NAVIGANT

CONSTRUCTION

RISK MANAGEMENT ON GAS-RELATED CONSTRUCTION PROJECTS

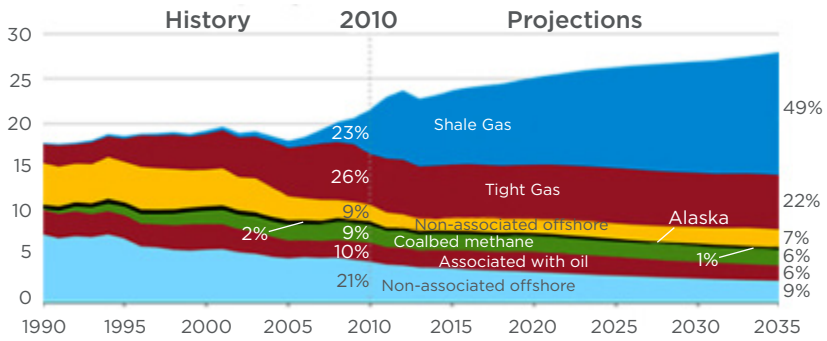
According to the International Energy Agency (IEA) total global energy demand is expected to grow some 40 percent by the year 2035 (over total demand in 2009). IEA estimates that a significant amount of that demand will be met by natural gas, which is forecasted to increase some 43 percent during this period.[1]

This surge in energy demand will spur substantial investment in energy projects at all stages of the energy chain, from exploration, to generation, to transmission. The IEA estimates that global investment in energy projects between 2011 and 2035 will total U.S. $38.0 *trillion*. Of this amount, it is estimated that some U.S. $17.0 trillion will be invested in the power sector, U.S. $20.0 trillion in the oil and gas sector, and the remainder to be invested in the coal and biofuels sector.

In the United States, the focus has recently turned to natural gas exploration, production, and consumption. Due to the break-through technology advancements in horizontal drilling and hydraulic fracturing there has been a transformation in the natural gas industry. Abundant gas supply and attractive supply-side economics (reduced energy costs and more jobs has allowed for the realization of energy independence for the United States.[2] The IEA has estimated that shale gas provided 27 percent of the natural gas supply in the U.S. in 2010 and 34 percent in 2011. The projected trend is that shale gas will rise to some 43 percent of the U.S. gas supply by 2015 and more than double to 60 percent by 2035. **Figure 1** below shows the increasing volume of shale gas in the U.S.

Figure 1. U.S. Natural Gas Production 1990–2035

Trillion cubic feet per year



Source: U.S. Energy Information Administration, Annual Energy Outlook 2012 (June 2012).

1. World Energy Outlook 2011, Organization for Economic Cooperation and Development/International Energy Agency, Paris, 2011.
2. "Fracking" is the process of injecting or pumping fracturing fluids consisting of water, sand and chemicals under high pressure into dense rock and shale or tight sands in order to create fissures. these fissures allow natural gas to move out of the rock pores in which it is trapped and flow to the earth's surface, where it is captured.

Abundant supply and the resulting low cost of natural gas spurred by fracking of shale gas is resulting in vast amounts of investment in shale gas capital projects.

> Some industry analysts estimate that nearly U.S. $2 trillion in shale gas capital investments will be made between 2010 and 2035.[3] More recent estimates place capital expenditures at $3 trillion in the gas sector across the entire upstream unconventional gas sectors and $5.1 trillion in capital expenditures if upstream oil is included.

In the near future, the U.S. $46 billion that has been spent on unconventional gas projects in 2012 will rise to U.S. $67 billion by 2015. Additionally, it is estimated that unconventional gas activity (on site and off site) supported approximately 900,000 jobs in 2012 will rise to some 2.9 million jobs in 2015 and increase to more than 1.6 million jobs by 2035.[4]

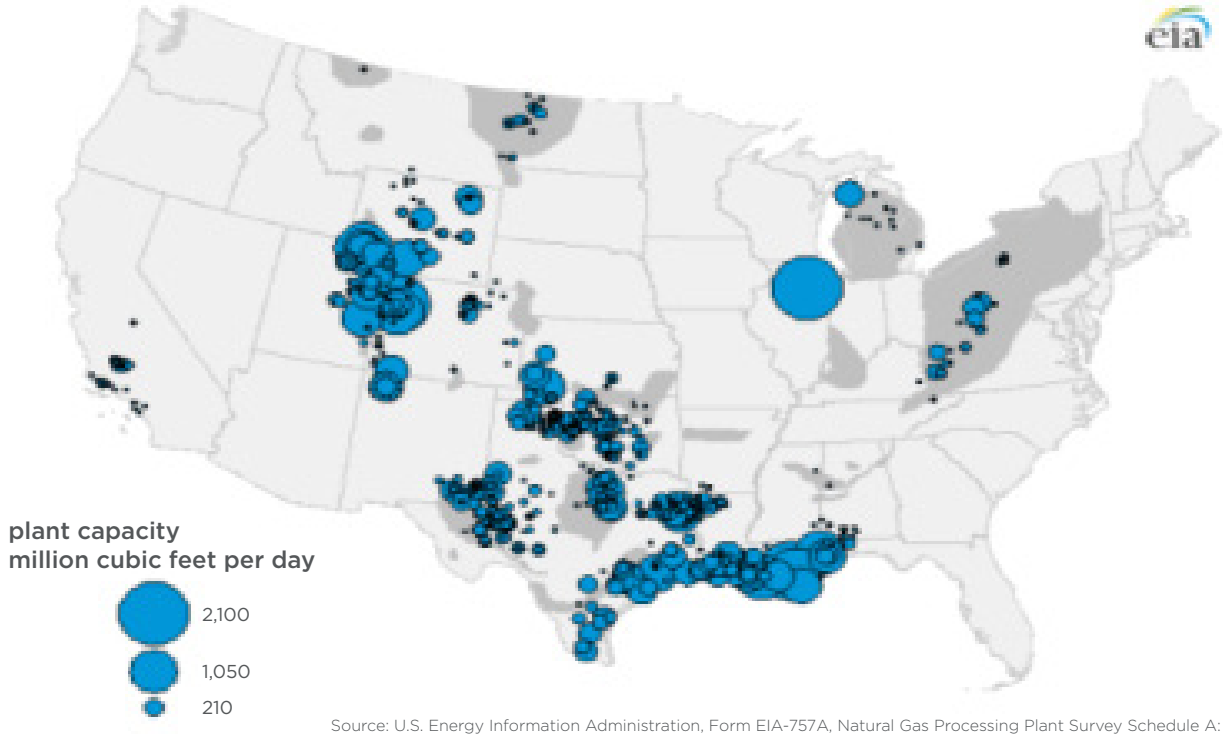
LEADING FACTORS FOR CAPITAL INVESTMENT

Navigant has identified at least three major factors for an increased investment surge in the natural gas and infrastructure.

I. NEW INFRASTRUCTURE AND SUPPORT FACILITIES IN THE FIELD OR TO TRANSPORT GAS TO MARKET

One key factor driving significant capital investment is the geographic location of the shale gas resources which tend to be located either in new production areas or in areas that do not currently have the infrastructure to provide support for fracking wells and transport product in large volumes. **Figure 2** identifies the current undeveloped or underdeveloped shale field include including the Jonah and Pinedale field in Wyoming, the Natural Buttes field in Utah, the Piceance field in Colorado, the Colony and Granite Wash field (covering portions of Texas and Oklahoma), the Barnett field in Texas, the Bossier field (covering portions of Texas and Louisiana), the Montney and Horn River field in British Columbia, the Marcellus field (covering portions of New York, Ohio, Pennsylvania and West Virginia), and the Antrim field in Michigan.

Figure 2. Undeveloped and Underdeveloped Shale Fields



Source: U.S. Energy Information Administration, Form EIA-757A, Natural Gas Processing Plant Survey Schedule A: Baseline Report

3. "The Economic and Employment Contributions of Shale Gas in the United States, IHS Global Insight, December, 2011".
4. "America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy, IHS Global Insight, October 2012.

As a result, significant investment in infrastructure projects to support wellhead shale gas production is required. Included in this investment will likely be new separator tanks, natural gas pipeline networks to move the gas from wellheads to gas processing facilities and then onto storage facilities, industrial end users, local distribution companies and perhaps, to liquefied natural gas (LNG) export terminals. For example,

> Kinder Morgan Energy Partners LP (KMP), the biggest U.S. pipeline company, and its rivals are planning to add 2.4 billion cubic feet a day of export capacity within three years, or enough gas to heat 32,000 U.S. homes. That's a 58 percent increase on this year's total, which in turn was up 34 percent from 2011.[5]

In addition to this new or expanded network of natural gas pipelines, the abundance of shale gas is expected to promote other shale gas related capital investments. These investments include greenfield or expanded gas processing plants and the conversion of LNG export facilities and accompanying infrastructure such as new roads, housing and businesses in communities near the shale fields, marine facilities, water lines and water treatment facilities.

II. CONSTRUCTION OF FACILITIES THAT RELY ON NATURAL GAS AS THE PRIMARY FEED STOCK

Natural gas can be processed and converted to many high demand end-products, which will be more profitable given due to the relatively low and stable natural gas prices predicted to result from the shale gas exploitation. Some examples of new facilities to be built in the U.S. are the re-emergence of the U.S. ammonia fertilizer industry and new petrochemical industry developments across the country.

III. FACILITIES POWERED BY NATURAL GAS

The relatively inexpensive price of this suddenly abundant gas will create great incentives to modify or construct facilities to use natural gas as the primary fuel source, for more cost effective operations. For example, gas-fired power plants as Navigant pointed out last month's issue of *NG Market Notes*[6] are already replacing aging coal-fired generating plants or in the future may even replace mothballed nuclear facilities. Other process plants and major industrial facilities that are experiencing significant operational costs may now be incented to convert to less expensive natural gas that looks to be in place for the long-run.

For these and a host of other reasons, it is expected that the shale gas boom will spur a corresponding boom in investment in the renovation and construction of capital projects.

OVERVIEW OF THE RISKS INHERENT IN THE CAPITAL INVESTMENT

While there are many benefits to capital investment targeted to take advantage of the abundant and affordable supply of natural gas, it also presents substantial risks to the owners and developers of these projects. In general, the most significant risks faced on such projects are extended delays to project completion and runaway cost overruns. A leading source of information in the industrial construction market, Industrial Info Resources, reports that, "it was estimated that the potential overspending across the whole capital budget of the [oil and gas] sector could be about 13 percent, which represents $5 trillion based on the IEA forecast."[7] This is very similar to the findings expressed in a recent study conducted by Navigant in conjunction with McGraw Hill and Pepper Hamilton LLP, which concluded that the average cost overrun reported by the participants in such projects was 14 percent.[8]

> Industrial Info Resources further reported that only 34 percent of the respondents had delivered their construction projects within 25 percent of their approved budget and only 32 percent reported completing their projects on time. Navigant's Mitigation of Risk 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.

Significant delays in completion will result in added costs for the construction project and substantial losses of revenue due to the delayed onset of plant operations. Our study determined that the average delay to project completion equals 17 percent of the planned schedule. Given the large sums likely to be invested in unconventional natural gas production and accompanying infrastructure projects the need for increased risk analysis, management and mitigation appears to be self-evident.

5. "Gas Boom Means U.S. Exports Grow Fastest Rate Since '70s, Bloomberg Businessweek, November 2012", ENR.com, June 2011".
6. "Coal-to-Gas Switching: A Phenomenon, NG Market Notes, October 2012.
7. *Oil & Gas Energy Project Delays and Overruns Could Cost $5 Trillion through 2035*, Richard Finlayson, Industrial Info Resources Industry News Alert, July 26, 2012.
8. 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.

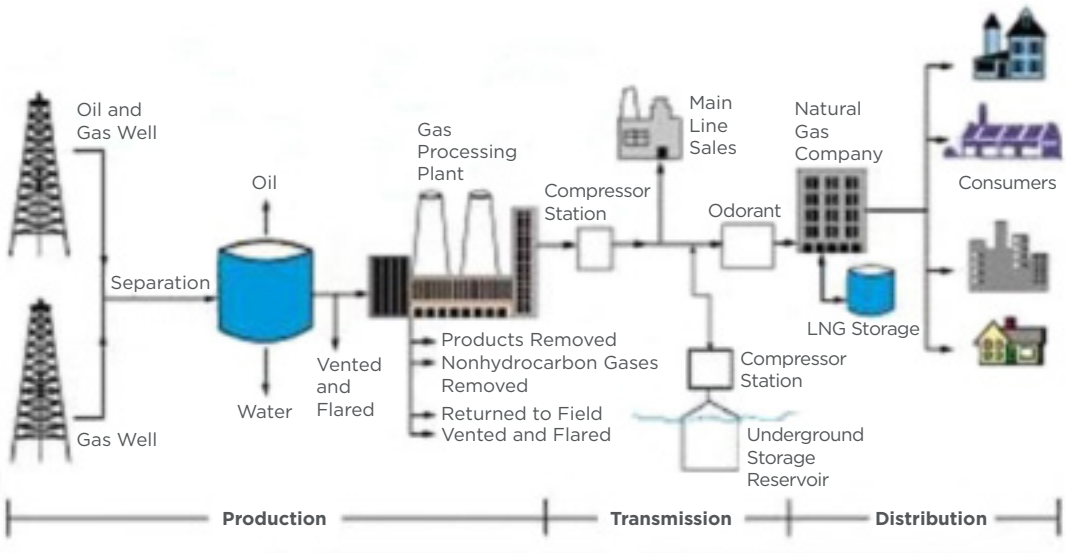
SPECIFIC RISKS & CHALLENGES TO SUCCESSFUL PROJECT DELIVERY

Based upon Navigant's extensive experience with energy-related construction projects and our knowledge of the industry as a whole, there are three potential issues that could pose significant risks to project owners and developers on the construction of these gas-related industrial facilities.

I. DELIVERING PROJECTS IN UNDERDEVELOPED AREAS

While much of the development in the power, oil and gas, and petrochemical industry sectors over the past decade has involved the expansion of existing facilities or new construction in existing industrial complexes, it's likely that much of the new gas-related construction will occur in relatively undeveloped or underdeveloped areas. Facilities needed to support fracking operations as well as transport the natural gas obtained from these operations will necessarily occur in these relatively underdeveloped (industrially and in terms of transportation infrastructure) areas. Also, owners of new plants that will consume the shale gas may want to locate their facilities in these regions, to limit transportation costs. Finally, many of the LNG export facilities[9] that are currently being planned to distribute some of the product overseas are located in areas that are largely undeveloped with respect to industrial and transportation infrastructure.[10] **Figure 3** below generally outlines the natural gas industry process. If the wells are in close proximity to the gas processing facilities and other infrastructure then the cost of developing the wells and producing product is relatively lower than if the fracking wells are remote and in underdeveloped sections of the country.

Figure 3. The Natural Gas Industry



As a result, owners and developers 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. 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, the logistics of mobilizing equipment, manpower, materials and other requisite construction resources needed to build infrastructure projects in remote or underdeveloped site locations can significantly increase the risk of budget overruns and extend construction schedules considerably compared to a typical project located in an existing industrial complex.

9. Assuming that current projections are correct regarding the quantities of natural gas to be harvested via fracking, the United States may in the next decade convert from a net LNG importer to a net LNG exporter nation. This will require new LNG facilities along the nation's coastlines.

10. For example, the Jordan Cove LNG export project near Bend, Oregon (currently in the permit review process at DOE and FERC) would be constructed in an area that is relatively underdeveloped from a transportation and industrial standpoint. Large LNG facilities being constructed on the western coast of Australia have experienced challenges due to the remote and underdeveloped areas in which they are being built.

II. ENVIRONMENTAL AND HEALTH AND SAFETY REGULATIONS

The second major challenge facing construction owners and developers on these gas-related projects relates to the high level of environmental regulation, regulatory scrutiny and approval processes that such projects typically face.

Owners and developers of these types of projects customarily undertake a rigorous upfront planning process aimed at better understanding and accommodating the regulatory requirements and risks when developing project budgets and schedules. Despite such diligent planning, energy projects are subject to great regulatory and political uncertainty. A case in point is the recent and ongoing controversy over the Keystone Oil Pipeline. Even setting aside regulatory requirements concerning fracking wells and projects, the environmental regulations with respect to new pipelines, process plants, chemical plants, power plants, and even roadways are substantial and ever changing.

> Navigant's experience with these types of projects has been that regulatory requirements that are not fully studied and addressed during a project's planning phase can lead to significant design changes and delays during the construction phase.

The primary risk is that the completion of projects will be significantly delayed, driving up the construction costs and delaying the onset of revenues. For example, changes to design required to meet regulatory requirements often times impact the contractor's sequence of work and causes delays to the project completion date. Such changing environmental regulations and political considerations carry the potential to add significantly to the cost and complexity of successfully delivering an operational project.

III. SHORTAGE OF PROFESSIONAL AND SKILLED CRAFT LABOR

Labor shortages can limit the ability to reach the construction production levels needed to achieve the planned schedule and result in extended durations for items such as piping and mechanical equipment erection. There are two distinct types of labor required to deliver projects of this nature. The first is professional labor which includes, engineers, construction managers, project controls personnel, etc. The U.S. is experiencing a distinct lack of such technical construction professionals needed for these projects. In an article published by *IT Business Edge* it was noted that the U.S. Department of Labor, Bureau of Labor Statistics (BLS) projects that there will be a shortage of some 160,000 engineers by 2016.[11] The article went on to note that this estimate is probably low as it does not take into account the number of engineers expected to retire in the next few years.

There is a corresponding lack of skilled craft labor, which is also absolutely critical to the successful delivery of heavy industrial facilities. The BLS reports that in 2010 the construction industry employed approximately 5.5 million people. This same report projects that by 2020 construction will need to employ some 7.4 million people.[12] This represents a foreseeable need for nearly 2.0 million additional craft workers, at a time when the average age of craftsmen is increasing and many experienced craftsmen are approaching retirement. Navigant has observed that there already exists a significant shortage of certain key skilled craftsmen, including heavy industrial welders, pipefitters, boiler makers, and millwrights. The expected boom in heavy industrial projects will likely create severe competition for these key craftsmen, and may result in a limited availability of workers in certain regions and for certain projects.

RISK MITIGATION OPPORTUNITIES

Navigant has identified some risk mitigation opportunities and strategies which should help owners and developers of fracking projects deal effectively with some of the risks identified.

I. INCREASED RISK MANAGEMENT

The first suggested response to help face and address such key risk factors is that project owners and developers employ comprehensive and disciplined risk management programs. Navigant's *Mitigation of Risk in Construction* report (December 2011) concluded that 50 percent or more owners have adopted and are currently utilizing formal risk mitigation procedures.[13] The follow on report, *Hope is Not an Effective Risk Mitigation Technique*, concluded that "... the most harmful risk areas are those associated with front-end planning, design, budget..."[14] This closely corresponds with the Industrial Info Resources article which stated "...there is a need to focus on risk management with a rigorous approach, cross functional input, as well as robust monitoring processes at the

11. *America Needs More Engineers*, IT Business Edge, http://www.itbusinessedge.com, August 26, 2008.
12. *Economic News Release – Employment Projections: 2010–2020 Summary*, U.S. Department of Labor Bureau of Labor Statistics, Washington, D.C., February 1, 2012.
13. 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.
14. Hope is Not an Effective Risk Mitigation Technique, Brian C. Fox and James G. Zack, Jr., Navigant Construction Forum™, March 2012, www.Navigant.com/NCF.

project and portfolio levels…"[15] While risks can never be completely eliminated from such projects, a robust risk assessment and management program will allow the project owner to more effectively anticipate problems, have mitigation plans ready in the event they surface, and limit the effects of problems on the duration and cost of performance.

II. STRENGTHENED PLANNING AND PROJECT CONTROLS

As expansion of well-developed industrial complexes is a more mature delivery model, the project controls role has typically been outsourced to the Engineer-Procure-Construct (EPC) contractors who have worked previously with the project owner, often times for several decades. The gas-related projects of today will involve types of construction that were often not needed on the typical projects in existing facilities (e.g., extensive roadways, bridges, marine facilities), and will involve new technologies and new means and methods. In this new environment, it is essential that project owners establish strong construction planning teams and put in place effective construction monitoring and project control strategies in order to reduce the risk of projects being completed substantially late or over budget.

III. MODULARIZATION

One way to address the shortage of field craft labor is for owners to use a modular construction strategy, where major sections of process structures are built remotely in "Mod yards," 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 piping and equipment work that must be "stick-built" at the project site, thus reducing the number of specialty craftsmen needed on site. Similarly, during procurement, owners should consider maximizing 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 will reduce the peak manpower and potential congestion at the site, and is particularly important in regions in which insufficient manpower is available and/or there are many other competing projects being built.

IV. ENHANCED PARTNERSHIP WITH EPC CONTRACTORS & VENDORS

Many important technological innovations in oil and gas field development and processing have come from contractors and suppliers. Technological advances such as 3D 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 faster, more cost effective, safer, higher quality and more profitable projects being developed.

15. *Oil & Gas Energy Project Delays and Overruns Could Cost $5 Trillion through 2035*, Richard Finlayson, Industrial Info Resources Industry News Alert, July 26, 2012.
16. Employees born between 1965 and 1980.
17. Employees born between 1981 and 1999.

V. INCREASED EMPLOYEE TRAINING

Finding and maintaining the talent necessary to deliver projects successfully has always been challenging but is becoming increasingly more difficult today than in past times due to the increased mobility of personnel and advances in communications. This challenge is increased by the existence of a multigenerational workforce. The Gen Xers[16] and the Millennials[17] are driven by different incentives than the Baby Boomers who are generally today's senior managers. Navigant's experience is that, in an industrial construction boom such as those that are expected to be spurred by the shale gas phenomenon, energy developers often make extensive use of contract hires and project labor. While a certain amount of such labor will inevitably be necessary, developing and maintaining loyal employees in key positions will differentiate more successful companies. The employer's willingness to invest in developing its people in order to enhance the competitiveness of the company is absolutely critical.

In conclusion, the availability of an abundant supply of natural gas, at affordable prices resulting from the exploitation of shale gas reserves, will spur a large capital investment in industrial facilities that process, transport, and consume natural gas. There are a number of risks involved with developing such projects. Fracking projects face a set of challenges unlike those common when expanding existing industrial complexes including, construction in relatively undeveloped areas, environmental and regulatory impediments, and shortages of construction professional and skilled craft labor. Implementation of robust risk assessment and management systems, utilization of modularization, enhanced partnerships with EPC contractors and vendors, and increased training and development of in-house staff will help owners identify, quantify, manage, and limit the impact of these risks and overcome these challenges.

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