BUILDING THE SMARTER ENERGY SUPPLY CHAIN

Global Paper on how to build next generation energy Supply Chains

CONTENTS

EXECUTIVE SUMMARY

The energy industry is undergoing a seismic shift. "Energy markets are experiencing a centennial moment — a phenomenon that last occurred a century ago when the structure of the industry dramatically transformed based on a switch from steam coal to oil and gas…" writes Energy Analyst Chip Register in a recent Forbes magazine article.[1]

The revolution within the energy industry is driven by development of new, unconventional sources of energy—e.g., shale gas, tight oils, coal seam gas and oil sands. The International Energy Agency's (IEA) Medium-Term Oil Market Report 2014 indicates that "while no single country outside the United States offers the unique mix of above- and below-ground attributes that made the shale and light, tight oil (LTO) boom possible, several countries will seek to replicate the U.S. success story."[2] Australia, for example, recently announced that multiple discoveries of oil and gas in the Australian outback and off the Australian coast could be worth trillions of dollars, turning Australia "into a new Saudi Arabia".[3]

Put simply, in Register's words, "This is not your father's energy economy."

What this white paper covers

This white paper, based on research and interviews with supply chain practitioners in the energy sector, takes a closer look at the dynamics, challenges and opportunities that are shaping both the unconventional and conventional energy sectors. It looks at how supply chains are adapting to tackle these issues and what creative solutions exist to build next generation energy supply chains.

The paper divides into four sections:

- Part 1: The current state and driving trends
- Part 2: Supply chain impacts and challenges
- Part 3: Building the smarter energy supply chain
- Part 4: Conclusion: Benefits of a smarter solution

The paper is designed to provide a unique supply-chain focused view into this tremendously dynamic global industry.

1 Chip Register, "Technology is the New Black in the Energy Economy," http://www.forbes.com/sites/chipregister1/2014/07/24/technology-is-the-new-black-in-the-energy-economy, Forbes, 2014.
2 "International Energy Agency, "Unconventional Oil Revolution to Spread by 2019," http://www.iea.org/newsroomandevents/pressreleases/2014/june/name-104999-en.html, 2014.
3 Jonathan Pearlman, "Trillions of Dollars Worth of Oil Found in Australian Outback," http://www.telegraph.co.uk/news/worldnews/australiaandthepacific/australia/9822955/Trillions-of-dollars-worth-of-oil-found-in-Australian-outback.html, 2013.

PART 1: CURRENT STATE AND DRIVING TRENDS

The energy sector is divided into different segments, each with their own supply chain issues and challenges. The three sub-sectors include:

- Upstream oil and gas, which includes exploration, extraction and production
- The midstream sector, which involves the transportation (by pipeline, rail, barge, oil tanker or truck), storage and wholesale marketing of crude oil or other petroleum products
- The downstream sector, which incorporates petroleum crude oil refining and the processing and purification of raw natural gas, as well as the marketing and distribution of products derived from these source.

"Contrary to conventional wisdom, which many embraced during back-to-back oil crises in the 1970s and again in 2008, oil is not running out," writes Deborah Gordon in a Carnegie Endowment report. "It is, instead, changing form—geographically, geologically, chemically, and economically. The new oils are emerging along a continuum from conventional crudes to transitional oils to unconventional oils, with their classification varying according to the ease of extraction and processing."[4] The same holds true for gas.

While growth in the conventional energy sector currently hovers around 1 to 2 percent per annum, the unconventional segment is booming. The IEA projects that by 2019, tight oil supply outside the United States could reach 650,000 barrels per day (650 kb/d), including 390 kb/d from Canada, 100 kb/d from Russia and 90 kb/d from Argentina. US LTO output is forecast to roughly double from 2013 levels to 5.0 million barrels per day (mb/d) by 2019.[5]

Looking further ahead, BP's Energy Outlook 2030 predicts that the 'shale revolution' (first for gas and then for oil), will see shale gas production from 2011 to 2030 more than triple and tight oil output grow more than six-fold. "Together they will account for almost a fifth of the increase in global energy supply to 2030."[6]

Shifting Geographies

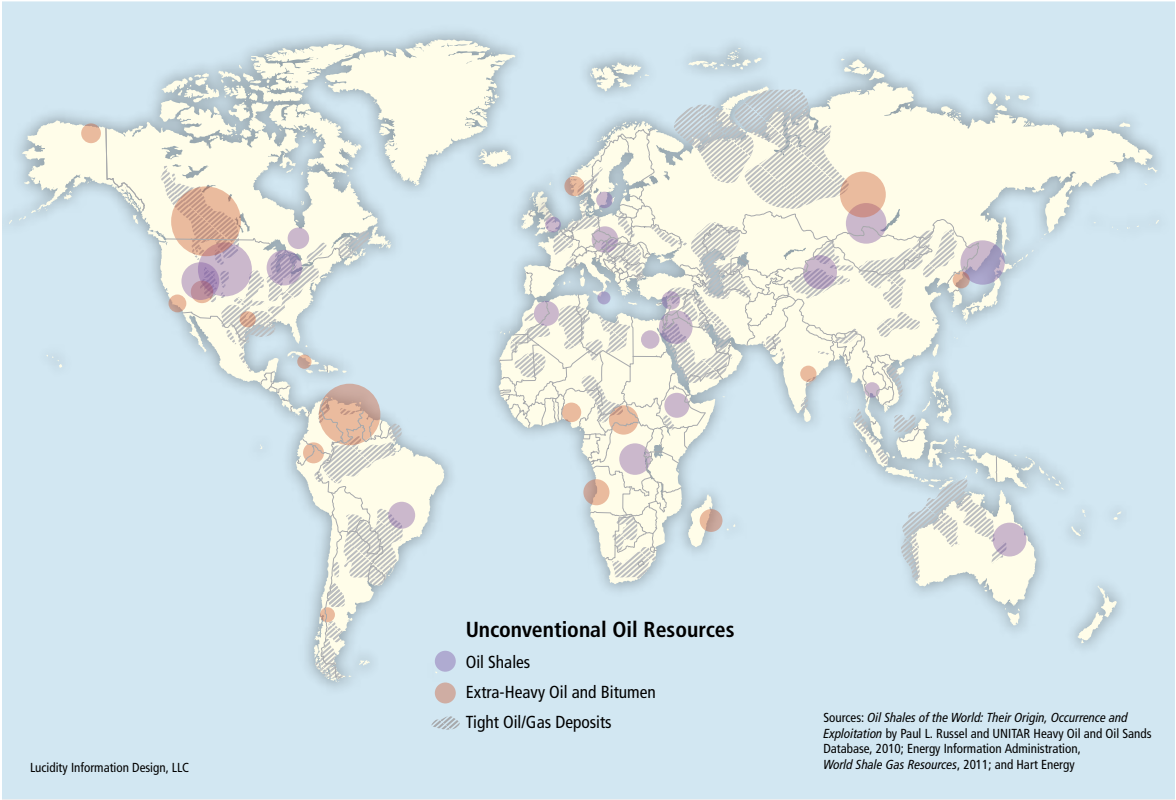
Not only is the make-up of oil drastically changing, so too is its political geography. As shown in Figure 1, which depicts the projected geographies of new oil (and oil derivatives) based on current knowledge, the world's oil supplies will no longer remain concentrated in the Middle East, Africa and Russia.

The IEA projects that North America is home to the world's largest stores of unconventional oil and gas. Analysts estimate that North American unconventional oil reserves are 50 percent greater than total conventional reserves in the Middle East. Thus, North America is rapidly becoming a significant player in the new geography of oil.

There are still significant barriers to the growth of unconventional oil and gas in certain regions, however. Taking Europe as an example, according to McKinsey Global Institute, technically recoverable shale gas resources in the European Union (EU) are estimated at 499 trillion cubic feet, 58 percent of the U.S. level. However, land ownership is much more fragmented in Europe than in the United States. Publicly owned, below-soil land rights mean that there is less incentive for European residents to support nearby drilling. Public concerns about the environmental impact of shale gas are intense and bans on the industry are in place in Bulgaria, France and the state of North Rhine-Westphalia in Germany.[8]

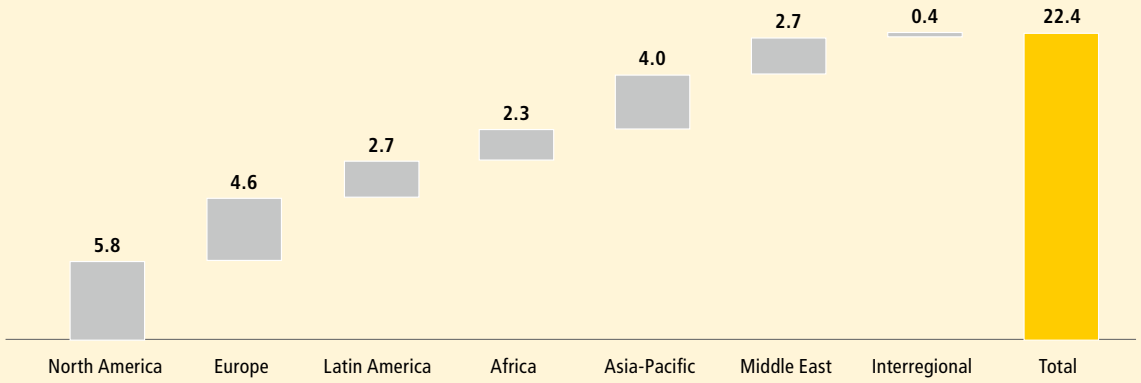
4 Deborah Gordon, "Understanding Unconventional Oil," Carnegie Endowment, 2012, p. 1.
5 International Energy Agency, "Unconventional Oil Revolution to Spread by 2019," http://www.iea.org/newsroomandevents/pressreleases/2014/june/name-104999-en.html, 2014.
6 British Petroleum, "Energy Outlook 2030," 2013, p. 21.
7 Gordon, op. cit., p. 10.
8 McKinsey Global Institute, "Resource Revolution: Tracking Global Commodity Markets," 2013, p. 17.

Figure 1: The New geography of energy[7]



Source: Carnegie Endowment, 2012.

Figure 2: Regional cumulative oil and gas investment, 2014 to 2035 (US$t)



Source: World Energy Investment Outlook, International Energy Agency, June 2014.

Trillions in investment

Expanding energy supply and tapping the new sources of energy, will require trillions of dollars in investment over the coming decades—some $1.6 trillion per year through to 2035, according to the IEA (Figure 2). Unconventional energy is particularly dependent on heavy and continuous infrastructure investment. Extracting oil from oil sands, for example, costs 10 times as much as traditional on-shore oil well extraction.

The high cost of extraction in unconventionals stems from the fact that, in the case of production from fracked wells (tight oil, shale gas), output declines rapidly in the initial years of production. The average decline of tight oil wells in North Dakota's Bakken shale field, for instance, is 44 percent per year, with some wells losing 70 percent or more of their production in the first year[9]. In contrast, conventional oil or gas wells can maintain a high level of production for many years—even decades—with an average decline of about 5 percent per year[10].

Because of this high first-year decline rate, more and more wells must be drilled just to maintain production and significant further investment made in 'workover' of existing wells. For example, the Eagle Ford Shale (EFS) play in South Texas has over 250 operating rigs, but operators needed to drill over 6,000 wells in 2013 just to maintain current production rates.[11]

These and other factors are causing concern, with annual cost inflation rates of 10 to 15 percent in some areas of the energy industry, according to the Journal of Petroleum Technology.[12]

Shifting geography of demand

Finally, the demand side of the equation, the IEA reports that the centre of gravity of global energy consumption is moving decisively towards emerging economies. They will account for more than 90 percent of net energy demand growth to 2035. Demand growth in Asia is led by China this decade, but will shift toward India and, to a lesser extent, South-East Asia after 2025. The Middle East will emerge as a major energy consumer, becoming the second largest gas consumer by 2020 and the third largest oil consumer by 2030. Meanwhile, the United States is moving steadily towards meeting almost all of its energy needs from domestic resources by 2035.[13]

9 Tom Zeller Jr., "Is the US shale Boom Going Bust?" BloombergView, 2014.
10 European Parliament Research Service, "Unconventional Gas and Oil in North America," 2014, p.8.
11 http://eaglefordshale.com/, accessed September 13, 2014.
12 Niels Phaf, Thomas Seitz and Clint Wood, "Unconventional Oil and Gas: Unlocking Value Through Collaboration," Journal of Petroleum Technology," Nov. 2013, pp. 6-7.
13 International Energy Agency, "World Energy Outlook 2013 Factsheet," 2013, p. 1.

PART 2: SUPPLY CHAIN IMPACTS AND CHALLENGES

From a supply chain perspective, both conventional and unconventional energy companies face an intriguing set of challenges. "Some would believe that the supply chains supporting conventional energy are already fully mature, given that they have had 150 years to develop," observes Jonathan Shortis, Vice President, EMEA—DHL Energy Sector "However, this is clearly untrue. The conventional energy market is still developing. In order to maintain growth to meet global demand, companies have had to expand into ever more inaccessible and remote locations, such as deep-water sites and the Arctic. In these areas, conventional energy faces the same challenge as unconventional—establishing and maintaining a robust infrastructure to support production."

With conventional energy, companies must also contend with the need to support ongoing production. "The job," says Shortis, "is to keep existing operations running, to maximize asset utilisation and production while also developing the new expansion areas."

For unconventional energy, because reserves are frequently located in undeveloped and/or remote geographies, pipeline infrastructure does not exist. "Midstream companies must build gathering networks to serve the well-heads and link up with pipelines that traditionally carry oil or gas," explains Steve Harley, President of the Energy Sector at DHL. "Hydraulic fracturing, by its nature, requires a higher density of wells in any new operating location. Therefore, you have midstream companies developing the infrastructure to carry the oil and gas away. In the interim, as in the Bakken Basin, for example, this means putting the oil and gas on rail."

Because the unconventional energy market is so new and the supply chain support system is evolving rapidly, logistics costs are a much higher proportion of overall production costs. "In fact," says Harley "the logistics burden is immense, requiring the large scale movements of pipe, casing, water, proppant, chemicals and so on. This demands a robust logistics process to maximise drilling utilisation and team productivity. Supply chains also need to be highly flexible to meet the ever moving well-site locations."

Much of the present exploration and development of shale gas deposits in the US is not being made by the traditional oil majors, but rather by new players in the market. These new participants frequently have less experience executing the development of efficient supply chains, generally. There is a need, therefore, for major logistics service providers to develop new relationships with these new players (beyond their traditional oil and gas major client base) and to work hand-in-hand with them to orchestrate these operations. Failure to do so will only delay the development of optimal supply chains for these new entrants.

Logistics complexities in the conventional sector can quickly drive up costs and eat into profit margins, if not well managed. Energy companies, therefore, are placing growing emphasis on finding and eliminating waste in their supply chains. Leading firms understand that just-in-time material coordination and delivery to well pads, for example, must be operated with the same sophistication as warehouses and factories that support industries such as Automotive and High Tech.[14]

14 Ernst & Young, "Supply Chain Management in a Shale Market,", 2013, p. 1.

Energy Supply Chains—Key Characteristics

There are actually five supply chains that support energy sites. As Steve Banker of the ARC Advisory Group explains in a recent Forbes article[15], these include:

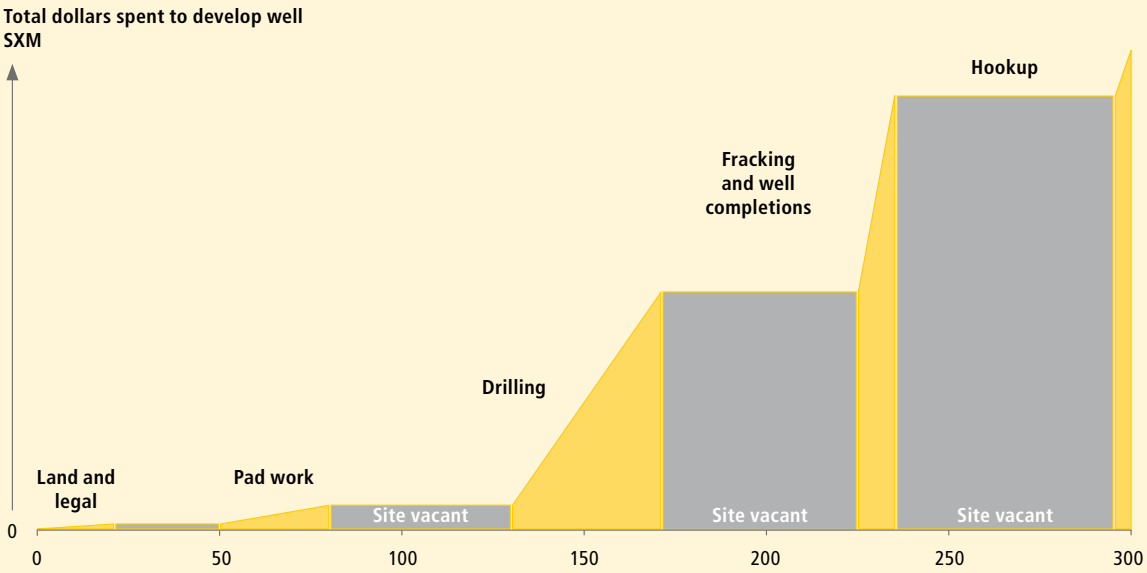
- Upstream supply chain—associated with building rigs and the necessary supporting infrastructure
- The in-bound supply chain—bringing in and staging the materials associated with drilling. In conventional energy, these materials include drill casings, drills, water, drilling mud, and lubricants for the rig. In unconventional fields, materials include high volumes of water, sand and fracking chemicals
- The out-bound supply chain—transporting the oil and gas produced by the field, often in an environment where logistics infrastructure is limited or non-existent
- Remote worker supply chain—providing workers in remote locations with all the supplies needed to sustain life and protect health, together with the people movements themselves—i.e., managing the transportation of drilling crews into and out of the production basins in line with their rotation schedules.
- The emergency supply chain—supporting energy companies' risk-based emergency response plans for controlling fires, leaks, Medivac and other health, safety and environmental risks.

Within these five supply chains, many challenges exist—all of which must be addressed and mitigated:

- Health, safety, security and environment (HSSE)—managing safety in all aspects of the supply chain, including management of third party sub-contractors, vehicle condition management and maintenance, driver capability and training and general safety around drill sites and other operations. This also includes maintaining a complete audit trail for HSSE requirements.
- Complex operations—managing multiple stakeholders, numerous drilling locations operating in parallel, high drilling frequency and a wide variety of materials and services flowing to and from the site
- Fragmented supply chains—highly extended, multi-national supply chains with the presence of numerous players invites disconnects, causes delays, makes accountabilities unclear and adversely affects data interchange
- Dynamic operations—frequent plan changes to reflect current drilling performance impact materials demand and service requirements
- Data management—to monitor and improve performance in the supply chain supporting the site and allow end-to-end supply chain visibility, traceability and management
- Materials monitoring—tracking materials usage and flows across the supply chain—adapting to frequent plan changes
- Purchasing—optimizing purchasing from suppliers (through framework agreements) and service companies and minimizing the use of distributors, to drive down costs and improve emergency delivery and collection
- Site logistics—controlling the complex array of services required to support multi-drill sites is to ensure site safety, security, efficiency and production

15 Steve Banker, "The Upstream Shale Oil Supply Chain," http://www.forbes.com/sites/stevebanker/2014/08/08/the-upstream-unconventional-oil-gas-supply-chain/, Forbes, 2014.

Figure 3: Impact of poor supply chain planning on drill-site productivity



Source: Bain & Co., 2013.

Managing these myriad challenges is no easy task. One international oil and gas company executive says two issues, in particular, top his list of supply chain concerns:

- Coordination of logistics to support large capital projects
- Finding a safe and reliable logistics partner, willing to engage consistently, repeatedly and safely in 'crazy' upstream locations.

"Turnover, labor and infrastructure in these areas are potentially devastating challenges for us," the executive stresses. "Being able to depend on a logistics partner to engage with us is critical."

"We're also trying to figure out how we standardize our approach to providing logistics solutions to reoccurring projects so we're not reinventing the wheel each time we start a new project in a remote location," he continues. "We need to be able to provide a quick solution to high-risk moves. We also need to develop a holistic view of the overall project so we can gain better control."

This issue of continually reinventing the wheel in energy projects is very common, particularly in unconventional energy. "Rarely are consistent, global supply chain strategies being followed," Shortis notes. "Each supply chain and the associated contracting strategies are being established on a project-by-project or even site-by-site basis and that elevates cost as well as risk—reducing project time and cost certainty."

Another supply chain vice president at a multi-national oil company reports grappling with similar issues. "Our top two supply chain challenges are visibility and predictability," he says. "With the complexity of the supply chain, number of suppliers and numerous internal/external systems, our visibility into materials moving through the supply chain is inadequate. This creates uncertainty and unpredictability, and makes it tough for our internal customers to plan. As a result, they hedge their bets—particularly with increasing inventory which internal customers cannot accurately plan for."

Lack of reliability in the supply chain carries immediate and often significant negative repercussions. "The difference between profit and loss," note John McCreery and Ethan

Phillips of Bain & Co 45, "can depend on losing a drilling day waiting on mud system arrival, losing a week of production because of a treating-chemical stock out, or missing a day of retail sales because the refinery production schedule was not aligned with demand."[16] Similarly, when an oil rig stops, millions can be lost in a matter of hours. Thus, intelligent energy supply chain risk management must balance trade-offs such as the high cost of downtime vs. the expense of carrying slow-moving parts and supply inventories.

Figure 3 illustrates the cost of poor supply chain planning. Lack of critical materials and supplies left an unconventional drilling site idle for nearly two-thirds of the development time.

Energy companies compensate for risk by maintaining high inventory levels of just about everything, close to remote sites and using expensive ad-hoc air charter services for items not on site. In addition, labour is diverted from well sites to solve immediate material availability issues, thereby impacting efficiency, asset availability and, of course, production. With margin shrinkage and cost inflation, however, this approach is not sustainable, quickly eating into profit margins. To address this issue, leading companies are adopting an end-to-end supply chain operating model, instituting a data-driven, integrated solution that connects all stakeholders in the chain. This solution—the smarter energy supply chain—blends state-of-the-art visibility and analytics with best-practice process management to achieve bottom line results. The next section of this paper describes this emerging energy supply chain.

16 John McCreery and Ethan Phillips, "Integrated Planning: The Key to Upstream Operational Excellence," Bain & Co., 2013.

PART 3: BUILDING THE SMARTER ENERGY SUPPLY CHAIN

The smarter energy supply chain is a highly integrated, orchestrated and data-driven approach to managing the energy supply chain on a true end-to-end basis. Creating the organizational infrastructure, processes, services and assets to manage the supply chain holistically requires time and a significant investment. Knowing this, energy companies are asking themselves, "Do we want to invest in and train the staff a successful global supply chain now requires, or should we engage an integrated supply chain partner that has those skills as core competencies?"[17] Increasingly, these energy companies are opting for the latter approach, outsourcing to a third party logistics company (3PL) under a lead logistics provider (LLP) model.

"Typically, the first step in this outsourcing process is for the 3PL to analyze the current supply chain operations and, based on this information, develop a new design focused on optimizing processes and flows," says Harley. "The purpose of this activity is to create a supply chain that is more cost effective, while at the same time improves support for the production process."

Within this new operational design, the 3PL partnership is specifically designed to support the five types of supply chains described in the previous section. The LLP sits atop the supply chain hierarchy and orchestrates all in-bound and out-bound logistics. For the in-bound supply chain, for instance, this solution involves management of materiel:

- from international or domestic suppliers
- through origin consolidation hubs and customs clearance
- to the in-country primary stock location, consolidation center or cross-dock

It also incorporates managing the warehouse and yard, providing value-adding services such as materials consolidation or kitting before delivery to the site stores and lay-down areas. The solution layers on information systems that provide full visibility and traceability of materials across the supply chain to all stakeholders, including visibility in remote stock locations. It integrates with the client enterprise resource planning (ERP) system for accounting and asset management purposes, enabling markedly improved financial control.

From a functional viewpoint, this integrated, data-driven approach covers every element of the supply chain: logistics planning and design; procurement/sourcing; expedited or transactional purchasing; in-bound transportation (both international and domestic); warehousing; domestic distribution and in-plant, on-site services such as packaging, loading or off-loading.

The keys to confidence: Visibility

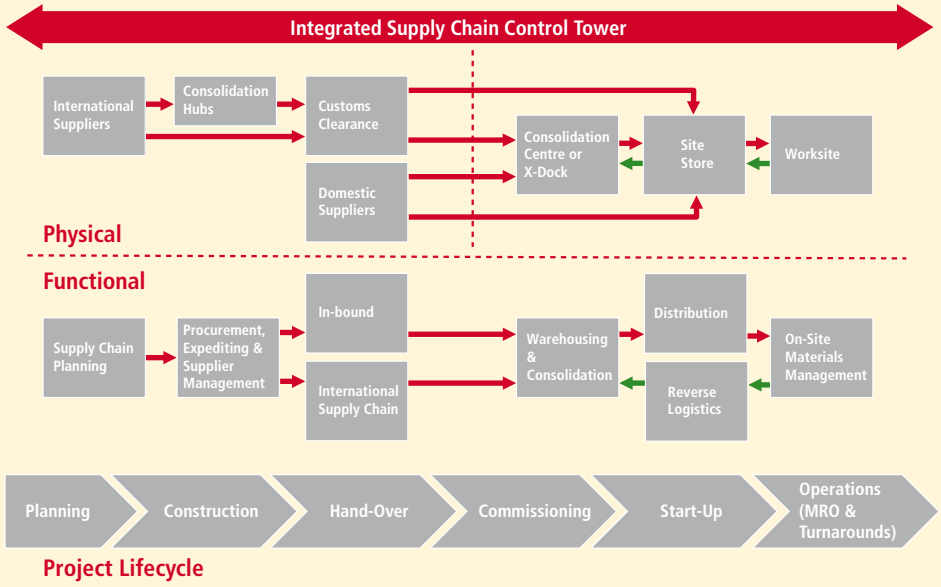
While an outsourced, end-to-end approach is uncommon in the energy sector, it is highly successful in other industry sectors. In Aerospace and Automotive, for example, the integrated, data-driven supply chain approach is in widespread use—i.e., the so-called in-bound-to-manufacturing (I2M) strategy. Supply chain management is seen as a key differentiator in these industries, creating competitive advantage for the business by reducing costs, improving agility and decreasing risk.

Developing confidence in the supply chain's ability to perform is essential in a successful outsourcing situation. The first step toward building confidence is gaining the kind of visibility described above. "An end-to-end, data-driven supply chain provides a single source of truth for all project stakeholders," says Shortis.

"In an ideal case," Harley elaborates, "we have visibility into the full project lifecycle, so we can see and manage all the materials requisitions, flows and inventory levels."

17 PwC, "New Conventions for Unconventional Oil and Gas Series: Reducing the Drag to Achieve Speed and Efficiency,", 2013, p.2.

Figure 4: The integrated energy supply chain



Source: DHL Supply Chain 2014.

Visibility enables more strategic and effective inventory management with "just-in-time" processes that eliminate duplication and redundancies. "A 15 to 20 percent reduction in inventory costs is often achieved through this step alone," Shortis reports. Real-time visibility over integrated transportation systems and networks (including warehouses) also allows suppliers to consolidate shipments. Other 'lean' techniques and competencies eliminate unnecessary costs and build on economies of scale.

The keys to confidence: Reliability

If visibility is step one, reliability of the supply chain is step two. Historically, oil and gas companies have not trusted that their supply chains could deliver what they needed, when they needed it. This distrust is a direct result of the siloed, fragmented structure of traditional energy supply chains. Purchasing and other departments operated independently, with little or no inter-departmental visibility or coordination.

To build trust in the supply chain, the smarter energy supply chain establishes processes and practices that cut across and connect all involved departments—much like the processes employed in managing a just-in-time (JIT) Automotive or High Tech manufacturing plants. As PwC explains, "Although unconventional energy operations such as shale-basin development and production certainly are not manufacturing, the development of each well shares a key manufacturing characteristic—a general process that repeats tens of thousands of times. That repeatability ('the factory concept') lies at the heart of applying manufacturing concepts and processes to these operations."[18]

"In energy," Harley notes, "it's not so much a question of making this many widgets. It is more a maintenance process focused on increasing asset availability and up-time—how do I keep this manufacturing-like process up and running? There is a flow of materials going to the end users, and those materials must always be available when needed. We look at usage patterns of materials so we can create intelligent replenishment strategies to ensure that just-in-time availability."

As Figure 4 illustrates, the integrated energy supply chain establishes a dedicated control tower to plan, orchestrate and execute the supply chain from in-bound suppliers, to on-site materials management, to out-bound product flows.

18 "New conventions for unconventional oil and gas series: Optimizing the play to improve returns," PwC, 2013, p. 2.

PART 4: CONCLUSION: BENEFITS OF A SMARTER SOLUTION

A data-driven, outsourced supply chain provides a number of benefits to energy companies, regardless of their segment. These include:

- Visibility and traceability across the supply chain
- Simplified communication—a single point of logistics accountability and control
- Significant cost reduction and service enhancement—through end–to-end optimization
- Improved planning—reducing the necessity for emergency response deliveries
- Standardization of system and process across all supply chain sub-contractors—reducing HSSE and compliance risk
- Performance management—through systematic Key Performance Indicator (KPI) reporting
- Supply chain risk reduction—a single logistics service provider can take a holistic view of a project or facility and hence identify constraints and proactively develop mitigation strategies
- Metric-driven continuous improvement and innovation.

"Ideally," says Shortis, "the integrated supply chain concept spans the entire project lifecycle. The greatest benefit can be realized by setting up the team at the design stage, to formulate the supply chain in parallel with the design of the facility, then building the supply chain through the capital expansion phase (construction, commissioning) before 'flipping' the supply chain to support the operational expansion phase thereafter."

"With better visibility and more predictability," says one Global Energy Supply Chain Vice President, "we can decrease the cost of expediting and execute planned work on time more often, while building more confidence in the supply chain itself. This requires implementation of a common systems platform, better integration with our in-bound logistics providers and a standardized organization and process to support a more consistently executed supply chain."

By applying the best outsourcing techniques and lessons learned from other industries—Automotive, Technology and Heavy Industrial, conventional and unconventional energy companies can reap the benefits of better control, increased asset up-time and improved production.

CASE STUDY: APPLYING THE INTEGRATED SUPPLY CHAIN MODEL IN REMOTE CHINA

Challenge: Build a supply chain to support development of on-shore, unconventional gas operations in the Sichuan basins of China.

An international oil company was launching an unconventional gas operation in the Sichuan region of China—a highly challenging environment. Drilling locations are remote and the local populace had little or no experience in oil and gas operations.

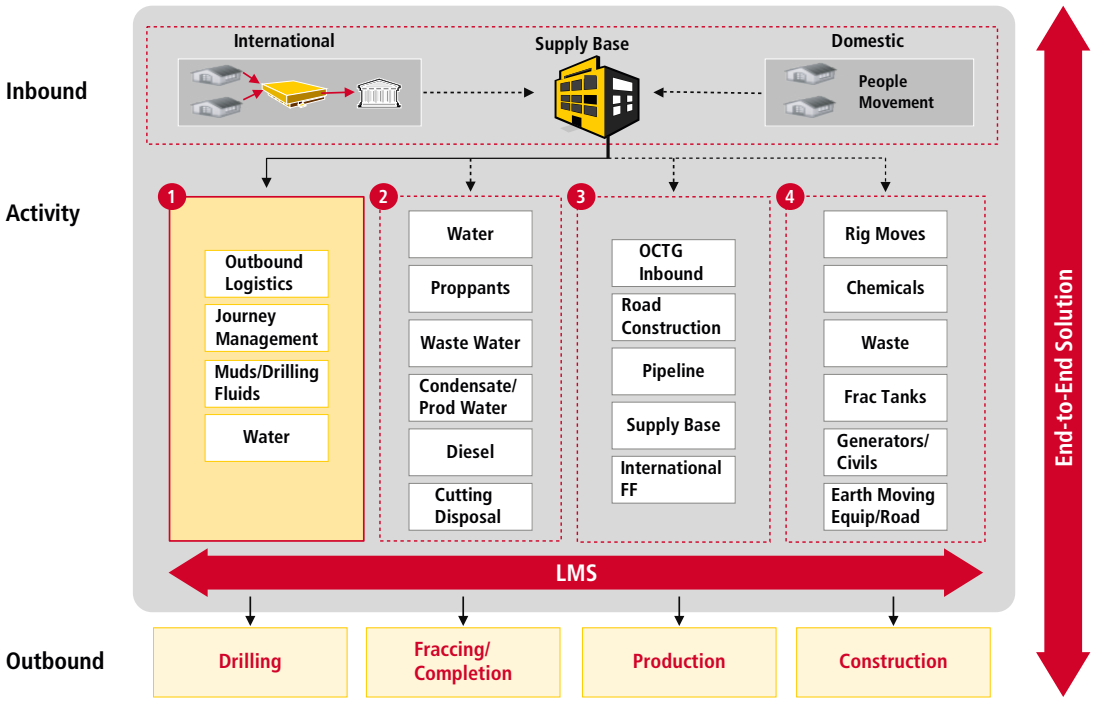
The energy company understood it needed a global supply chain partner to manage the entire, integrated, in-bound supply chain to support these new exploration and production operations. DHL was successful in winning this business in early 2013 and is implementing its solution, with teams now deployed and operating in the field.

The scope of the contract is that of a highly complex control tower operation, which supports all phases of the on-shore gas field development, from drilling, through fracking, to production and ongoing operation. The complex project is being implemented in a phased approach—establishing a successful outcome in one area before increasing complexity and scope.

Initially the work is concentrating on driving improvements in the third party logistics (3PL) operations in Sichuan. The highest perceived risk associated with these operations relates to sub-contractor road safety. As such, the scope initially focused on managing the movements of a small number of commodities such as drilling muds, drilling fluids and water. The work concentrated on improving planning, journey management and, above all, HSSE performance.

The DHL team audits all sub-contractor transportation movements, assesses areas such as driver performance, training, and equipment condition with a goal of improving safety performance. Because

Figure 5: China control tower case study



Source: DHL Supply Chain 2013.

very small transportation companies dominate the logistics market in China, bringing these firms up to speed on HSSE practices is no small task.

The scope of the supply chain solution will expand to include direct management of the 3PL sub-contractors, control of all other major material groups, such as proppants for fracking, waste water, diesel, pipe and casing, chemicals, frack tanks and earth moving equipment. It will also include management of other supply chain functions such as supply base/forward operating base management, warehousing, pipe yard operation and international freight forwarding and customs clearance.

While the full solution is still being implemented, it already is delivering supply chain cost reductions, increased team productivity, enhanced asset utilisation and increased production. Importantly, the international oil company plans to apply this end-to-end supply chain model across other new regions and basins both nationally (in China) and internationally. Figure 5 diagrams the China solution.

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