



## WHITE PAPER

# Downstream Oil and Gas: Achieving Excellence by Integrating Operations

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## IN THIS WHITE PAPER

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In this IDC White Paper, IDC Energy Insights discusses the best practice approaches of improving operations in today's downstream oil and gas industry, particularly refining, gas processing, and petrochemicals. The focus is on organizing people, processes, and technology to achieve continuous improvements, taking advantage of recent advances in technology and new management techniques. Guidance is provided on what steps oil and gas companies can take to ensure that they meet their business objectives for profitability, growth, and product quality while mitigating risks to the environment, safety, and health.

## SITUATION OVERVIEW

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With the low prices of crude and natural gas, refining, petrochemical, and processing margins are experiencing a comeback after years of lackluster performance. These conditions are not likely to persist. Operating costs will increase with more stringent regulation of emissions and safety. Availability and uptime may be affected by operating equipment at higher utilization rates, especially for equipment that has been performing under capacity. In the long run, prices of feedstock are likely to increase with the lifting of export bans and the development of liquefied natural gas (LNG) infrastructure. At the same time, competition will place pressure on wholesale refined product prices. Sitting in the middle of the energy value chain – between producers and consumers – downstream leadership needs to be prepared to respond quickly to changing conditions. With a wealth of information more easily available, now is the perfect time for lines of business and information technology (IT) organizations to develop the means to orchestrate the organizational response by integrating operations.

### Supply Chain Is Changing

#### *Long-Term Demand Shifts to Asia and the Middle East*

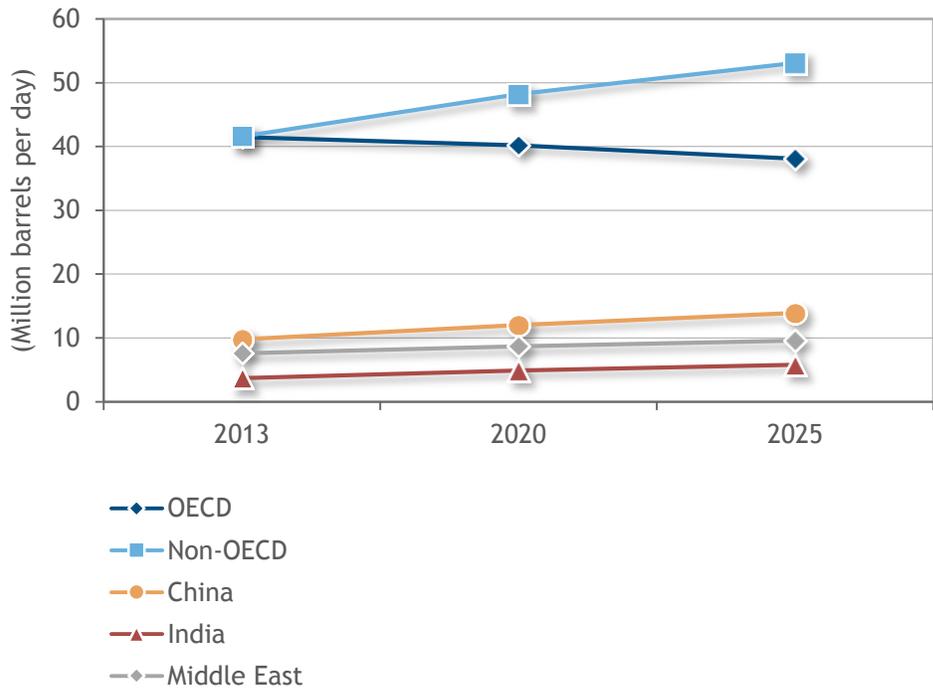
Demand for energy, particularly oil and natural gas, is shifting to Asia and the Middle East.

According to the New Policies Scenario in the International Energy Agency's (IEA's) 2014 *World Energy Outlook*, from 2013 to 2025, demand for oil will decrease in OECD countries while increasing by 42% for China, 57% for India, and 26% for the Middle East (see Figure 1). (Note: Countries in the OECD – Organisation for Economic Co-operation and Development – are Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway,

Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.)

**FIGURE 1**

**Change in Demand for Oil, 2013-2025, New Policies Scenario**



Source: International Energy Agency's *World Energy Outlook*, 2014

Globally, the demand for oil over the coming years will focus on transport and refined products rather than generation, according to the IEA. As for transport, the United States and Europe are just coming out of a period of lowered gasoline consumption motivated by the economy, fuel efficiency standards, and high prices, although lower crude oil prices are driving more consumption with the return to larger vehicles. On the other hand, demand for transport fuel is increasing in Asia and the Middle East, in part due to subsidies that give advantage to fossil fuels for transport and despite adoption of the first fuel efficiency standards in China and India. As for petrochemicals, production is expected to grow from 11.1 million barrels per day (MBPD) in 2013 to 14.7 MBPD in 2025. According to the IEA in the 2014 *World Energy Outlook*, "Together with China and the Middle East, the United States sees the highest increase in oil consumption for petrochemicals to 2025."

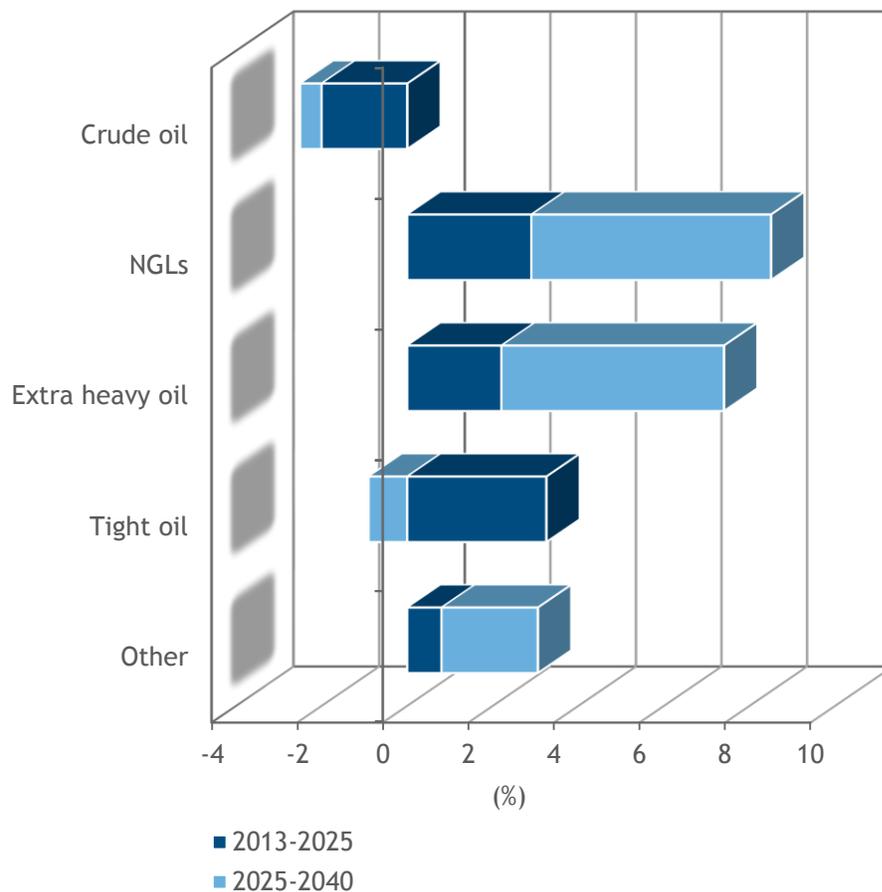
In its New Policies Scenario, the IEA forecasts that the "demand for natural gas grows by more than half, the fastest rate among the fossil fuels, and increasingly flexible global trade in liquefied natural gas [LNG] offers some protection against the risk of supply disruptions." China saw 18% growth in demand for natural gas from 2012 to 2013, according to the IEA. The demand for natural gas in China is expected to increase as the country seeks to substitute coal-fired generation with cleaner burning gas. The Middle East is also expected to see an increase in the demand for natural gas.

## The Rise of Unconventionals

The rise of unconventional – tight oil, shale gas, oil sands, and deep water – over the past several years has radically changed the oil and gas industry. The International Energy Agency's announcement in November 2012 that the United States would be able to meet all of its energy needs internally and become a net exporter of oil and gas in the 2030s raised eyebrows. Figure 2 shows that from 2013 to 2025, the rate of growth of crude will decline, while the rate of growth of natural gas liquids (NGLs), extra heavy oil found in the oil sands, and tight oil will increase.

**FIGURE 2**

### Changes in World Oil Production by Type, 2013-2025 and 2025-2040



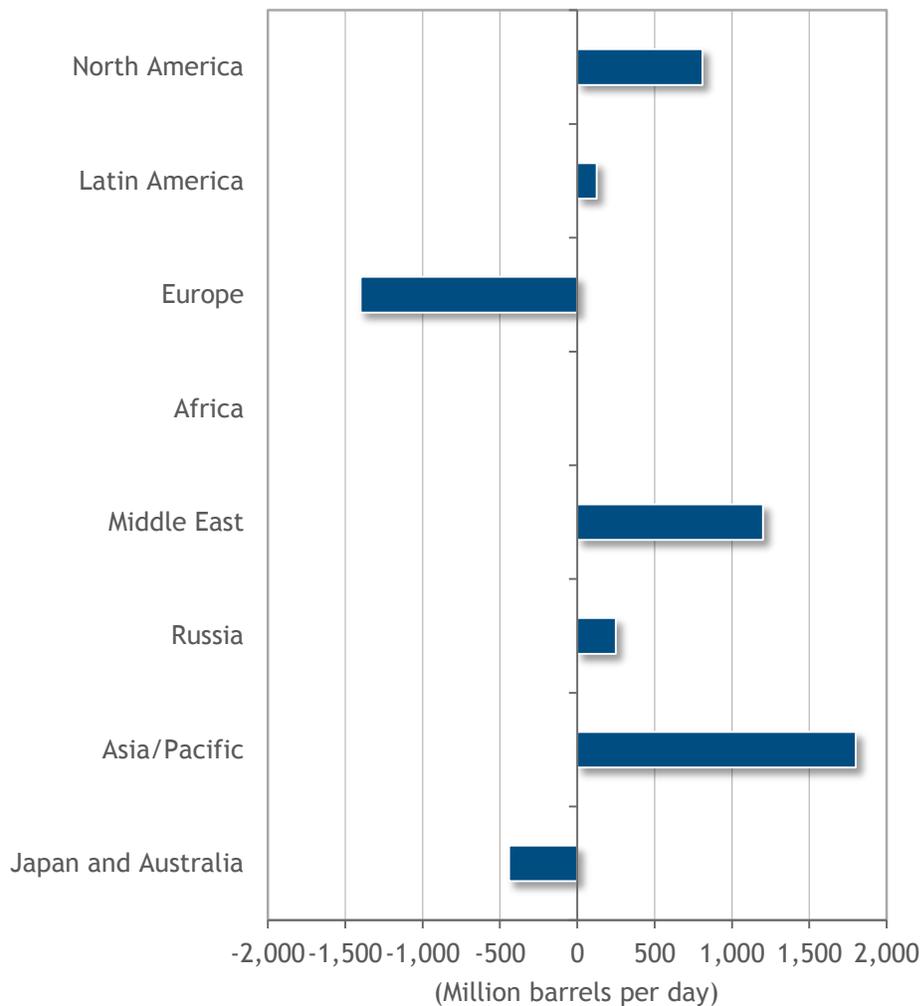
Source: International Energy Agency's *World Energy Outlook*, 2014

## Refining Moves Close to Demand

Much of the new refining capacity is located in proximity to demand as a result of the expense of delivering refined products. Exports of crude to Asia for processing are at record highs. Figure 3 displays the clear growth in capacity in Asia and the Middle East, followed by North America, while Europe has shuttered capacity. Proximity to demand depends on whether it is premium product or commodity that is a by-product, the cost of feedstock, and the transportation of feedstock that may not be local.

FIGURE 3

### Refining Capacity Changes, 2009-2014



Source: Turner, Mason & Company, 2015

At the same time, there is excess refining capacity in the world. According to the 2015 edition of BP's *Energy Outlook*, "Global spare refining capacity is already 7 Mb/d above its recent low [2005] and, in recent years, a net 1 Mb/d additional capacity has been added each year." The conclusion is that there will be a long period of volatile margins with capacity reductions in areas like Europe.

## LNG Rises to Meet Global Demands

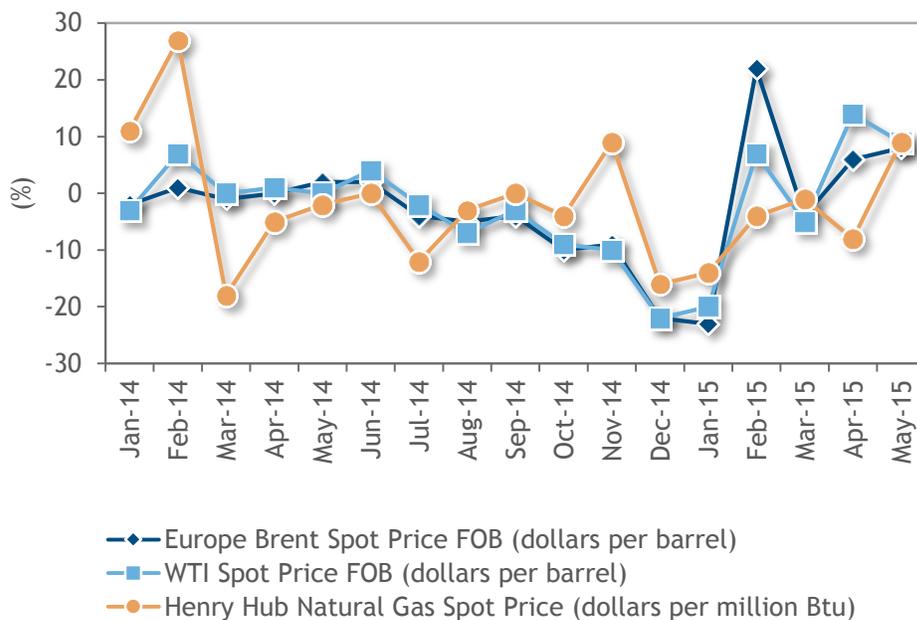
Natural gas is becoming a more global commodity. With access to natural gas constrained in Europe and demand rising for cleaner fossil fuel, the interest in LNG has grown. Royal Dutch Shell has made a large investment in LNG with its acquisition of the BG Group so that it can gain scale in the market. Building the infrastructure to support LNG processing – natural gas pipelines, liquefaction, and regasification plants – requires significant investment, so LNG operations put a premium on efficiency to achieve return on investment.

## Price Volatility Picks Up

A significant drop in oil prices in the fall of 2014 was largely due to unanticipated production in Libya, along with shale and tight oil production in North America. This drop benefited refinery margins for a period of time while product prices were still high. How quickly prices will recover is the topic of much speculation. What is clear, however, is that there is increased price volatility in feedstock (see Figure 4).

FIGURE 4

Percent of Price Volatility in Crude Oil and Natural Gas, January 2014 to May 2015



Source: Department of Energy, Energy Information Administration, June 2015

## Refiners Benefit from Drop in Oil Prices

Margins have seen a boost as crack spread grows with the low price of oil. In fact, for vertically integrated companies in today's environment, refining is adding value to vertically integrated companies.

According to one refining and retail company, in addition to stable cash flow and environmental performance, "Refinery margins is [sic] probably the area where we as a company, and probably most oil companies, have the most potential to add value to their bottom line – by improving refinery margins – and we're no exception to that."

According to the IEA, "Refinery margins have been on an upward trend since mid-2014, despite initially lackluster demand growth. More recently, cold weather and lower retail product prices helped spur stronger demand growth in some countries. Perhaps more importantly, refinery outages and weaker runs in many non-OECD countries seem to have created opportunities for plants with surplus capacity in more mature markets."

Even if the crack spreads are good overall, not all plants will have good margins. Not all regions experience good margins. Margins may be pressured in regions of overcapacity (Europe) or where there is limited native production of feedstocks (China), necessitating imports that may be at a higher price.

## New Product Demands

There are demands for new petroleum-based products as technology advances. An emphasis on cleaner fuels has driven interest in substitutes for traditional gasoline with the emergence of electric vehicles, biofuels, and natural gas-powered vehicles.

## Business Objectives

What is becoming increasingly clear is that with globalization, conditions can change quickly. The convergence of multiple events – unplanned processing shut-ins, political decisions to shut down pipelines, unanticipated increases in natural gas or crude oil production – can lead to significant changes in prices for supply and products. Oil and gas companies are coming to understand the need for agility. Oil and gas processing companies must be able to accommodate a demand-driven supply chain.

Companies processing oil and natural gas have always needed to be focused on profitability, product quality, growth, availability, and risk management. Today's best-in-class companies continue to focus on achieving operational excellence. What is different is the increased attention to:

- Improving feedstock flexibility
- Growing high-value product yield
- Guaranteeing availability
- Increasing logistics capabilities
- Reducing risk

## Improving Feedstock Flexibility

Processing plants need to be flexible enough to work with a different type of feedstock. For example, unconventional resources produce different qualities of oil than conventional crudes. Tight oil differs from conventional crude as it is lighter and has less sulfur than conventional crude. It also has more contaminants due to the hydraulic fracturing process. With moderate capital investments, refiners can process tight oil, such as the addition of screening for contaminants and catalysts for anti-waxing.

New processes are needed as well for growing production of NGLs. According to IEA's 2014 *World Energy Outlook*, "NGLs have a higher liquid content, requiring different processing. Overall production will be either on the light or the heavy end of the spectrum. This bifurcation of oil supply and the squeeze that it exerts on the share of conventional crude is one of the challenges facing the global refining sector."

## ***Growing High-Value Product Yield***

Consistent product quality is a differentiator for oil and gas processing companies, whether they are bringing to market refined products or natural gas for industrial use. Quality is especially important for petrochemicals where the process and product are more complex. According to one supermajor, "One of the things we've been putting a lot of effort in with money and budgeting is supporting the refining quality of the volumes moving strategically in supporting the bulk plants and the bulk customers and the products ranging from the gasoline, petroleum and gas, big tank farms, the exports as well and also moving into the natural gas side."

As demand for specific products shifts geographically, oil and gas companies seek to find new markets where they can compete and grow. Companies that can respond rapidly to changes in demand for specific products will have a competitive advantage. As part of its integration, Neste Oil is modifying one refinery to provide feedstock for production of valuable products like diesel and offering aviation fuel at another to compete with Russian plants.

There is also opportunity in the development of new products. Companies can invest in products produced directly from crude, such as producing butylenes and propylene. However, there may be more attractive opportunities in marketing products that are a by-product of refining or processing.

## ***Guaranteeing Availability***

Operational availability – the percentage of the year that a unit is available for processing after deducting the time spent on turnaround activity and all mechanical, process, and regulatory downtime – has always been important to processing industries. In fact, for BP, refining availability – which was 94.5% in 2014 – is one of the 14 metrics that the company uses to measure its performance. In an environment of low feedstock prices, many companies are opting to continue processing and storing product for later sale, despite the potential price-dampening effect that oversupply can have. This strategy requires high availability.

Although some conditions such as hurricanes require shut-ins, availability – and its cousin reliability – is largely within a company's control. Asset management practices such as condition-based monitoring and predictive maintenance help reduce unplanned plant outages caused by asset failure. Asset failure could be due to poor asset health related to aging assets or usage over capacity. Best-in-class companies plan outages for maintenance activities based on price and seasonality. To reduce downtime and lower maintenance costs, companies plan for noncritical maintenance tasks to be done during planned outages. More important is the orchestration of procurement of replacement parts and labor resources at the site.

## ***Increasing Logistics Capabilities***

With the new energy supply chain, at a very basic level, logistics have become more complicated with multiple means of transport and new processing facilities coming online. The balancing of pipelines becomes more complex, as do contract terms and transport capacity, especially in the context of more volatile pricing. Knowing where the cargo is at any point in time and whether the components of that cargo have changed during transport is more important than ever.

**Companies that can respond rapidly to changes in demand for specific products will have a competitive advantage.**

## Reducing Risk

Any discussion of processing operations must include protecting worker safety, community health, and the environment. The industry is well aware that incidents can result in loss of life, environmental damage, damage to reputation, fines, and loss of production. For BP, key performance indicators (KPIs) tied to remuneration for 2014 and 2015 include tier one process safety, reportable recordable injury rate, and loss of primary containment. ExxonMobil's objectives for refining and chemicals are to reduce emissions and minimize environmental impact.

## Approach

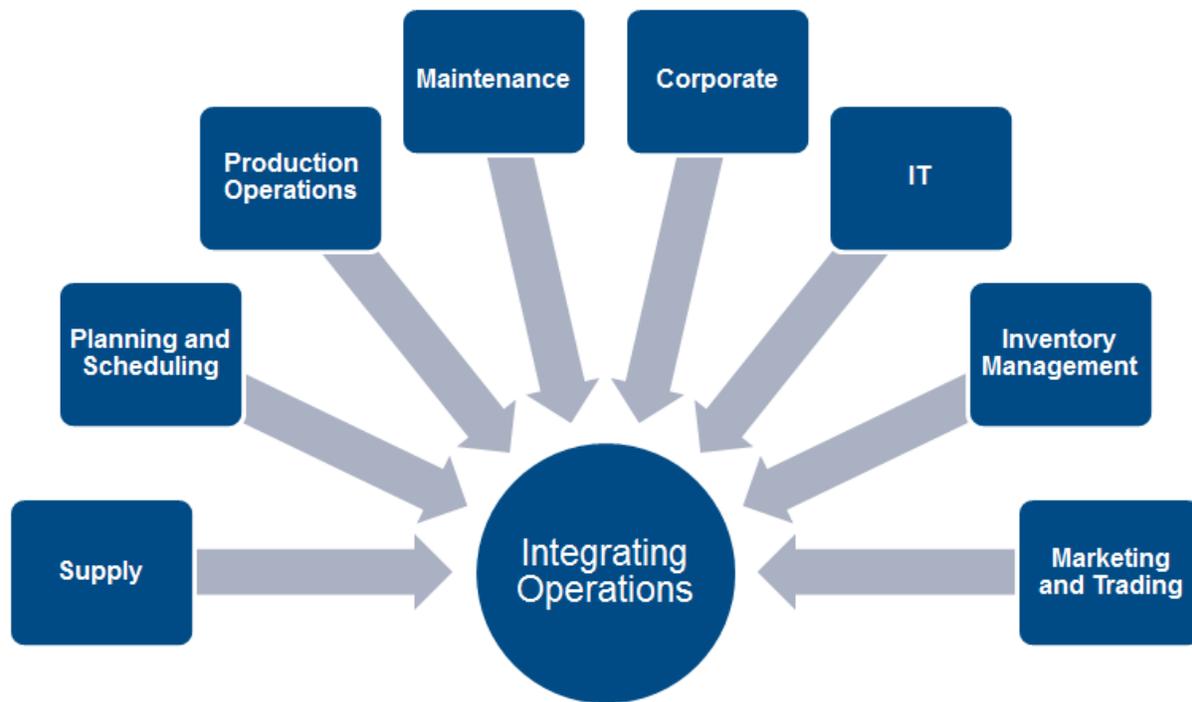
Best-in-class companies seek to integrate operations at refineries, gas processing plants, and petrochemical facilities. Integration creates benefits to shareholders in reduced costs and to customers in improved product quality and delivery. According to one company, "We've been looking at the vertical side but also the horizontal ... where it goes across the business and we can achieve improved processes but also where we can ... save costs at the same time, so looking at what they call heterogeneous business processing, where we can sit across the whole of the business in total ... through refining all the way through to [sale to] ensure we post the same quality processes and look at where we can optimize the end to end." In another situation, a midtier LNG firm with refining and processing capabilities said, "Improved processes across the entire estate would allow us to cut costs and return improved shareholder value."

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Integrating operations for downstream means managing outputs in the context of market demands; costs, especially feedstock costs; and risks to health, safety, and the environment. An end-to-end approach consists of vertical and horizontal business process integration across the value chain from feedstock acquisition to marketing and trading (see Figure 5). Executing this strategy depends on having the governance, business process, and technology in place.

FIGURE 5

## Integrating Operations



Source: IDC Energy Insights, 2015

### Governance

Clear governance backed by top levels of the organization supports optimization. In the absence of corporate governance, business units will work at cross-purposes. For example, if marketing wants 100% demand fulfillment, then supply needs to have inventory on hand. From a financial standpoint, the holding of inventory may not be optimal for the company as a whole. Governance percolates throughout the organization, supporting consistent approaches at each level of the organization. This approach is important for alignment of executives on the objectives and across business units in conjunction with IT.

Governance involves both operational technology (OT) and IT. Plant operations are supported by a combination of OT – programmable logic controllers, distributed control systems, manufacturing execution systems, SCADA/control systems, and so forth – and IT business applications – enterprise asset management, inventory and materials management, enterprise resource planning, and supply chain, plus health, safety, and environment (HSE). More emphasis is being placed on the integration of OT and IT to support autonomic processes, as well as supply of OT real-time data for decision making in a number of areas, including capital investment planning and maintenance scheduling. OT and IT governance establishes rules about enabling the use of data while protecting the security of the systems.

## Business Process

Efficiencies and optimization require integration across the business units, through integration of applications, and through workflow. In fact, many of the business processes cross organizational boundaries. Table 1 displays selected business processes to be considered.

**TABLE 1**

### Subprocesses Feeding the End-to-End Feedstock to Marketing and Trading Process

Subprocess	Sub-subprocess	Functions
Feedstock to product	Planning and scheduling operations	Planning, production operations, marketing
Feedstock to product	Securing feedstock	Accounting, procurement, marketing, production operations, trading, scheduling, quality, supply
Feedstock to product	Delivery and receipt	Trading; scheduling; planning; production operations; health, safety, and environment (HSE); quality
Feedstock to product	Production process (input to output)	Production operations, HSE
Asset monitoring to resolution	Energy management	Production operations, accounting
Asset monitoring to resolution	Planning and scheduling work	Maintenance, accounting, production operations, HSE
Product to market	Marketing and trading	Trading, marketing, accounting
Product to market	Output to delivery	Scheduling, planning, production operations, HSE, quality

Source: IDC Energy Insights, 2015

## Technology and an Emphasis on Analytics

The technology currently exists to support integrating operations – integrating applications, enabling collaboration, establishing workflow, and providing access to information for tactical and strategic decision making. Application integration and workflow are mature technologies. For financial and operational management, best-in-class companies are working toward an analytics platform for role-based access to business intelligence tools (dashboards with KPIs such as production uptime, system availability, production levels, quality, plan versus actual). For agility, advanced analytics (optimization, simulation, prediction) guide operational decision making based on product demand and crude availability.

Timely optimization performed through the use of advanced analytics should be based on company priorities. For example, one company in this study has a weekly iterative process between production,

supply, and marketing in which each of the business functions optimizes the data it is given and feeds the results back. According to this company, the optimal solution would be "where everyone could feed the information into a common system where they can instantly see all the impacts that would be related. If marketing changes a demand at a particular terminal, it would be nice to hit the easy button and then have it tell refining how they need to adjust their plans because marketing has an opportunity .... If we get to the point where we use common software ... [we] could shrink it to hours or instantaneous even. That's the opportunity."

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**Maturity of the Industry**

The industry today is halfway to the ideal for integrating operations. Most work to date has been done for single or regional assets. Supermajors and national oil companies are focusing on taking a manufacturing approach and moving to treat all processing assets as a global fleet.

As part of this study, five oil and gas companies with processing businesses were asked to assess their process and governance maturity in integrating operations. Most rated their process and governance maturity a 3 or 4 (see Table 2).

**TABLE 2**

**Oil and Gas Companies' Self-Assessment: Process and Governance Maturity**

	<b>Process Maturity</b>
1	Business processes are not well defined.
2	Business processes are defined in the business units across a specific function but not integrated across units or asset life cycle.
3	There are some business processes that are defined that cross business units, but most business processes are defined within the business unit.
4	Business processes are defined across business units and asset life cycle and are measured and monitored.
5	Continuous business process improvement is enabled by quantitative feedback.
	<b>Governance Maturity</b>
1	We do not have consistent governance structures for business process improvement.
2	We have ad hoc business unit governance structure to support business process improvement.
3	We have a well-supported and funded business unit governance structure to support business process improvement.
4	We have an ad hoc corporatewide governance structure to support business process improvement.
5	We have a well-supported and funded corporatewide governance structure to support business process improvement.

Source: IDC Energy Insights, 2015

Still, there are companies that have only limited access to information such as monthly access to plan versus actual production, HSE, and maintenance plans. According to one company, "There are some business processes that are defined that cross business units, but most business processes are defined within the business unit."

## FUTURE OUTLOOK

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Enabling integrated performance management across assets will be essential to competitive advantage. People, process, and technology will be expected to support best practices in plant operations and maintenance on a day-to-day basis across the fleet of assets. From an operations and maintenance perspective, integrated operations will bring together work management; maintenance, repair, and operations (MRO) supply chain management; and asset management. Decisions will be made based on market conditions and weighted corporate objectives. It will not just be the MRO supply chain that will be optimized. Integrated operations will support the energy supply chain as well. It will orchestrate preprocessing of feedstock for other assets in the fleet. More importantly, there will be great optionality in choosing feedstock and responding to market demand for products.

IDC defines *digital transformation* as the continuous process by which enterprises adapt to or drive disruptive changes in their customers and markets (external ecosystem) by leveraging digital competencies to innovate new business models, products, and services that seamlessly blend digital and physical and business and customer experience while improving operational efficiencies and organizational performance. Digital transformation including 3rd Platform technologies (cloud, Big Data and analytics, mobility) and innovation accelerators (3D printing, robotics, natural interfaces, Internet of Things, cognitive systems, and next-generation security) will become the norm in oil and gas processing. For example, industrial process simulation models will help plant operators identify opportunities to "debottleneck" certain units and increase yields. According to one company, "Digital will definitely change the business process – the refineries will work in different ways. The business processes need to adapt to the way the technology is evolving."

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## ESSENTIAL GUIDANCE

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Even without the lifting of export bands, upward price pressure is expected as low prices encourage greater consumption of refined products. This in turn will put pressure on margins. The "good times" are the ideal time to scan for future opportunities. Companies that invest in processes and technology that can adjust to market changes – demand for products and price of feedstock – will have the advantage. Especially in times of price volatility and shifting demand, processors need to standardize business processes in a way that supports continuous improvement.

### Involve Stakeholders in the Design from the Beginning

Greenfield and major expansion projects provide the best opportunity for integrating operations. In these situations, a company can start with a clean slate. Following a leadership mandate, one large joint venture greenfield refinery started during the construction stage to define process and procedure, map business processes with the assistance of IT, define the organization, write job descriptions, and recruit and train employees. A brownfield initiative requires executive backing – COO, CFO,

chief sustainability officer (CSO), and CIO – at the highest level. That type of implementation is more difficult as new processes may need to be developed and supported by intensive change management.

Whether your initiative is greenfield or brownfield, infrastructure and business applications need to be aligned with business expectations and processes. Participation of operational-level representatives from all relevant business units must come to agreement on business processes and subprocesses across the value chain. The business defines the processes, which are translated into a business map, and IT conceptualizes it. Involve suppliers and customers in planning from the beginning. In the previous example, the greenfield refinery was hampered because contracts and pricing were negotiated before business process planning began, putting pressure on the group to design a business process to conform, rather than starting from best practices.

## **Integrating Operations Can Be Done as a Big Bang or in Phases**

In-depth interviews revealed that integrating operations can be done either in a big bang – typically in a greenfield situation – or in phases. If done in phases, the initiative must have executive backing to ensure momentum is maintained and the subsequent phases proceed.

## **Engage Professional Service Firms That Can Address Processing**

Embarking on a project to integrate processes across business units can be difficult as each business unit has its own perspective, largely based on the business unit's primary functions. An independent professional service firm can provide objectivity, making it easier to bring the parties together. A professional service firm can also provide frameworks and guidance based on long-standing experience or expertise in oil and gas processing. When working with professional service firms, be actively involved in the development of the framework. Ensure that the framework is flexible enough to be managed by your company or others without constant rebuilding.

## **Monitor the Business Processes as Well as the Key Performance Indicators**

Continuous improvement should be the mantra of your organization. Going into the initiative, it is important that you build in business process monitoring in the design stage and beyond. Monitoring can help you track the quality as well as the financial impact of the processes. In the early stages of the project, one best practice company reviewed the business process map with top management on a regular basis.

## **Usability and Role-Based Access Is Essential**

Integrating operations is not just a planning exercise; it must be workable on a day-to-day basis by personnel at all levels involved with operations. This takes attention to detail so that personnel have access to the information and tools that they need to execute on their part of the business process. Transparency of the business process is important, but not all staff should have access to all information for security reasons.

## **Equip IT with the Requisite Skills**

The IT organization that supports integrating operations will likely look different from a typical IT organization. According to one company, "We're recruiting people who have been in the refining industry who are technology aware, who can interface with our systems people. So where we used to have systems people and systems analysts driving the business or working with the business, we're now having true business analyst experts within the IT department who really understand and who are people that can challenge and ask the questions."

## METHODOLOGY

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IDC Energy Insights used a combination of primary and secondary research to develop this document. Secondary review of literature on oil and gas processing was conducted. In-depth interviews were conducted with business and IT leadership from four oil and gas companies involved in oil and gas processing.

## About IDC

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