, etc., is the most basic tool in the construction industry for the allocation and control of risk. And as the characteristics and size of projects in the oil and gas industry have changed over the decades, project delivery models have evolved to keep pace. The most traditional construction project delivery model, design-bid-build,[7] has not been common in the oil and gas industry for decades. Such an approach requires an extended period of time, delaying the first delivery of product to market. In addition, it creates the potential for gaps in responsibility between the design and construction entities, often leading to delays and claims.

  In order to address these problems, the industry moved toward the EPC model, in which the owner contracts with one entity to design, procure equipment and commodities, construct, and commission the facility. Importantly, this allowed for the contractor to overlap the design and construction process, significantly reducing the duration of projects. It also eliminated any gaps in responsibility for design and construction activities and reduced claims for design changes (other than those imposed by the project owner) or incomplete design.

5. "Oil and Gas Energy Project Delays and Overruns Could Cost $5 Trillion through 2035," Industrial Info Resources Industry News Alert, July 26, 2012.
6. See *Mitigation of Risk in Construction: Strategies for Reducing Risk and Maximizing Profitability*, McGraw-Hill Construction, Navigant Consulting, and Pepper Hamilton, LLP, New York, December 2011.
7. Under which the project owner hires an engineering firm to perform a complete "ready for construction" design, and then that design is sent to contractors, which then submit fixed-price bids to perform the work.

However, as addressed above, the increase in the scope of current LNG projects, due to the need to construct substantial infrastructure prior to the onset of construction of process facilities, can significantly increase the duration and cost of the project. Under the typical EPC delivery model, this could result in too long a period to first operation, as well as projects too large for most contractors to accept the risk of a fixed-price contract.

Based on Navigant's experience with projects in Canada, Australia, Europe, and Latin America, the industry has adapted to these challenges by beginning to employ the following delivery methods:

- **Engineering, Procurement, Construction Management (EPCM) Contract** — Cost reimbursable: Under this method, the owner contracts with one entity to perform the engineering, procurement, and construction management services on a cost-reimbursable basis. The EPCM entity performs the engineering and procurement work, and with the assistance of the CM team of that entity, the owner contracts with various contractors to construct the facility. This approach allows for the benefits of the EPC approach (overlap of design and construction and input from the CM firm early in the process), but avoids the problem of finding a contractor willing to accept the risk of a US$10 billion fixed-price contract. It also provides the owner with the opportunity to have significant input regarding the purchase of equipment, key design or technology issues, and contractor selection. It does, however, require that the owner employ a very large team of experienced construction personnel to fulfill its substantial responsibilities. It also exposes the owner to risks of unexpected cost overruns.
- **Engineering, Procurement (Cost-Reimbursable) Contract, Followed by Fixed-Price Construction Contract** — The owner contracts with an entity for the front-end engineering design (FEED) and procurement activities as well as initial infrastructure construction work, on a cost reimbursable or allowance basis. Once the initial work is complete and the design of the process system has advanced sufficiently to identify the full scope of the work, the entity provides a target price or a guaranteed maximum price for the remainder of the design and construction work.

  The selection between these two methods generally depends upon the factors on which the owner places the greatest emphasis: (1) owner control and input as well as shortest duration (EPCM); or (2) reliance on a major design-construction firm and limited cost growth. In either event, use of these delivery methods have allowed project owners to address the challenges of initial infrastructure work, daunting cost estimates, and a limited supply of capable design and construction firms for today's major LNG projects.

- **Use of Modular Construction** — Over the years, the energy construction industry has adapted to problems of overheated markets for process equipment and tanks and construction commodities by creating a global supply market. Facilities are routinely built in the U.S. using structural steel fabricated in China, and process equipment manufactured in Asia and Europe is installed in plants throughout the world. A similar approach is being used on major oil and gas projects to address shortages in experienced field craft labor at the project site: modular construction.

  Under a modular construction strategy, major sections of process structures are built remotely and then transported to the project location, and dropped into place and connected. Modules generally include steel framing, along with mounted tanks, piping, conduit, and wiring. Using this approach reduces the amount of steel, piping, equipment, and electrical work that must be stick-built at the project site, thus reducing the number of specialty craftsmen needed on-site while at the same time increasing the quality of the modules and decreasing the amount of field rework. Similarly, during procurement, owners are often considering the purchase of fully developed equipment or utility "skids," rather than purchasing the parts individually and assembling on-site. In both cases, purchasing remotely constructed modules or skid-mounted items is being employed to reduce the peak manpower and potential congestion at the project site, particularly in regions in which insufficient manpower is available and/or there are many other competing projects being built.
- **Force Majeure Contract Clauses** — In order to best manage the risks of certain types of unpredictable events, project owners have been re-thinking traditional force majeure clauses. The common contractual approach to force majeure events has been to provide the contractor with a time extension but no cost reimbursement for force majeure delays. However, for mega-projects such as LNG facilities, contractors often cannot bear the risk of the significant delay costs that accompany a substantial force majeure event. Further, as discussed earlier, the increased risk of weather and tide-related issues is greatly increased on LNG projects due to the large volume of marine work. Accordingly, owners began to notice that contractors would include significant contingencies in the price, to protect from the catastrophic effects of significant force majeure events. In order to avoid paying for such risks that may not occur, project owners have begun to revise force majeure clauses to provide that, up to a certain limit (either per event or in total), the contractor will receive only a time extension for force majeure events. However, for periods in excess of those limits, the contractor

would receive adjustments to time and cost of the work. This protects the contractor from the catastrophic effects of an extended force majeure event, and therefore, eliminates the need for related contingencies.

- **Technological Advances Developed by Suppliers and Contractors** — Many important technological innovations in oil and gas field development and processing have initially been identified and developed by contractors and suppliers. Technological advances such as Building Information Modeling, 3-D subsurface imaging, cable-free land seismic data acquisition, flexible drills and directional long reach drills, carbon capture and storage processes, deep electromagnetic imaging, and **the digital oilfield** are all technological advances created by EPC vendors. An enhanced partnership with EPC vendors can result in the faster development of more cost-effective, safer, higher-quality, and more profitable projects.
- **Supplier Technical Representatives** — Over the past several years, Navigant has worked on projects for many of the leading equipment manufacturers for the oil and gas and power industries. Capable, experienced technical site representatives always seem to be in short supply. To protect their interests, project owners are taking steps to obtain adequate support from these important resources during both erection and commissioning of major process equipment. Such steps include: detailed criterion and characteristics for such personnel specified in the supply agreement; increased allowances for such personnel over prior typical levels; and liquidated damages related specifically to the supply of qualified tech rep personnel.
- **Effective Risk Management and Claims Management Activities** — The mitigation of risk in construction study cited earlier (see footnote 6) identified a number of strategies pertaining to construction project risk management that are applicable to LNG mega-projects. Among them are the following:
  - **Perform Adequate Upfront Project Planning** — The project team (including both the owner and the EPC contractor) must learn as much as possible about the project prior to starting the design and construction phases. An adequate and achievable project plan (schedule and budget) must be jointly developed by the team and then communicated to all involved project participants.
  - **Establish a Clear, Well Defined Scope of Work** — Very early in the process there must be complete agreement between all project participants concerning the scope of work. One well-known cause of disputes on EPC projects are arguments concerning what constitutes scope development (traditionally considered as the EPC contractor's responsibility) and scope changes (most often a risk assigned to the project owner). It is Navigant's experience that the majority of these disputes would be avoided through an agreed-upon, up-front and clear scope of work.
  - **Prepare a Realistic Schedule** — All too often, project schedules are overly optimistic (and unachievable) from the outset. They are based on wish and not on rational analysis. That is, the project schedule is not risk adjusted. The opinions of all project participants (including the owner, the EPC contractor, their subcontractors and suppliers, etc.) concerning work sequences, logic, activity durations, etc., must be sought and included in the project plan and baseline schedule. Logistics, especially in remote and underdeveloped areas, must be well thought out, realistic and achievable.
  - **Negotiate Clear Contract Documents** — Clear and enforceable contract documents require that the parties define and negotiate project risks and responsibilities. Further, all potential ambiguities must be clarified prior to contract execution.
  - **Familiarity With the Project and the Project Team** — The project participants must understand and acknowledge the abilities of their own firms and the firms they are contracting with to execute the work within the allotted time. The financial viability and reputation of other project team members must be thoroughly researched and decisions made based upon a realistic understanding of the capabilities of these other players. Finally, the entire project team at all levels must do their best to avoid litigious behavior and practices. A team approach that focuses on problem resolution instead of blame; that strives to address and resolve problems promptly rather than positioning; and that seeks to resolve problems at the lowest possible level, is much more likely to achieve project success.
  - **Risk Mitigation Must Be a Priority for the Project Team** — A culture of risk identification and risk management must be established from the top down for the project team. Every activity to be performed during the project execution phase must be analyzed for potential risks and appropriate actions taken to avoid, alleviate, or mitigate such risks. A project risk review — on a monthly basis for a mega-project — must be performed by the entire project team as risk morphs as project execution evolves.

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In summary, it's a long road from knowing you want to build a liquefaction plant and have the financing and approvals, to sending out the first shipload. It has been our experience that the risks along that long road can be managed to make the growth in LNG markets a reality.

The opinions expressed in these article are those of the authors and do not necessarily represent the views ofNavigant Consulting, Inc.

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