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The challenge of renaissance
Managing an unprecedented wave of oil and gas investment

Deloitte Center
for Energy Solutions

Contents

Introduction

Having viewed North America as a mature oil and gas region with limited prospects for major production growth for nearly 25 years, the energy industry now finds itself racing to invest the capital needed to unlock a newly accessible abundance of resources. Horizontal drilling, combined with multistage hydraulic fracturing, has unleashed a bounty of largely untapped onshore oil and gas resources. Advances in deepwater drilling technology and continually rising production of Canadian oil sands are also boosting North America's burgeoning oil and gas production.

The International Energy Agency (IEA) has projected the United States could become the world's largest oil producer by early 2020, with peak production of 11 million barrels per day (mmbbl/d), overtaking Saudi Arabia's projected 10.5 mmbbl/d.[1] Total U.S. natural gas production — including shale gas and tight oil — is forecast to rise to 75 billion cubic feet per day (bcfd) in 2020[2] from just 49 bcfd in 2005.

Realizing the potential of this North American energy renaissance will require tremendous investment and astute project management especially at a time when the industry is competing for increasingly scarce talent. Additionally, the number of capital megaprojects (those with capital investment of $1 billion or more) in North America will increase, substantially driven by the push to develop deepwater resources; the development of midstream infrastructure to support oil and gas production from new producing areas; and investments to add value to low-cost natural gas and gas liquids through liquefied natural gas (LNG) exports, petrochemical capacity expansion, and, potentially, gas-to-liquids (GTL) facilities.

This huge increase in North America, however, will need to compete with an increasing number of global oil and gas megaprojects to develop deepwater, remote natural gas, and other frontier resources, which are larger

and more technically complex than ever. Although the industry has successfully completed many of these large-scale projects in the past, the sheer number of concurrent megaprojects around the world is unprecedented. Adding to these concerns, the deterioration in projected returns on capital, which results from substantial budget overruns, will be a challenge to even the most experienced companies in the industry.

Furthermore, these investments will be undertaken in complex and changing regulatory environments. Uncertainty regarding energy policy and potential legislation and regulations has many projects in the United States, as well as Canada, in a state of limbo. These areas of uncertainty, which include potential policy decisions involving LNG exports, cross-border pipeline projects, and evolving environmental regulations, amount to tens of billions of investment dollars at stake.

To navigate this promising yet challenging future, oil and gas companies are working to proactively address the myriad of issues highlighted in this paper.

Global oil and gas investment trends

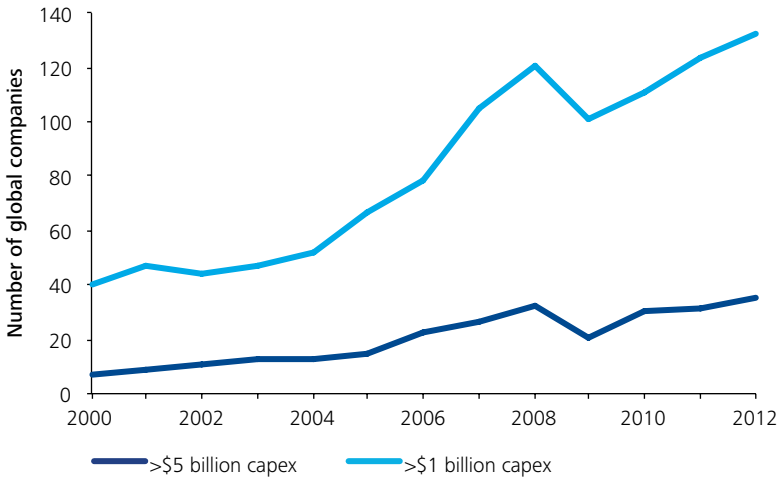
The oil and gas industry continues to develop ever more geologically complex, expensive, and technologically demanding projects across the globe. New planned capital expenditures in key oil and gas development regions are soaring. These projects will compete for technical expertise, critical materials, and capital, many of which will add to their cost and financial risk.

Barclays estimates that, outside North America, total oil and gas exploration and production (E&P) expenditures in 2013 will reach nearly $459 billion.[3] In Australia, total planned capital expenditures for its large portfolio of LNG projects are nearing $250 billion.[4] In Brazil, total currently planned capital expenditures are projected to be nearly $150 billion over the next five years, with more than $93 billion targeted just at the country's pre-salt reservoirs.[5]

Modern, high-conversion refineries being built in Asia are adding nearly 6.4 mmbbl/d of refining capacity at a cost of nearly $145 billion.[6] Additionally, new frontiers in the Arctic are in the earliest stages of exploration and could eventually unlock significant resources. The capital cost associated with new offshore Arctic projects may range from $10 to $50 billion each, making them among the most expensive and technologically demanding endeavors the industry has ever undertaken.[7]

Globally, oil and gas companies have been ramping up spending to meet those capital needs. The number of global oil and gas companies with capital budgets exceeding $1 billion more than tripled to 132 in 2012 from just 40 in 2000, while those with capital expenditures exceeding $5 billion increased fivefold from seven in 2000 to 35 in 2012 (Figure 1).

Figure 1. Number of global oil and gas companies with large capital investments



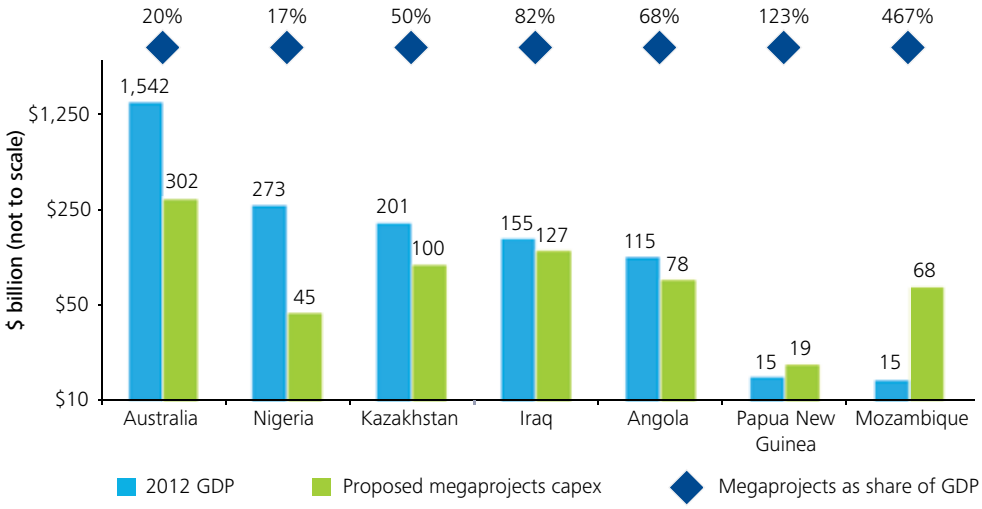
Sources: FactSet and Deloitte analysis

However, many of these foreign projects bring additional execution and financial risks beyond those found in similar North American projects. For instance, the large scale of investment in many countries is massive relative to their existing economic and industrial base. Planned investment amounts to a significant percentage of, or in some cases exceeds, the gross domestic product (GDP) of the entire country (Figure 2).

The nearly $100 billion in megaprojects planned for Mozambique, for example, is more than 400 percent of the country's total GDP, and the planned oil and gas investments in Papua New Guinea are 123 percent of GDP. Even in large, developed economies, the size and scale of new oil and gas investments can represent a significant portion of the total economy. The combined value of Australia's new oil and gas projects represents nearly 20 percent of the country's $1.5 trillion GDP for 2012. The economic benefits to the country of getting the projects right are enormous. A third of the growth of Australia's exports by 2016 will be accounted for by LNG if all the projects are brought online. However, many of these projects are being reevaluated in light of large cost increases and uncertainty regarding competition from potential North American LNG projects.

Investment in international deepwater will continue to attract a large share of investment. In fact, worldwide ultra-deepwater rigs are expected to increase by 75 percent over the rest of this decade.[8]

Figure 2. Megaprojects capex versus 2012 GDP



Note: For Mozambique, data is based on the list of proposed projects as of April 2013. A final investment decision is pending for some projects, which include all 10 LNG trains planned.

Sources: Company reports, Goldman Sachs estimates, IMF World Economic Statistics, World Bank, and Deloitte analysis

Investment in the North American energy renaissance

The scale of the global investment in oil and gas projects is mirrored by the potential investment in North America. Hydraulic fracturing of shale deposits in North America and other unconventional technologies, such as those required to upgrade Canadian oil sands production, have made it possible to tap reserves long thought to be uneconomical. However, unlocking these resources will require a vast and sustained amount of investment to achieve the future production estimates currently being made by industry analysts. The IEA estimates nearly $5 trillion in upstream oil and gas investment is needed in North America through 2035 to maintain current levels of output and to meet future demand growth.[9] This required investment translates into a prodigious amount of onshore well activity and oil sands development.

North American onshore unconventional and deepwater

As unconventional resource development accelerates across the United States, hundreds of thousands of wells must be drilled and completed in a growing number of basins. The Energy Information Administration projects more than 630,000 new wells will be needed to bring available U.S. shale gas and tight oil resources into production. A detailed breakdown by basin of the magnitude of potential well requirements for developing technically recoverable resources (TRRs) is shown in Figure 3.

Figure 3. Potential wells needed for TRRs in selected shale gas and tight oil plays

U.S. shale gas		
Basin/play	Number of potential wells	TRRs (bcf)
Appalachian		
Marcellus	90,216	140,565
Utica	13,936	15,712
Arkoma		
Woodford	5,428	10,678
Fayetteville	10,181	13,240
Chattanooga	1,633	1,617
Caney	3,369	1,135
Texas-Louisiana-Mississippi Salt		
Haynesville/Bossier	24,627	65,860
Western Gulf		
Eagle Ford	21,285	50,219
Pearsall	7,242	8,817
Anadarko		
Woodford	3,796	10,981
Remaining shale gas plays	229,009	307,843
Total U.S. shale gas	**410,722**	**481,783**

U.S. tight oil		
Basin/play	Number of potential wells	TRRs (million barrels)
Western Gulf		
Austin Chalk	21,165	2,688
Eagle Ford	8,665	2,461
Anadarko		
Woodford	16,375	393
Permian		
Avalon/Bone Springs	4,085	1,593
Spraberry	4,636	510
Rocky Mountain		
Niobrara	127,451	6,500
Williston Bakken	9,767	5,372
San Joaquin/Los Angeles		
Monterey/Santos	27,584	13,709
Total U.S. tight oil	**219,728**	**33,226**

Note: bcf = billion cubic feet
Source: U.S. Energy Information Administration, "Annual Energy Outlook 2012 with Projections to 2035," June 2012, http://www.eia.gov/forecasts/archive/aeo12/index.cfm.

The sheer number of wells required in these plays substantially raises the capital requirements for resource development, even as operators face hefty pressures to bring wells online as efficiently as possible. One of the key challenges operators face to bring these wells online is their ability to acquire experienced project managers and skilled talent. Once online, these wells will ultimately require recompletion, artificial lift, and, eventually, enhanced recovery to keep them producing. To maintain production and meet rising demand, this level of onshore well activity across North America will need to be sustained for the next 20–30 years.

In Canada, oil sands production is driving the growth in liquids production. Total Canadian production from oil sands — in-situ production, mining, and enhanced oil recovery — is projected to rise from 1.7 mmbbl/d in 2011 to 5.6 mmbbl/d in 2046 under the base development scenario by the Canadian Energy Research Institute. The total initial capital investment needed over the 35-year period to support this growth is estimated at $229.7 billion, supported by annual capital investments growing from around $2 billion in 2011 to an average of $8.7 billion by 2046.[10] This growth in Canadian oil production will be accelerated as a host of projects come online.

If the significant unconventional gas resources in Canada are successfully developed, it could account for nearly 60 percent of Canadian natural gas production by 2030. Developing, in addition, Canada's onshore shale gas resources will also require significant investment and ongoing drilling activity.

The development of natural gas resources is particularly important to Canada's oil sands development because natural gas costs represent the highest operating expense for in-situ thermal oil sands development projects. In order to sustain production under a high-development scenario, daily natural gas requirements are expected to rise to 3.7 bcfd in 2046, up from 1.3 bcfd in 2011.[11]

In addition to onshore activity in North America, the oil and gas industry is pushing into ever more challenging domains. In the Gulf of Mexico (GOM), deepwater activity continues to ramp up, following the post-Macondo slowdown. Deepwater drilling projects continue to remain competitive with onshore investments for many operators as difficult reservoir conditions and infrastructure challenges are being overcome.

As of April 2013, there were a total of 37 semisubmersibles and drill ships under contract in the GOM, and that number is expected to rise to 54 by the end of 2014.[12] Approximately 3.75 mmbbl/d of oil production will be attributable to deepwater in 2020, or about 18 percent of the estimated total for North America.[13]

North American LNG

The abundance of low-cost oil and natural gas has largely decoupled North American energy costs from world prices and thereby created opportunities for major capital investments beyond just the upstream sector. Large investments in oil and gas fields and rising production are driving growth in megaprojects in every subsector of the industry, including construction of LNG export facilities, new and expanded pipelines, processing plants, GTL plants, and other large capital infrastructure projects. In addition, low natural gas prices are fueling investments in the petrochemical, manufacturing, and electric power industries.

Most visibly, high price differentials between Henry Hub and world natural gas prices have created a rush to develop LNG export terminals. More than 30 export LNG project applications have been submitted to the U.S. Department of Energy (DOE). As of mid-November 2013, the DOE has authorized 29 applications for the export of LNG to free trade agreement (FTA) countries and five applications to export to non-FTA countries.[14] By 2020, this could translate to LNG investments of about $60 billion.[15]

Examples of these world-scale megaprojects requiring billions of dollars of investment and years to construct include:

- **Sabine Pass LNG** — the only export facility approved by both the DOE and the Federal Energy Regulatory Commission (FERC), with a capacity of 2.2 bcfd and a reported total capital cost of nearly $12 billion[16]
- **Freeport LNG** — with a capacity of 1.4 bcfd and an estimated cost of more than $10 billion[17]
- **Trunkline LNG** — with a capacity of 2 bcfd and an estimated cost of more than $ 2 billion[18]
- **Dominion Cove Point LNG** — recently approved by the DOE, this facility will modify an existing import terminal to export LNG; is expected to gain FERC approval in early 2014; will have a capacity of 1 bcfd; and, is estimated to cost more than $3.5 billion[19]

If all of the proposed LNG projects come online as planned, we could see a total of more than 20 bcfd of export capacity by 2020, an equivalent of 14–19 percent of domestic production.

Canadian producers are also planning significant investments in LNG — with nine LNG projects under consideration — aimed in large part to access Asian markets and to redirect energy exports that traditionally target the United States. Of the nine projects under consideration in Canada, only one, Kitimat LNG, has received approval from the Canadian National Energy Board for a 20-year export license.

As with the examples in the United States, these facilities are also world-scale megaprojects with capital costs in the billions. Costs for the construction of Kitimat LNG and LNG Canada are estimated at $10 billion and more than $12 billion, respectively. If approved and constructed, these plants have the potential to supply 13 bcfd of expected export demand for North American gas.

Midstream and GTL

Although megaprojects for the midstream sector tend to be smaller, they are nonetheless becoming a reality that is growing beyond just LNG. New pipeline construction and pipeline expansions are another by-product of the substantial North American oil and gas production growth. Additionaly, as trillions of dollars are pumped into American shale plays and Canadian oil sands, it is estimated the oil and gas industry will need to spend more than $200 billion on additional pipelines to handle the increased production.[20] The $7 billion Keystone XL pipeline is the most widely recognized currently planned project in North America, with the $2.3 billion Gulf Coast pipeline extension expected to come online in late 2013.[21] Construction on the Gulf Coast project, which will serve as Keystone XL's southern leg, is 95 percent complete.[22] Other notable pipeline projects include the $1.5 billion Eastern Gulf Coast Access pipeline[23] — to convert and reverse a natural gas pipeline to carry 420,000–660,000 barrels per day (bbl/d) of Bakken crude from Illinois to Louisiana in 2015[24] — and the $2.5 billion Sandpiper pipeline — slated to carry 375,000 bbl/d of Bakken crude to Wisconsin in early 2016.[25]

As drilling activities continue, particularly in U.S. shale plays and Canadian oil sands, new and expanded pipelines will be required to meet both logistical and capacity needs. *Oil & Gas Journal* predicts pipeline spending will reach $38 billion in the United States in 2013 and $5.7 billion in Canada, with the vast majority of this spending attributable to natural gas pipelines.[26] Over a period of one year, gas processing capacity additions of 1–2 bcfd may require nearly $1 billion of capital investment.[27]

As the natural gas supply grows in North America, thereby putting downward pressure on prices, companies will be looking at ways to convert methane gas to premium products via GTL projects to maintain demand for onshore shale gas development. By converting methane to liquid hydrocarbon compounds, GTL facilities can produce clean diesel and jet fuels that contain less impurities and are much cleaner burning than conventional fuels. Currently, Sasol and Shell are exploring options to build GTL megaprojects along the U.S. Gulf Coast. Sasol is reportedly evaluating a $10 billion facility that would convert methane GTL fuels and sell them to blenders.[28] The project is estimated to result in more than 1,200 permanent jobs in the region and will inject an estimated $46.2 billion into the local economy for the next 20-plus years.[29] Shell, also, has recently approved the construction of a $12.5 billion GTL facility in Louisiana, which will create nearly 740 direct jobs.[30] The project will be similar in scale to Shell's Pearl GTL facility in the Persian Gulf. The projects have the potential to put natural gas on the map to compete with higher-priced crude oil as a key building block for transportation fuels. The economic benefits of using low-cost natural gas (either as GTL, compressed natural gas, or LNG) to fuel portions of the U.S. commercial vehicle fleets could grow many sectors of the U.S. economy.

Petrochemical and other industries

In addition to midstream and GTL, the petrochemical industry also, has revived in recent years as a response to the North American energy renaissance. Dow Chemical, Shell Chemical, Chevron Phillips Chemical, Sasol, and Formosa Plastics have all announced plans to build plants in the United States, each of which demands major capital investments upwards of $1.5 billion.[31] The combined ethylene production capacity if these plants were to be constructed is estimated at 7.4 million tons per year by 2017 — a 28 percent increase over the existing U.S. ethylene capacity.[32]

There are substantial follow-on benefits throughout the North American economy in addition to the direct benefits being seen in the oil and gas industry. Through the end of March 2013, nearly 100 chemical industry investments valued at $71.7 billion had been announced.[33] The majority are being made to expand production capacity for ethylene, ethylene derivatives (i.e., polyethylene, polyvinyl chloride, etc.), ammonia, methanol, propylene, and chlorine. Much of the investment is geared toward providing cost-advantaged production for sale into export markets, which is likely to bolster the overall U.S. balance of trade.[34] In addition, the U.S. electric power industry is expected to increase its use of natural gas by about 50 percent over the next decade alone as it becomes the fuel of choice for new or expanded electricity generation plants.[35]

Challenges to the renaissance

The energy renaissance is made possible by the technical complexity of the required megaprojects in the oil and gas industry. The benefits of these new capital projects are widespread and contribute substantially to a growing economy, but the associated challenges cannot be ignored. The level of financing that will be required will exceed many of the traditional financing methods used in the past. There are an increasing number of projects competing for funding, both internally and externally, where capital effectiveness and predictable performance are being assessed more rigorously. For the complexity and technical experience required to deliver these projects, the number of engineering, procurement, and construction (EPC) companies capable of delivering them is limited, and this global growth will strain their resources and capability to deliver on time and within budget. Shortage of skilled talent is one of the key concerns to the oil and gas industry in completing these large projects. Both the oil and gas companies and the EPC companies compete for the same pool of talent, and the retirement of experienced staff, combined with the increase in projects, is creating a shortfall in the industry.

Financing and capital effectiveness

After a period of low oil and gas prices from 2008 to 2010, which saw a decline in industry capital expenditures, oil and gas companies have been improving their balance sheets and ramping up capital expenditure spending. West Texas Intermediate crude prices have recovered from less than $40 per barrel in 2009 to more than $100 per barrel in 2012. In the United States, natural gas prices have risen from lows of less than $2 per million British thermal units (MMBtu) to highs of more than $3.50 per MMBtu. The increase in commodities prices improves the ability of companies to self-finance large projects. However, as companies take on more megaprojects concurrently, they will consume a larger portion of annual company cash flows. Research shows that in 2013 oil majors are undertaking from three to five megaprojects concurrently, which account for 24–35 percent of their annual cash flows.[36] Even some of the larger independents in 2013 are undertaking from two to four megaprojects concurrently, which account for 12–115 percent of their annual cash flows.

How can the project development and execution process be adapted to better reflect the complexity of these megaprojects?

This level of spending creates significant risks in terms of attracting capital at a reasonable cost and managing the volatility of price cycles for key inputs like oil field and EPC services. Managing this price volatility and anticipating future swings are critical aspects of attracting sufficient capital to the industry. Furthermore, competition for financing will be stiff as the number of players in the industry continues to increase with the influx of independents.

The North American oil and gas industry will likely require more complex financing structures to meet the level and breadth of investment forecast. Onshore, large and midsize independents have financed shale gas and tight oil plays, along with debt and joint ventures (especially with inbound foreign investors), using historical cash flow, while smaller players have been increasingly supported by private equity, high-yield notes, and debt capital markets. The achievements in directional drilling and hydraulic fracturing are improving cash flows, which is attracting the interest of major oil companies that are somewhat less sensitive to short-term swings in commodities prices and are able to finance larger programs internally.

Megaprojects (deepwater, LNG) have traditionally been the domain of supermajors and large independents (as well as national oil companies outside of North America) because of the concentration of risk and the difficulty of funding. Increasingly for deepwater, however, smaller independents have found funding through private equity and capital markets for new projects. LNG projects have traditionally been dominated by supermajors and national oil companies (in both producing and consuming countries) that have been able to create integrated projects with lower-risk profiles. However, with the LNG investment moving to the United States with highly liquid gas trading markets, a new set of players and new potential funding sources are emerging. Large independent E&P companies are now involved in major U.S. and Canadian LNG projects, which have traditionally been the domain of the supermajors. Master limited partnerships traditionally used by midstream businesses could become attractive as funding sources for LNG plants if the variety of risks, including construction delays, customer credit, operational risk, and regulatory uncertainties, can be managed.[37] Traditional project finance could become an additional source of funds for LNG plants as long as long-term supply and offtake contracts can be arranged. The debt capital markets have become more aggressive and liquid since 2010, which should help provide financing for projects in the United States and Canada.

Government and regulatory uncertainties

The wave of capital being invested in the oil and gas industry has also created a variety of new regulatory uncertainties in North America. Finding a regulatory regime that cultivates industry investment and provides appropriate government oversight is critical to the success of the North American energy renaissance. Some of the issues related to government and regulatory uncertainties include the following:

- **Development of unconventional plays in new states:** Unconventional plays are widely dispersed in North America, and many of the newest shale reserves are in states that have had little experience in regulating the oil and gas industry.
- **Permitting:** Shale plays, for example, require more wells to develop a reservoir than conventional fields, which is creating a rising tide of permitting requests.
- **Tax regime:** Federal and state governments are eager to collect their portion of the economic rent generated by the oil and gas extracted from shale formations. Incentive and taxing regimes significantly affect the economics of investment but are, in many cases, in flux and subject to potential changes to long-standing oil and gas tax policies.
  - State and local governments offer tax credits and financial incentives aimed at increasing employment and attracting new investment in their communities. Credits and incentives, such as job creation and investment tax credits, capital grants, property tax exemptions and abatements, and infrastructure improvement grants, offer companies a potential opportunity to reduce or offset start-up and operational expenses and increase profitability.
  - A variety of different indirect taxes, including value-added tax, sales and use tax, excise tax, and fuel tax, are imposed across various federal, state, and local jurisdictions. The complex, high-volume transactional nature of these taxes can result in significant cash leakage with error rates of 10 percent and greater. Synchronizing tax and business strategy at the onset of capital project planning can help to lower indirect tax cost and minimize risk.

The impact of taxes on capital investment should be evaluated at the earliest stages of project planning. Indirect taxes can add up to 10.5 percent to initial project cost and operation. Proper tax planning can help reduce these burdens and maximize capital efficiency.

- **Trade restrictions/market access:** As the abundance of North American oil and gas supply outpaces demand, issues around trade become more important. For example, the continued development of Canadian oil sands is threatened by delays in the approval of the Keystone XL pipeline. On the other hand, there is pressure from manufacturing and consumer interest groups to limit LNG exports. Also while some in the oil and gas industry would like the ability to export certain domestic crude supplies, there are existing federal restrictions that prohibit these actions.
- **Environmental regulation:** As activity moves into nontraditional areas, public concerns about the drilling process and possible contamination of water supplies have resulted in stricter rules for shale development, and some states and municipalities have enacted drilling moratoriums while they consider even more restrictions. Oil and gas investments have garnered increased regulatory attention in recent years. For offshore oil and gas, the Bureau of Safety and Environmental Enforcement has also recently proposed a rule to update regulations regarding production safety systems and equipment used to collect and treat oil and gas from offshore production facilities, which could put further financial constraints on offshore deepwater drilling projects.

EPC resource capacity

According to a Morgan Stanley Research estimate, EPC spending in North America is expected to rise from $24 billion in 2012 to nearly $30 billion by 2020.

Figure 4. North American EPC spending

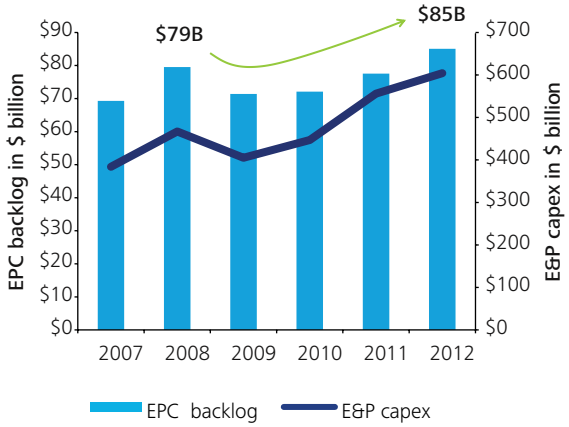
$ billion	2012	2013E	2014E	2015E	2020E
EPC and installation	**24.0**	**19.8**	**23.1**	**26.1**	**28.8**
Engineering	7.6	5.7	6.4	6.2	6.7
Construction	13.1	11.3	12.5	16.2	15.9
Subsea umbilicals, risers, and flowlines	3.3	2.8	4.2	3.7	6.2

Note: This table includes both capex and opex spending.

Source: "Global Oil Services, Drilling & Equipment," Global Upstream Spending Review, Morgan Stanley, May 30, 2013.

Robust upstream spending, which grew 35 percent globally from $447 billion in 2010 to $604 billion in 2012, is a key driver of the backlog of orders for EPC companies. The order backlog of the top U.S.-based EPC companies fell 10 percent during the global economic slowdown and commodities crash of 2008–2009, when global upstream spending fell 13 percent. However, orders have rebounded — rising at a compound annual growth rate of 10 percent since 2010 — with the EPC order backlog rising from a little more than $70 billion to $85 billion in projects over the period.

Figure 5. EPC order backlog



Note: Top five NYSE listed companies based on 2012 revenue (Fluor Corporation, Jacobs Engineering Group, KBR Inc., CB&I, and McDermott International, Inc).

Sources: Company annual reports and Deloitte analysis

Although the growth in orders is generally good for EPC company balance sheets, backlogged EPC companies, like the operators who employ them, face their own hiring challenges, and they find their technical capabilities stretched thin as they try to maximize the talents of their best people. Fluor Corporation, one of the large EPC companies, estimates that over the next decade current planned oil and gas projects in the United States will require 20,000–50,000 skilled workers — nearly half the entire skilled workforce of the United States — to complete.[38] In addition, ManpowerGroup has identified skilled trade workers as one of the top 10 most difficult positions to fill.[39] The lack of skilled trade workers is expected to be a key pinch point for the industry, making it difficult for oil and gas companies to execute capital projects and increases the cost of new capacity.

Should contractors become more integrated, and retain larger and more permanent engineering and fabrication capability?

Increasing competition from lower-cost rivals is putting pressure on established EPC companies. However, as the market heats up and more projects demand priority queuing from EPC companies, EPC costs and margins could likely increase with the form of contract changing to the EPC's benefit. The return to reimbursable contracts has begun to shift the project risk to the operators, who are now increasing staff to compensate.

Given the reliance of the oil and gas industry on EPC companies for megaproject execution, it will be critical to the success of the North American energy renaissance to effectively address the challenges the EPC industry will face.

The skilled talent gap

Yet another challenge the North American oil and gas industry is facing takes the form of skilled talent shortage. Not anticipating the domestic shale boom and increased talent demand, much of the hiring by oil and gas companies in the United States over the past decade had been focused overseas. Now, in order to complete the capital megaprojects currently being planned, the oil and gas industry will have to address the current shortage of skilled workers, which include trades people, project managers, and engineers.

As oil prices fell in the 1980s and remained low during the 1990s, oil and gas companies laid off thousands of professionals and reduced their hiring of entry-level workers, which has created a generational gap in the current workforce. Additionally, companies did not invest in training or advancing the employees they did retain, which has exacerbated the industry's current shortage of skilled workers and resulted in the current pool of technical professionals who either have less than 15 years of experience or are nearing retirement age. The U.S. Department of Labor predicts that up to 50 percent of the U.S. energy workforce will retire in the next 5–10 years.[40] Now, as retirement looms for the most experienced workers, the industry is confronting its "big crew change" just as the demand for technical expertise intensifies.

Even though there has been some movement toward filling the talent gaps, many additional industry workers will be needed in the coming years. Currently, the number of oil and gas industry job openings in North America exceeds the number of qualified applicants. In the petroleum engineering space, this is in part due to the low number of skilled market entrants graduating from colleges and universities in related fields each year.[41] In recent years, even though companies have hired thousands of young engineers and geologists, companies are finding they lack the project management experience so necessary at this a critical time.

Compounding this workforce shortage, the hourly wages in the oil and gas industry have increased 27 percent since 2006[42] as increased demand for skilled industry talent in North America continues to drive up wages and put additional pressure on capital budgets. This trend bears a troubling similarity to the labor shortage faced by companies developing LNG and mining projects in Australia, where increased capital investments almost doubled the demand for skilled talent from 2006 to 2011. The resulting talent shortage pushed up wages by almost 85 percent in the mining sector since 2006. Construction wages increased by 93 percent over the same period.[43] Many projects are being reevaluated in response to the wage inflation over a short time, as labor costs exceeded many operators' expectations, forcing companies to reevaluate, postpone, or cancel planned projects.

With employers in the United States reporting skilled workers as the hardest jobs to fill, companies may find themselves facing similar wage pressures in the United States. It will take careful workforce planning to manage the oil and gas talent shortage going forward and determine which interventions, such as aggressive recruiting strategies, robust onboarding approaches, and accelerated employee development, will need to be implemented.

How can talent processes be changed to better manage the retention and quality of skilled workers and engineering/technical talent?

Capital project delivery — Looking ahead

As the oil and gas industry looks ahead and responds to both the opportunities and challenges presented by the unprecedented wave of oil and gas investments, it will be critical to explore the optimal blend of innovative approaches to capital project delivery with leading industry practices.

The current industry approach is based on the premise that capital project development and execution is a "complicated" process, which requires detailed design and procedures but is inherently predictable when the process is correctly executed. Recent experience and emerging industry thinking, however, suggest the capital project process is better characterized as a "complex" process, which is inherently uncertain and unpredictable and requires an understanding of system dynamics, constant learning, and adaptation.

How can contractors be incentivized to innovate and manage to project outcomes rather than just delivery of requirements?

Many major oil and gas companies have adopted a stage-gate process to govern the planning and execution of their megaprojects. They have invested heavily in developing their stage-gate processes and recruiting and retaining top talent to run the processes yet are still experiencing cost, schedule, quality, and production attainment problems.

From these results, various factions within the industry start to emerge: on one end of the spectrum are those who passionately support exploring different approaches; on the other end are those who are just as passionate about focusing efforts on making sure the current process is executed correctly: and in the middle are those who believe that the current process needs to be modified or improved.

Currently, many companies in the industry are updating or reviewing their processes in order to cope with the poor performance of their projects. Some are increasing the number of stage-gates a project has to pass through, some are adding additional peer reviews, and some are evaluating their project governance and organizational structure.

Some in the industry believe more resources dedicated to front-end planning will help improve project performance, while others believe that more innovative approaches are required. This, of course, affects cost and capital effectiveness. Supporting the former approach, however, are studies by Independent Project Analysis, Inc.,[44] which suggest that when more time and resources are spent on front-end loading, the predictability of the project's cost and schedule is significantly enhanced and operability problems are reduced.

Integrated project delivery

Some leading companies and agencies outside of the oil and gas industry have recognized the need for more innovative ways to deal with the lack of integration between the owner organization and other project participants, as well as its subsequent effect on project performance. These industries include public sector, health care, and microelectronics. One of the innovations adopted by these industries to enhance project performance is integrated project delivery[45] (IPD), and several oil and gas megaprojects have been successfully delivered using this framework.

As the name suggests, IPD at its core is underpinned by the true and complete integration of project participants (i.e., owners, engineers, contractors, subcontractors, major suppliers), from project inception to final turnover and closeout. In some cases, to ensure integration and collaboration among project participants, relational contracts can be used so that the commercial objectives of the project participants will also be aligned. Traditional project delivery frameworks often consist of numerous two-party contracts which do not promote innovation, integration or collaboration between project participants or across contractual swimlanes. Relational agreements are designed to create a collaborative, innovative and integrated project delivery framework whereby project participants are ultimately rewarded based on the project's collective team performance, not each individual's performance.

How should contractual models evolve to allow owner/contractor project teams to adapt efficiently to changing circumstances while minimizing commercial conflicts?

Advanced analytics

The industry is also evaluating whether advanced analytics can help identify early indicators of potential issues that ultimately could affect capital project performance. The industry's use of big data, its reliance on trend information, and its ability to use text mining and semantic analysis have assisted in facilitating its ability to predict capital project performance. In addition, incorporating other data, such as weather, political unrest, and multitier supply chain issues, will improve the line of sight into other issues that ultimately could affect project outcomes. The latest analytic tools utilize all project data, much of which is not used in traditional analysis because of its unstructured nature.

Lean project management

Another innovative structure that some in the industry are starting to evaluate is the new form of lean project management whereby the needs of project delivery are continually assessed so that the management model flexes or is dynamically adjusted to contemporaneous project requirements. Instead of analyzing deviations from a rigid and static baseline and then expending enormous amounts of resources to realign the project to the baseline, the effort is focused on defining those deviations that will ultimately and significantly affect project performance by using a dynamic view of the project. The added value of this approach is that project resources are dynamically adjusted to the needs of the project, not a fixed baseline. This flexibility results in more economical use of resources, which in a tight labor market reduces the pressure on staffing.

How can the huge amount of available project data be captured, analyzed, reused, and shared between owners and contractors to provide quicker and better insight into real-time project performance and potential problem mitigation?

Development of a knowledge ecosystem

As companies look into improving capital projects delivery performance, one of the recurring challenges both EPC companies and owners/contractors will face is the easy access to relevant and reusable information, tools, and lessons learned from prior capital projects. Accelerated knowledge development and sharing will be crucial as the oil and gas industry addresses issues related to the skilled talent gap. A knowledge ecosystem will bring together a convergence of emerging technologies to allow huge amounts of capital project data to be captured, analyzed, reused, and shared between owners and contractors. By doing so, companies have quicker and better insights into real-time capital project performance and potential problem mitigation, which can greatly improve their capital project performance.

These new structures hold the promise of improved project performance and smaller, more agile project teams, the realization of which will result in reduced project overhead and enhanced capital efficiency.

The path forward

In order to determine the optimal approach to managing these megaprojects, companies will need to challenge traditional capital project development and execution strategies and explore key issues such as the following:

- **Project development and execution:** How can the industry project development and execution process be adapted to better reflect the complexity of these megaprojects?
- **Culture:** What kind of new business unit and project leadership behaviors are required for this new area of complex projects?
- **Contractual models:** How should contractual models evolve to allow owner/contractor project teams to adapt efficiently to changing circumstances while minimizing commercial conflicts?
- **Incentives:** How can contractors be incentivized to innovate and manage to project outcomes rather than to delivery of requirements?
- **Knowledge ecosystem:** How can the huge amount of project data available be captured, analyzed, reused, and shared between owners and contractors to provide quicker and better insight into real-time project performance and potential problem mitigation?
- **Integration:** Should contractors become more integrated and retain larger and more permanent engineering and fabrication capability?
- **Talent:** How can talent processes be changed to better manage the retention and quality of skilled workers and engineering/technical talent?

As the oil and gas industry looks ahead and responds to both the opportunities and challenges presented by the unprecedented wave of oil and gas investments, it will be critical to explore the optimal blend of innovative approaches with leading industry practices. The oil and gas industry has shown a consistent ability to innovate and meet the challenges it faces, and we believe this same spirit of innovation will allow it to address the challenges of the energy renaissance.

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