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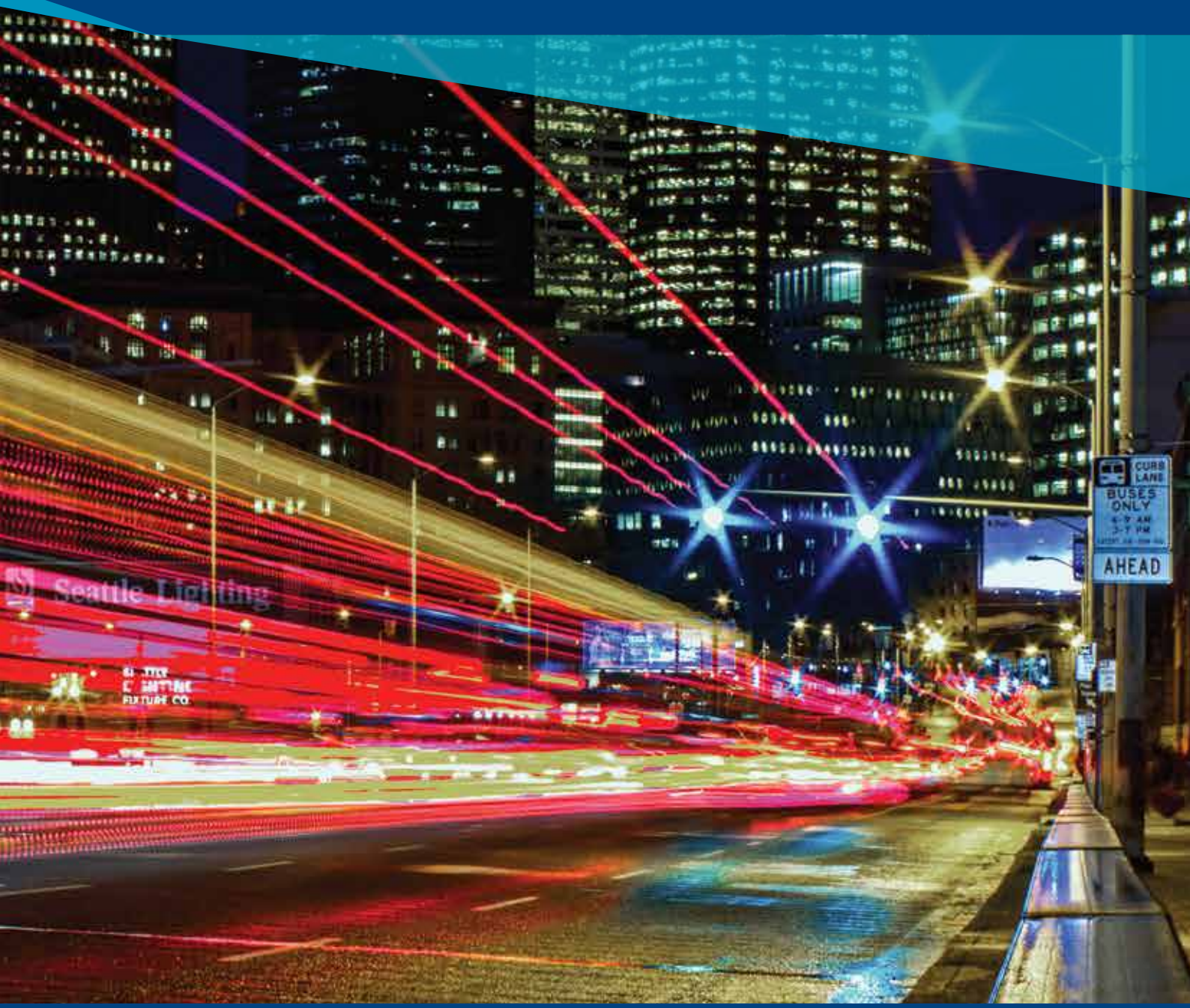


MARSH | GUY CARPENTER | MERCER | OLIVER WYMAN

MARSH & McLENNAN COMPANIES

INTRODUCTION

The energy industry stands at a historical turning point, analogous to when a global flurry of discoveries at the turn of the 19th century ushered in the modern energy industry. Barely a decade after Scottish chemist James Young set up a small business refining crude oil and Canadian geologist Abraham Pineo Gesner began installing lighting in the streets using kerosene, oil wells had been drilled everywhere from Pennsylvania to Poland, and the first modern refinery in Russia had been established in Baku. By 1881, the world's first public electricity supply was up and running, when the streets of Godalming in the United Kingdom were lit with electric light. Thomas Edison opened the world's first steam-powered electricity generating station in London and the Pearl Street power station in New York City.

Today, an outbreak of energy-related entrepreneurial innovations is unleashing a raft of new opportunities and risks that we believe will once again remap the energy industry. Major geopolitical and technological shifts will impact not just the energy sector, but also every company and every person who depends on it. With this in mind, we are pleased to share with you our inaugural issue of the *Oliver Wyman Energy Journal*. This publication reflects the latest thinking across Oliver Wyman's Energy practice concerning the macro trends and micro developments that are about to reshape the energy industry on multiple fronts.

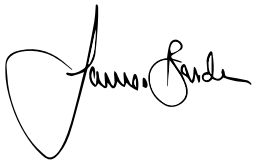
Our report starts with a discussion of how national oil companies, international oil companies and commodity traders are being forced to fundamentally alter their strategies in a much more competitive environment. We then examine how community energy initiatives are transforming power utilities and the way that potentially disruptive alternative fuel advances are about to rewrite the rules for airlines. Next, we take a look at what companies are doing tactically to turn operational and big data challenges to their advantage. Finally, we examine the risks that shortages in talent and financing pose to the industry's ambitions, as we take a look at a bold attempt currently underway in Germany to rely on renewable sources of energy.

In each article, our authors offer practical suggestions for how companies can thrive and grow their businesses in a rapidly shifting energy landscape. Our goal is to inform and provoke a re-examination of how your organization can become even more strategically and commercially successful.

We hope you enjoy reading our perspectives and that this publication sparks an ongoing and vigorous debate around these themes.

Francois Austin
Head of Energy Practice

James Basden
Head of Utilities Practice



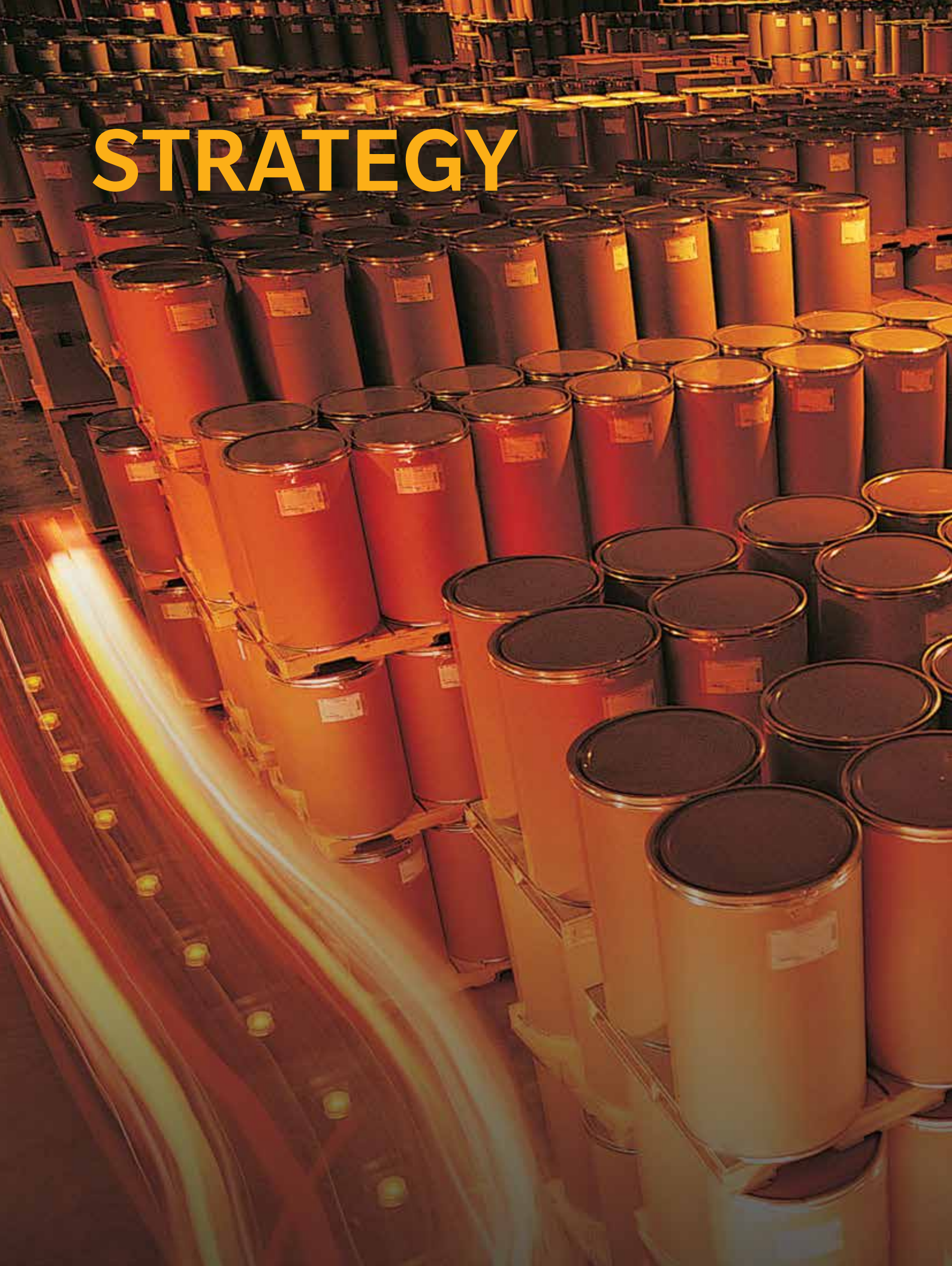
Roland Rechtsteiner
Head of Oil & Gas Practice

STRATEGY

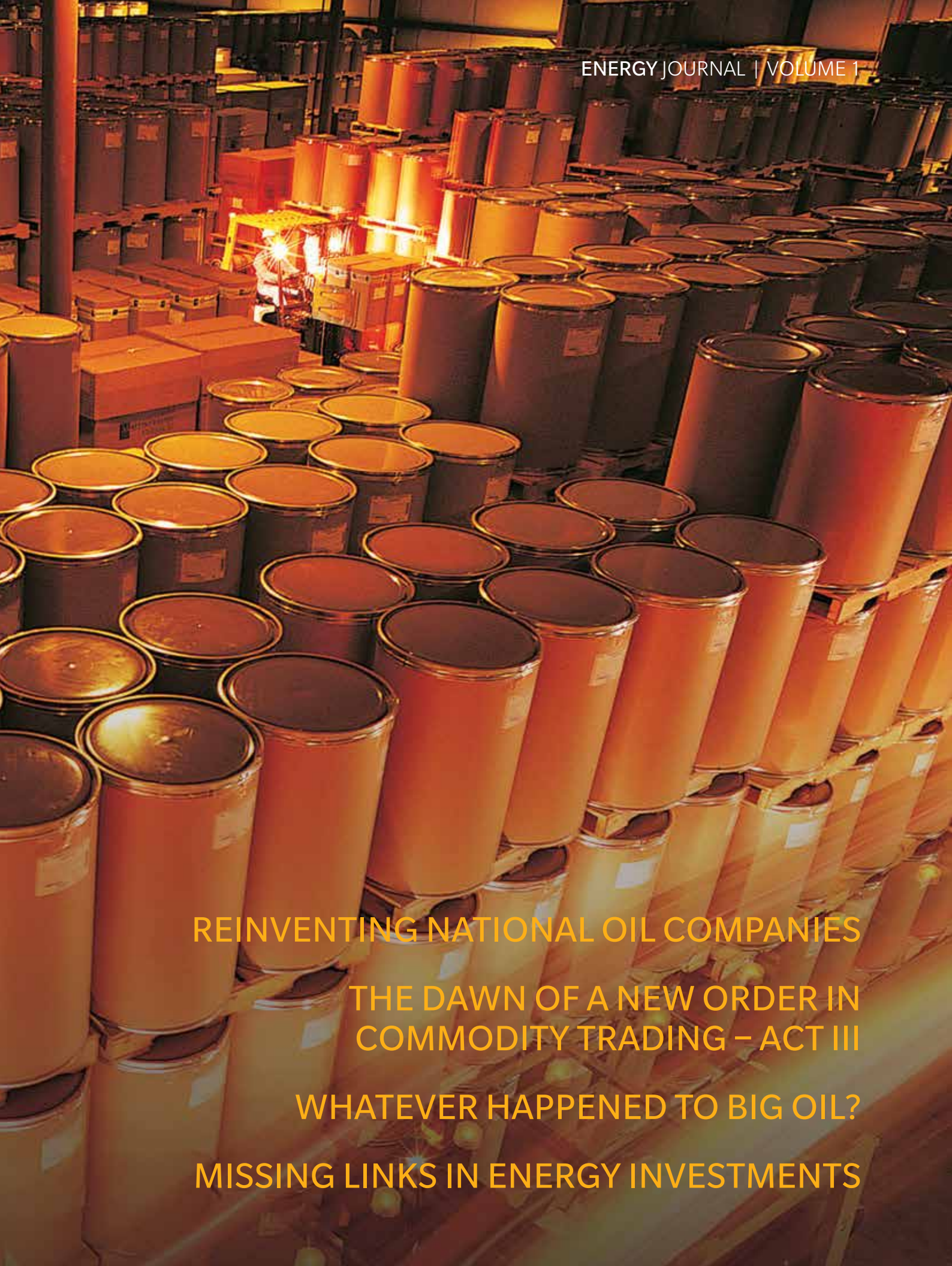
TRANSFORMATION

OPERATIONS

RISK



STRATEGY



REINVENTING NATIONAL OIL COMPANIES

THE DAWN OF A NEW ORDER IN COMMODITY TRADING – ACT III

WHATEVER HAPPENED TO BIG OIL?

MISSING LINKS IN ENERGY INVESTMENTS

REINVENTING NATIONAL OIL COMPANIES

BACK TO THE FUTURE

FRANCOIS AUSTIN
VOLKER WEBER

Many of the national oil companies that dominate today's oil and gas production – Saudi Aramco, the Iraqi National Oil Company and the Kuwait Oil Company – trace their origins back to partnerships forged with foreign investor-owned oil and gas companies at the turn of the century to develop local resources.

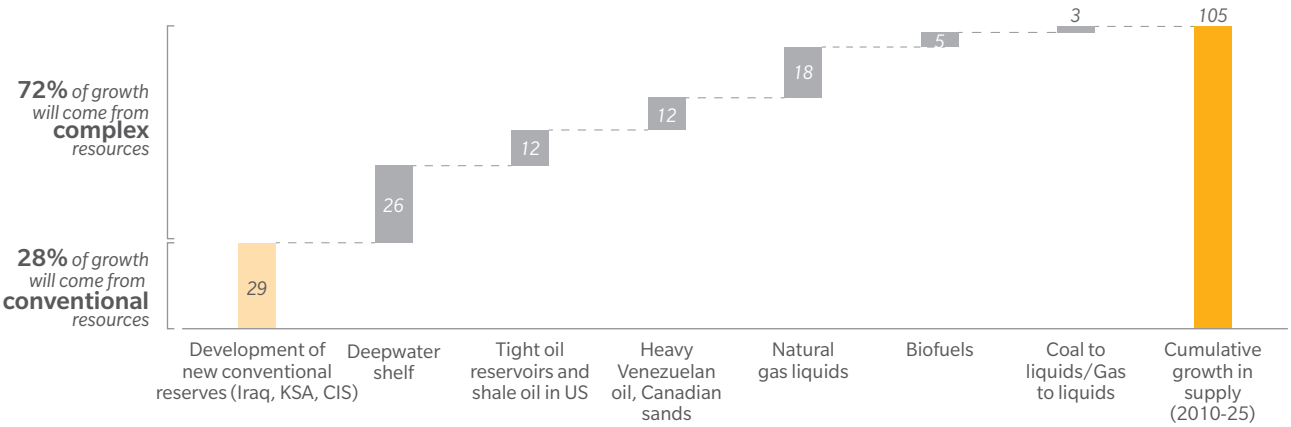
History is repeating itself now. The difference this time is that national oil companies are striking new energy partnerships with investor-owned oil and gas companies and other national oil companies to attain the global size, industrial scope and technical expertise required to manage the energy industry's rising risks. In recent months, Saudi Arabia's national oil company, Saudi Aramco, bought a 28 percent stake in a South Korean oil refining and marketing company for $2 billion. State-owned Turkish Petroleum Corp. announced that it will acquire a 10 percent interest in Azerbaijan's Shah Deniz field and the South Caucasus pipeline from Total SA for $1.5 billion. And Qatar's national oil company picked up a $1 billion stake in a Brazilian oil field from Royal Dutch Shell.

These transnational agreements are being triggered by the fact that drilling for oil and gas is becoming an exponentially higher-cost, hypercompetitive, technology-intensive business. We estimate that by 2015, more than 70 percent of the world's hydrocarbon supply growth will come from complex resources such as deepwater shelves, tight oil reservoirs, biofuels, Canadian sands and potentially the Arctic. Most oil exploration projects will have budgets of more than $5 billion; currently, only about one-third of

EXHIBIT 1: THE MAJORITY OF GROWTH IN HYDROCARBON SUPPLY IS SHIFTING TO COMPLEX RESOURCES...

CUMULATIVE FORECASTED GROWTH IN SUPPLY OF LIQUID HYDROCARBONS

IN MILLION BARRELS PER DAY, 2010–2025



Source: IEA, IHS CERA, IHS Herold, Oliver Wyman analysis.

exploration projects have budgets in excess of $5 billion. (See Exhibit 1.)

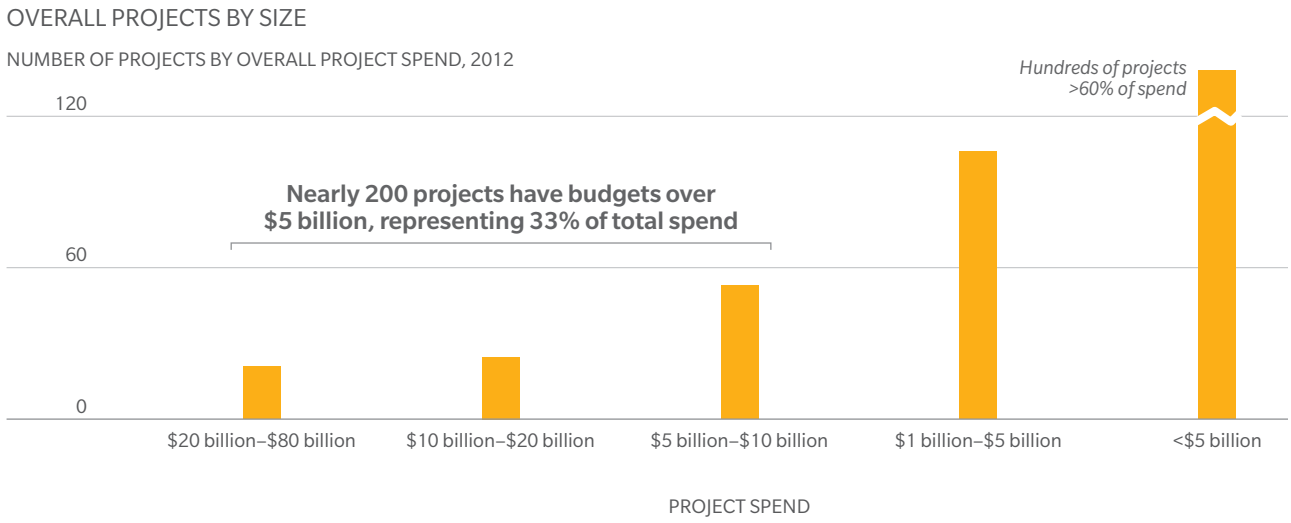
Customers' expectations are simultaneously rising as oil prices stall. Asia alone will need to import 40 percent more oil – about 30 million more barrels per day – by 2030 to keep up with rapidly growing demand. That's one reason why, over the past two years, the region's national oil companies have announced nearly $40 billion in new investments in foreign countries, according to our estimates. At the same time, customers are demanding environmentally sound energy, but they don't want to pay more for it. The result: Oil firms' profits are being squeezed as never before.

GLOBAL FOOTPRINTS

To thrive in this unforgiving environment, national oil companies must hedge their bets by developing all-encompassing global footprints in businesses ranging from offshore oil and gas exploration projects to gasoline stations. This target is achievable. China National Petroleum Corp. is active in 27 countries and has production-sharing agreements with Shell to explore, develop and produce oil and gas both in China and in West Africa.

But as the industry reshapes itself, national oil companies will be forced to proceed even further in two directions: They will have to spread their requisite tens of billions of dollars in research and development costs over a much wider range of assets, while partnering with investor-owned oil companies to reach the level of efficiency and returns on research that are needed to deliver on multibillion dollar projects globally. Today, publicly traded oil firms issue many more patents, according to our estimates, despite the fact that national oil companies invest roughly the same

...INCREASING THE SCALE AND TECHNICAL COMPLEXITY OF PROJECTS



Source: Oliver Wyman analysis.

percentage of their revenues in research and development. (See Exhibit 2.)

Many traditionally slow-moving national oil companies will have to overhaul their organizations. For the leaders, the goal will be to metamorphose into global enterprises that can nimbly respond to local challenges and manage more diversified businesses. To achieve those aspirations, they must first create robust governance structures that can manage the accompanying risks appropriately. In order to realize greater value across all of their assets, operations will need to be more globally integrated.

At the same time, national oil companies will have to apply greater discipline to each of their individual projects' risk management. National operational and safety management systems will have to become global, while risk management systems will need to cross the silos that presently exist in many organizations. Only then will national oil companies pursuing multiple initiatives grasp how much risk they are assuming overall.

By establishing local subsidiaries and centralized divisions for functions such as procurement, logistics and quality management, CNPC has made great strides toward remaking itself into a flexible, global oil giant. But no national oil company in the world considers itself sufficiently agile to meet the industry's mounting global hurdles ahead.

To reach their lofty ambitions, many national oil companies may have to weigh having less government involvement. Today, investors own 25 percent or more of only three of the world's 10 largest national oil companies, as measured in terms of production volume: Gazprom, Rosneft and Petroleo Basiliero. Managing the myriad new strategic, operational and organizational risks that will accompany ownership shifts will be difficult.

$40 billion

The amount of new investments in foreign countries that Asian national oil companies have announced in the past two years

If mismanaged, the result could be internal culture clashes or bigger problems should employees resist foreign pressure from foreign investors to perform.

EXTERNAL RISKS

National oil companies also will be forced to confront external risks outside their control. Entry barriers imposed by foreign governments, stricter health and safety requirements, potential flight of new investor capital and protests by countries' citizens against new foreign investors could all be concerns.

The first step toward getting ahead of these risks and the industry's fast-changing rules of competition is for national oil companies to develop and deliver a compelling corporate goal and financial case for their stakeholders. Before assembling complex investment portfolios, they must define their strengths and weaknesses in terms of both business mix and geography to provide a clear rationale for reinvention.

TALENT GAP

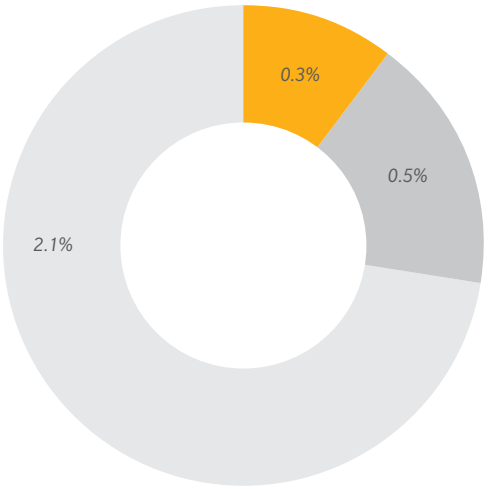
National energy industry champions must then assess and define new leadership capabilities and a change management strategy. They will need to regularly reassess and redefine their cultures and competencies for a much broader group of constituents. These new stakeholders will range from new in-house communities to new investors, regulators, suppliers and management teams. To gain an understanding of entirely new sets of customers, many firms will be forced to establish new marketing and trading operations worldwide.

In addition, long-term global workforce plans will be required to ensure that national oil companies have access to the highly skilled personnel necessary to carry out their objectives. A landmark study conducted by our sister company Mercer shows that the majority of oil and gas companies expect to experience a talent gap in petroleum and plant engineers in the next five years. (See "The Oil and Gas Talent Gap" on page 81.) If national oil companies fail to recognize and address this war for talent, they may be forced to delay major exploration and production initiatives simply because they do not have enough of the right workers.

EXHIBIT 2: NATIONAL OIL COMPANIES INVEST MORE IN RESEARCH AND DEVELOPMENT, BUT ISSUE FEWER PATENTS THAN PUBLICLY TRADED FIRMS

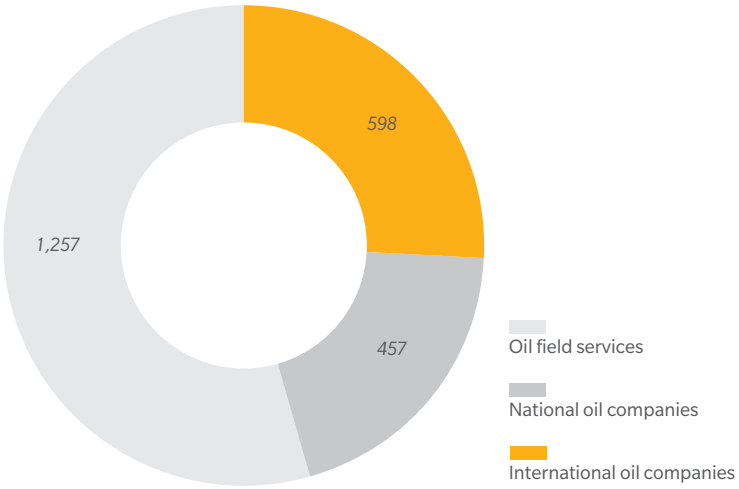
RESEARCH AND DEVELOPMENT INVESTMENTS BY COMPANY TYPE

PERCENT OF SALES, 2011



PATENTS ISSUED BY COMPANY

NUMBER OF PATENTS ISSUED, 2012



Source: FactSet, Energy Evolution, company reports, Oliver Wyman analysis.

The stakes involved in pulling off each of these transitions are high. But going it alone will only become more expensive. That's why a new network of "international" national oil companies is taking hold that will likely rewrite the rules for the energy industry over the next generation. Those companies that embrace the challenge of forging a new form of national oil company may finally close an energy gap that has persisted century after century. But this can only happen if they move to address the risks involved in attempting a major transformation in a rapidly evolving environment – now.

A new network of "international" national oil companies is taking hold that will likely rewrite the rules for the energy industry over the next generation

FRANCOIS AUSTIN
is a London-based partner and the head of Oliver Wyman's Energy practice.

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THE DAWN OF A NEW ORDER IN COMMODITY TRADING –ACT III

FIVE MEGATRENDS THAT WILL ALTER THE INDUSTRY

ALEXANDER FRANKE
ERNST FRANKL
ROLAND RECHTSTEINER
GRAHAM SHARP

Since 2011, oil prices have traded in a narrow band of around $100 per barrel in spite of a series of disruptions that in another era would have triggered significant price spikes. In Libya, rebels took over the government of the fifth-largest holder of proved oil reserves in the world. An anti-government uprising in Syria shut off more than one-twentieth of global oil production. South Sudan lost one-third of its oil production to fighting that damaged its oil wells.

Commodity markets are repeatedly shrugging off shocks for a simple reason: The world is oversupplied with everything from crude oil to coal to natural gas, everywhere from the United States to China to Siberia.

But it would be a mistake to be lulled into a false sense of security. Behind this benign excess, the commodity trading environment is changing radically, introducing new challenges and opportunities for traders, industrial companies and consumers worldwide. In our view, these new trends could potentially spark market disruptions, higher

levels of commodity price volatility and fundamentally alter the way commodity trading markets work in the future.

As we predicted in "The Dawn of a New Order in Commodity Trading" acts I and II, which appeared in the *Oliver Wyman Risk Journal* in 2012 and 2013, respectively, commodity traders, which traditionally leased or borrowed their assets, continue to invest in assets ranging from coal mines to storage terminals to gasoline retail chains.

Recently, traders have been increasingly trying to secure "structural shorts," the industry term for long-term sales contracts. Given that there is a glut in almost every type of commodity and the fact that they have built out extensive portfolios to capture a wide range of options, traders need to lock down stable sources of demand around which supply positions can be structured and optimized.

Historically, traders could achieve this by simply entering long-term sales contracts for a commodity. But in the current competitive environment, they must organize financing for asset investments, take equity stakes in their counterparties, or provide some form of expertise in areas such as financial risk management or technical blending to convince customers to enter such deals.

Take the example of independent trader Vitol. Since 2011, Vitol has paid billions of dollars to buy multiple assets from Shell, ranging from 870 service stations and a refinery in Australia to 1,185 retail stations and 900,000 cubic meters of storage in Africa. Vitol went so far as to agree to invest in and switch a power plant from fuel oil to liquefied petroleum gas for the US Virgin Islands' Water and Power Authority in order to secure LPG orders for seven years.

As commodity markets continue to shift, five new trends are accelerating, which we believe will change the face of the commodity trading industry. These megatrends will either unlock new avenues for growth for trading firms or become a potential cause for their undoing.

Predicting how each of these developments will play out depends on the reactions from market participants, policymakers and rating agencies. In this article, we examine three of the most likely potential scenarios from across a wide spectrum of possibilities. In our view, every company that produces, consumes or trades commodities should carefully review its strategies against these three potential courses of events.

But before moving on to describe those three scenarios, let's first examine the five trends that are rewriting the rules.

FIVE MEGATRENDS

TREND 1
COMMODITY MARKETS MATURE

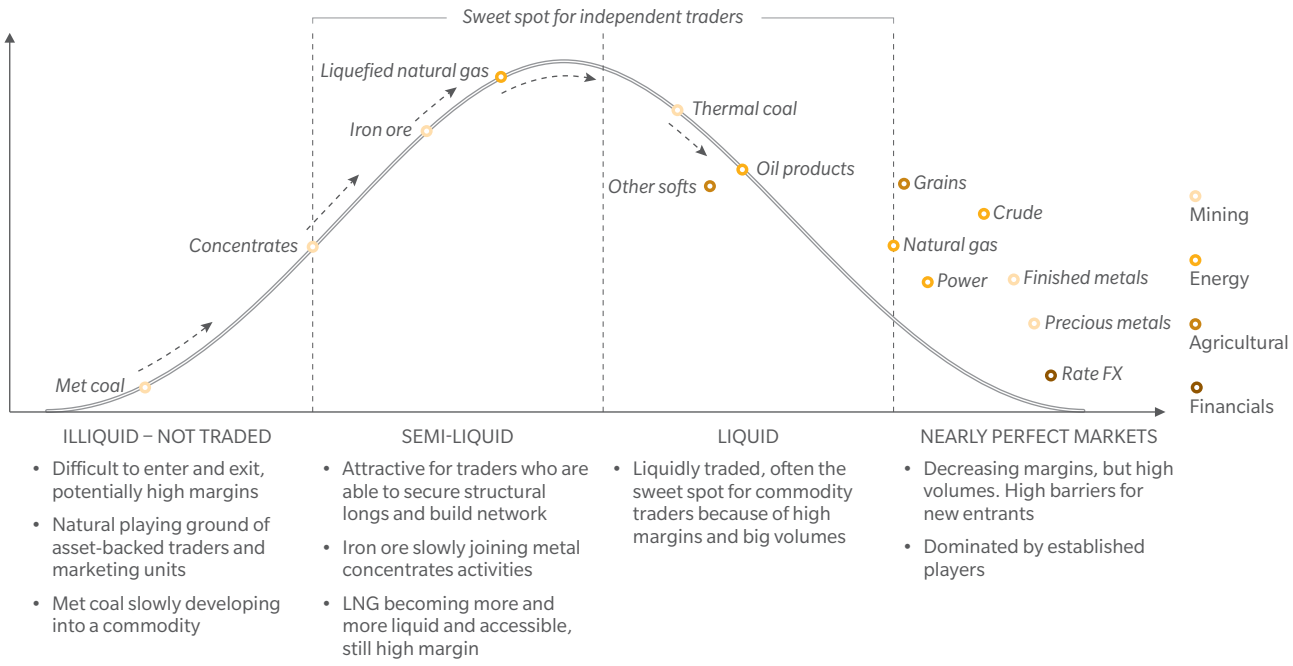
Traditionally, independent commodity traders earned their greatest profits from supplying commodities that could not be accessed easily on open markets. But now, many of these commodities are traded on markets that are transparent and liquid. (See Exhibit 1.)

As a result, traders can no longer act simply as intermediaries without the risk of losing market share. Transparent markets are also shrinking their margins. As recently as five years ago, traders earned margins of $3 to $5 per ton using long-term fixed price

EXHIBIT 1: TRADING MARKETS MATURE

SOME COMMODITIES TRADED MOST PROFITABLY BY INDEPENDENT TRADERS ARE MOVING OUT OF THE "SWEET SPOT"

TRADING ATTRACTIVENESS (MARGIN AND VOLUME CONSIDERATIONS)



Source: Oliver Wyman analysis.

arrangements to supply thermal coal. Now that thermal coal has become a much more widely traded commodity with transparent price benchmarks and indexed pricing, we estimate those margins have shrunk by 40 percent on average, to as little as $1 to $3 per ton.

TREND 2
BANKS EXIT COMMODITY TRADING

Since United States President Barack Obama signed the Dodd–Frank Act into federal law in 2010 and European Basel III/CRD IV regulations placed restrictions on banks' proprietary trading, nine of the world's 10 largest Western banks that have been active in physical commodity trading have made moves either to withdraw from commodity trading completely, or to curtail their activities drastically. Ten other smaller banks have exited as well.

The impact of these moves on market liquidity has varied. Exchange-traded derivative markets for widely traded commodities such as oil remain robust because the remaining participants picked up the business left by those players who have departed. A few commodity trading teams also relocated from banks to hedge funds and other trading houses.

But hedges are scarce in niche markets, especially for longer-term trades. We believe hedges will be in short supply in more

markets going forward, which could lead to rising hedging costs for producers and consumers. Ultimately, consumers will bear the brunt of these higher costs.

TREND 3
NEW MARKET STRUCTURES ARE FORGED

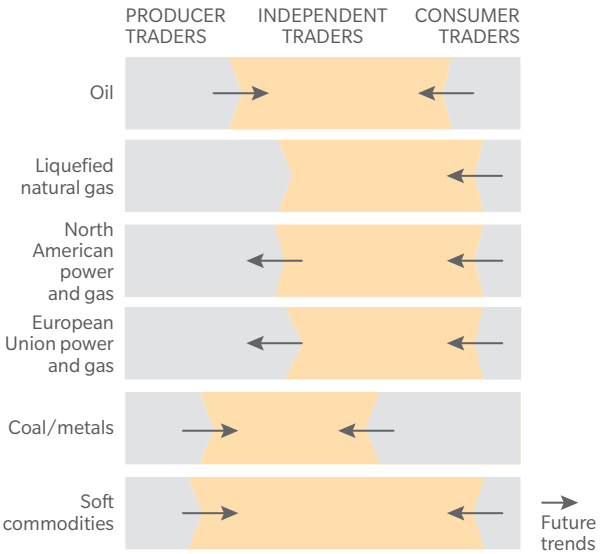
The commodity trading market is a three-tiered structure made up of producers, commodity traders (including intermediaries such as banks) and consumers. Today, the balance between producers, traders and consumers differs considerably across commodity classes. Metals and minerals markets are dominated by a few big players, while the markets for oil, power and gas are fragmented, with many participants.

In the next several years, we predict the structure across commodity markets will become more homogeneous. Players will enter those markets where they can create significant value from their existing positions and exit those where global scale is increasingly important.

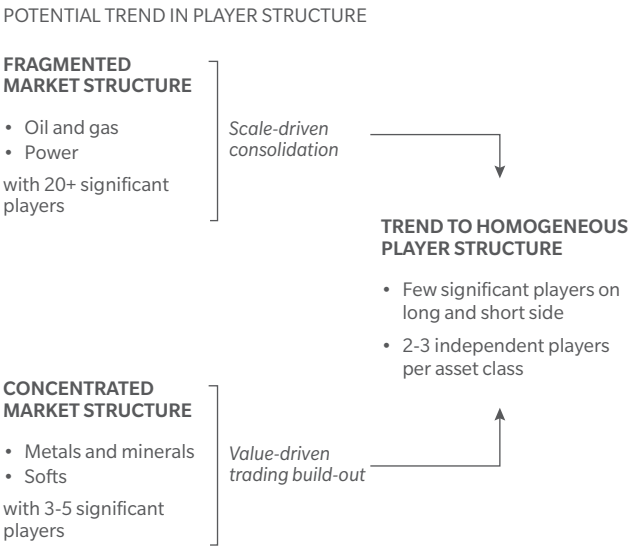
This new structure is already manifesting itself in multiple markets. Large commodity producers, such as oil majors and national oil companies, are increasingly establishing trading activities so that they can monetize their upstream production and gain greater control over their value chains. By contrast, smaller power producers are reducing their trading activities and leaving trading to larger players.

EXHIBIT 2: HOMOGENIZATION OF MARKET PLAYER STRUCTURE

MARKET STRUCTURES ACROSS COMMODITIES WILL FURTHER HARMONIZE, LEADING TO A THREE-TIER MODEL



MARKET PLAYER STRUCTURE WILL BE MORE HOMOGENEOUS IN THE FUTURE, ON THE BACK OF SCALE REQUIREMENTS AND VALUE-DRIVEN TRADING BUILD-OUT

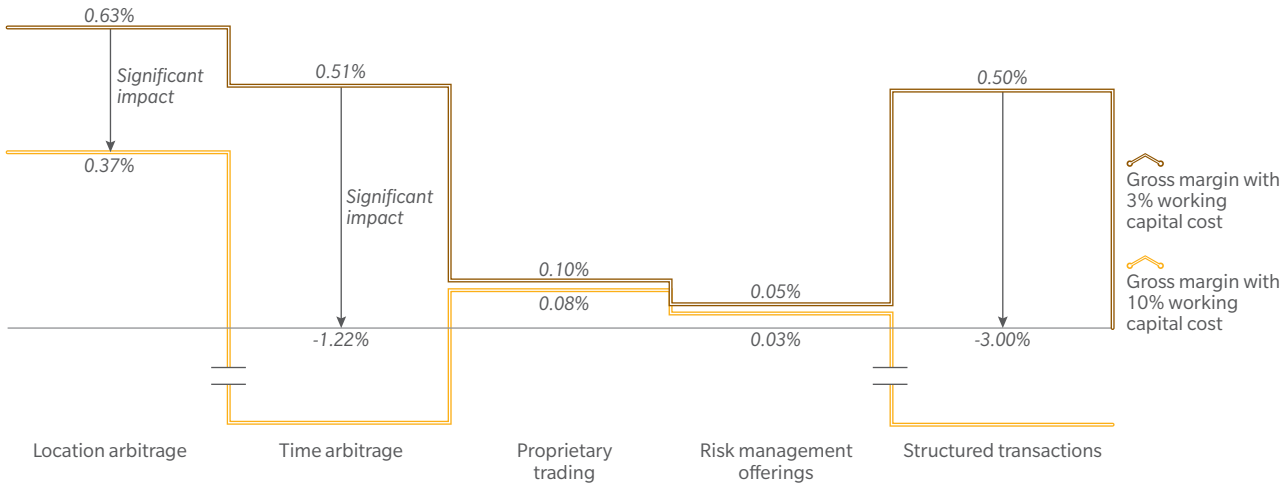


Source: Oliver Wyman analysis.

EXHIBIT 3: COMPRESSED MARGINS

STANDARD TRADING PLAYS WILL BECOME SIGNIFICANTLY LESS ATTRACTIVE IF TRADERS ARE CHARGED MORE FOR WORKING CAPITAL

IMPACT OF A CHANGE IN WORKING CAPITAL COST ACROSS STANDARD DEAL TYPES



Source: Oliver Wyman analysis.

Major soft commodity consumers, too, that have critical mass in one or more commodities, are becoming more active traders. More Chinese companies are building up trading businesses that can source foodstuffs from a broader network of suppliers instead of buying farmland in foreign countries. Global packaged consumer goods companies are following the lead of competitors with substantial trading businesses, such as Unilever and chemical giant BASF.

But independent trading players and smaller producers, which make up the market's middle tier, continue to be under pressure. In fact, we predict that soon only two to three will remain due to an increasingly cutthroat environment. Fewer traders that specialize in a single commodity class will prevail. (See Exhibit 2.)

TREND 4
PRICE SPIKES RESULT FROM CHANGING METRICS

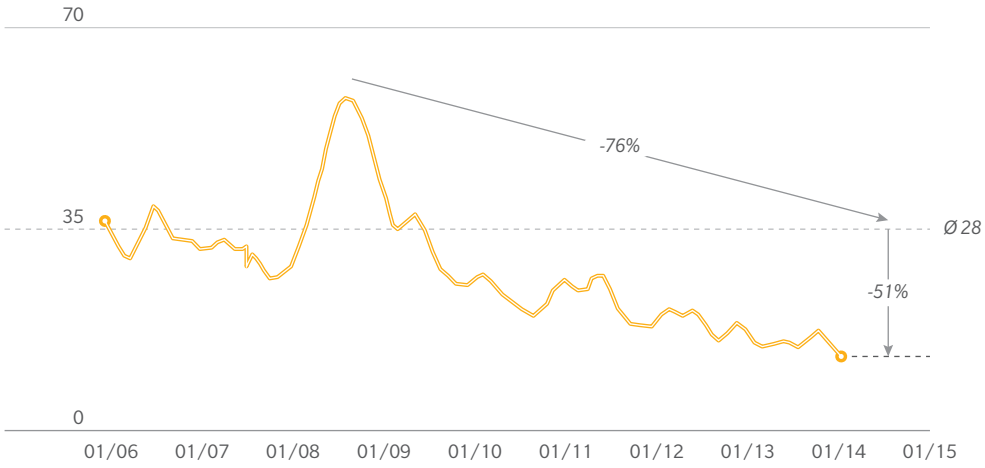
Since independent traders require more long-term capital to acquire assets, they are issuing more bonds and attracting greater attention from rating agencies. These agencies, in turn, are evaluating the independent traders' activities based on the expected returns from their total capital employed – instead of just their returns on equity.

Commodity price spikes will likely become more common in reaction to this basic shift in how potential returns from trades are evaluated. By taking the increasing amount of debt associated with trades into account, rating agencies are driving up the cost of traders' capital. These higher costs harm the margins of some of the industry's more traditional trading strategies, which have

EXHIBIT 4: LOW VOLATILITY

VOLATILITY IS CURRENTLY AT HISTORIC LOWS

AVERAGE ROLLING 60 DAYS IMPLIED VOLATILITY FOR KEY ENERGY FUTURES*
(PERCENT YEARLY STANDARD DEVIATION)



Source: Reuters, Oliver Wyman analysis.

* Average includes: Brent, WTI, ICE Gasoil, RBOB, ULSD, NatGas HH, Nat Gas NBP.

been critical to smoothing out demand and supply imbalances.

As a result, independent traders have significantly less incentive to make volumes of inventory readily available to resolve supply disruptions. If their capital costs rise by seven percentage points, we estimate the gross margins for trades associated with holding inventory could be cut by 50 percent or more on average. The gross margins on complex, structured trades, such as fixed-price supply agreements, could be reduced even more. (See Exhibit 3.)

TREND 5
LOW COMMODITY PRICE VOLATILITY HARMS SUPPLY SECURITY

The volatility of energy commodities has dropped to a historic low and is now about 50 percent below its long-term average. (See Exhibit 4.) An overabundance of supply is shredding traders' margins, forcing them into riskier, more capital intensive and complex deals. Traders are also abandoning some markets or reducing their activities, resulting in less available liquidity. Consequently, there is a higher probability of severe supply disruptions that could cause price spikes if supply or demand suddenly shifts.

Although the reasons for change and rising risks in the commodity trading landscape are clear, their consequences are complicated, and there are no simple solutions. Nonetheless, we have identified three illustrative scenarios that outline possible developments. Movement from one scenario to another can occur depending on regulatory or market reactions to these occurrences. (See Exhibit 5.)

THREE SCENARIOS

SCENARIO 1
TRADING IS NOT WHAT IT USED TO BE

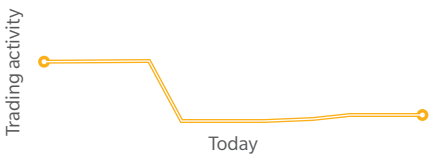
If the present levels of low commodity price volatility continue and present regulations and accounting rules remain in place, there is a significant risk that players currently active in the markets that are filling the void left by the banks will also eventually have to reduce their activities. The overall profitability from trading will be minimal. Independent commodity traders, consumers and producers will easily be able to find more promising and higher-returning uses for their capital.

The availability of hedging products and spot volumes will be limited. Market disruptions will have a greater impact on prices and supply chains. Intermediaries and their tools, such as hedges and inventory, will be missing, making it difficult for traders to smooth out imbalances in the same way that they have traditionally.

Although we believe this is the least likely of our three scenarios, it is also the one that market players most need to guard against. If it develops, there will be significant disruptions in global trade that will harm both industrial consumers of commodities and private households.

But a different scenario could materialize if these trends are mitigated by new developments. A better balance between supply and demand could be achieved if

EXHIBIT 5: THREE KEY MARKET SCENARIOS

		DESCRIPTION
"TRADING IS NOT WHAT IT USED TO BE" 	**Banks exiting the commodity trading space** **Homogenization of market structure**	• Banks leaving the market, no substitution, limited activity of independents, producer and consumer traders • Alternative usages for capital preferred • Prolonged period of low volatility
"BACK TO NORMAL" 	**Pressure on independent trader model** **Regulator changes (Dodd-Frank, Basel III, IFRS...)**	• Substitution of the banks' activities through producer/consumer traders • Alternative providers established for RM offerings and market liquidity • Increase to an average level of market volatility
"THE RETURN OF THE BANKS" 	**Commodity market dynamics and oversupplied markets** **Maturing across commodity classes**	• Change in regulation (potential for 3-4 year horizon) and/or engagement of emerging markets banks (BRIC, Singapore, Middle East) • Banks in commodities trading supported by consumer/producer traders • Increased market volatility

Source: Oliver Wyman analysis.

rating agencies treat marketable inventory and short-term debt differently than they do today. Market volatility could also return to its long-term historic average.

SCENARIO 2
BACK TO NORMAL

The combination of commodity price volatility returning to a long-term average and a different treatment of marketable inventory by rating agencies will make commodity trading markets more attractive. In response, commodity producers, consumers and new investors will become more active, replacing banks that have exited from commodity trading.

Established physical players will build up banklike risk management and product structuring offerings. This will enable them to offer risk management solutions to their clients and act as market makers. The result could be a well-functioning market, very similar to today's, with different players providing the cushion for short-term market disruptions and longer-term risk management solutions.

Participants who believe in this scenario have a strong incentive to build up product structuring and risk management capabilities now in order to be prepared and position themselves as the go-to players. Companies that cannot determine which of the two scenarios is more likely to occur should build the core set of capabilities and then be prepared to scale them depending on market developments.

However, it is also possible that the trading sector will grow in the future. If that happens, banks might return to the arena.

SCENARIO 3
THE RETURN OF THE BANKS

When American and European lawmakers placed restrictions on banks that encouraged them to exit from the commodity trading business, their goal was to avoid another Great Recession by stabilizing banks and the financial system overall. They also aimed to discourage speculative trading that could drive up consumer prices.

However, there is a risk that their efforts may have the opposite effect. We believe commodity prices will soon be more vulnerable to sudden disruptions than they have been over the past decade, and will remain so for the foreseeable future.

As a result, when there are disruptions, markets will experience more "spikes," which will have a greater impact on the real economy and consumers over the next several years.

Regulations may need to be revised to permit banks to re-enter the commodity trading business to provide market liquidity and a risk management offering to industrial corporations in the Western developed markets. Banks in less-regulated emerging markets (such as Asia or the Middle East) that are not subject to these restrictions will likely become major players in their own right. They will support the trading operations of commodity producers and consumers, starting with local trading firms.

We believe that this scenario will potentially materialize over time as a consequence of Scenario 2. Companies that position themselves well for the first two scenarios will benefit. If banks re-enter commodity trading, companies that have stepped in to provide the services traditionally provided

by banks will have a strong market position by then and may consider expanding further through joint ventures or other forms of cooperation with banks.

GAINING CONTROL OF RADICAL CHANGE

Radically shifting business landscapes can stymie capable companies when they fail to understand what is happening around them and why. But managers who take the time to grasp potential paradigm shifts have been known to turn the changes into opportunities for growth.

The trends and scenarios that we have presented in this article are not only relevant for the firms currently engaged in commodity trading. Every company that makes use of commodities, whether as raw material or in processed form, will feel their impact. Consumers may also confront periods of increasingly volatile prices for gasoline, power and other commodities.

Consequently, understanding these developments and preparing for their potential ramifications can assist a wide variety of companies to gain a competitive advantage and to grow their margins more than their more passive competitors. At a minimum, we recommend that every company that trades, consumes or produces commodities should evaluate its current capabilities and strategic position in light of the trends and scenarios described.

Management teams should ask themselves three critical questions:

QUESTION ONE
What is the scenario, or series of scenarios, that I believe is most likely?

QUESTION TWO
What capabilities am I missing to be one of the players who thrives in this scenario?

QUESTION THREE
Do I want to invest in building these capabilities in order to strategically position myself for this potential development?

The companies that openly and critically engage in this debate will be the future market leaders. They will be prepared to seize the opportunities created by new developments. Others may be caught by surprise when a situation suddenly transforms the commodity markets as they have come to know them.

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WHATEVER HAPPENED TO BIG OIL?

OIL MAJORS NEED A NEW PLAN TO OUTPERFORM OIL PRICES

FRANCOIS AUSTIN
FERGUS MACLEOD
ROLAND RECHTSTEINER

Oil prices have quadrupled since 2001. But many of the world's largest international oil companies have not kept pace. Instead, their operating cash flow has only doubled over the same period. And most of their stock market valuations have trailed even further behind, underperforming the broader stock market as a group by about 65 percent. (See Exhibit 1.)

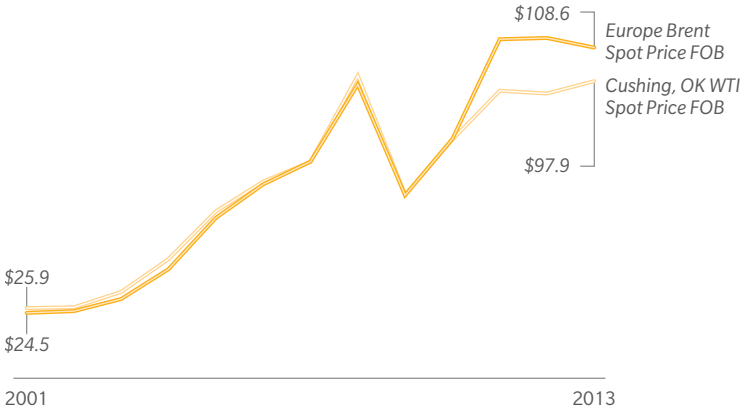
There's an important lesson for oil and gas firms here – but it may not be what you think. Most international oil companies are no longer capturing the value of rising commodity prices for shareholders, especially oil prices. That new development alone should set off alarms in the executive suites of international oil majors, since it potentially undermines the reason why most investors want to own stakes in them.

But the bigger lesson is that oil and gas firms urgently need either to break apart or become more vertically integrated. Those are two key ways they can deliver value to their shareholders commensurate with rising commodity prices, and remain the leaders of their industry going forward. Business models that straddle the middle ground don't seem to be working.

EXHIBIT 1: THE OIL MAJORS' DILEMMA

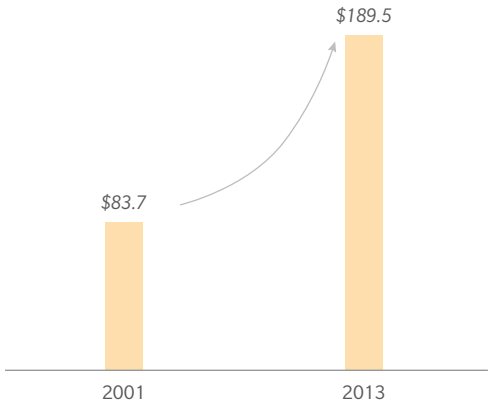
OIL PRICES HAVE QUADRUPLED...

DOLLARS PER BARREL



...BUT OIL MAJORS' OPERATING CASH FLOWS HAVE BARELY DOUBLED...

US$ BILLION



Source: Thomson Reuters: Datastream, Oliver Wyman analysis. Calculations reflect the world's six largest international oil companies.

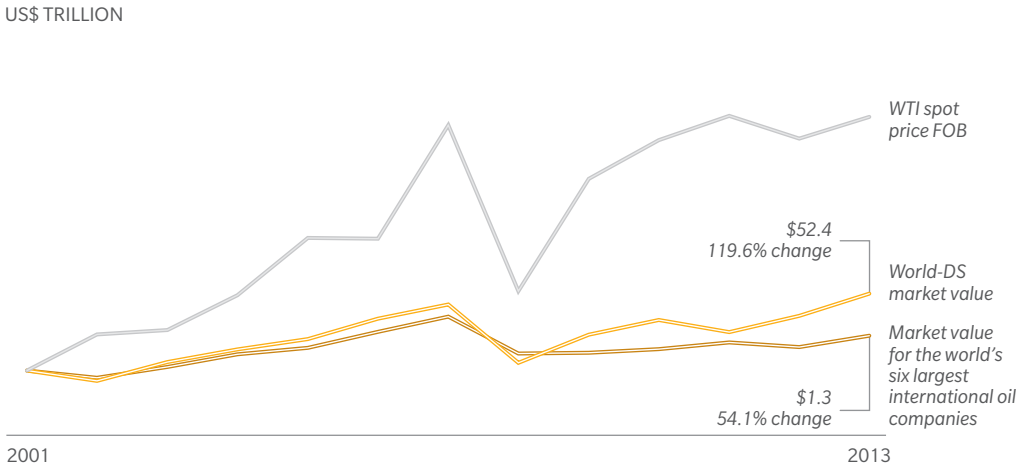
MIGRATING VALUE

The value created from oil field development is migrating to oil field services companies. At the same time, volume, which has been the favorite measure of growth for international oil companies, is becoming an unreliable indicator of growth in value for shareholders. The traditional correlation between the market valuations of most of the international oil companies and volume is breaking down as more natural gas is traded at a discount to oil prices, fewer petroleum supply agreements are structured around oil prices and the amount of capital required to renew a unit of production continues to expand.

The relationship between depreciation and capital expenditures is also fundamentally changing, making historic earnings almost meaningless. Until 2000, international oil companies expended roughly as much capital as their assets depreciated. But since then, their capital expenditures have increased by five times, while depreciation has risen by only half as much. (See Exhibit 2.)

Sooner or later, all that extra capital will have to be depreciated, a factor that is creating a potential new moral hazard for an industry that has been issuing distributions to shareholders based on historic earnings. Many oil majors have paid dividends to shareholders that have met or exceeded their combined cash flow remaining after capital spending – or free cash flow.

...AND THEIR STOCK MARKET VALUATIONS HAVE LAGGED THE BROADER STOCK MARKET



Source: Thomson Reuters: Datastream, Oliver Wyman analysis.

So what steps should the supermajors take?

INTEGRATE...

First, they should divert cash flow from capital spending and direct it back to shareholders. Due to the false signal of rising oil prices, capital spending is spinning out of control. More capital is being committed to high-stakes projects. But the hurdle rates to achieve returns on these megaprojects are higher than is generally recognized when adjusted for their greater inherent risks (including cost overruns and delivery delays), especially in today's increasingly fractured geopolitical environment. These projects may also suffer from a higher failure rate than in the past, in part because the chronic hollowing out of experienced workers and managers has made it more difficult for oil and gas firms to oversee contractors. (See "The Oil and Gas Talent Gap" on page 81.)

Supermajors should also seriously consider investing in a wide range of assets from which they can create value, ranging from oil exploration projects to oil field services. Doing so will require oil majors to forge new paths to make intra-business investment decisions now that oil exploration projects may no longer deliver the highest returns. In the past, an oil exploration investment would not be compared to other types of investments. But in the future, they may need to be.

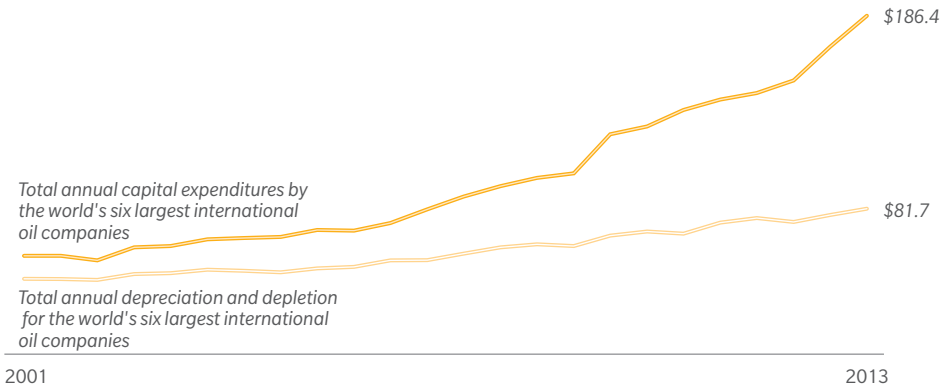
2x

How much the operating cash flow of international oil companies has risen since 2001

EXHIBIT 2: THE OIL MAJORS' DILEMMA

THE RELATIONSHIP BETWEEN CAPITAL EXPENDITURES AND DEPRECIATION FOR MOST INTERNATIONAL OIL COMPANIES HAS FUNDAMENTALLY CHANGED...

US$ BILLION

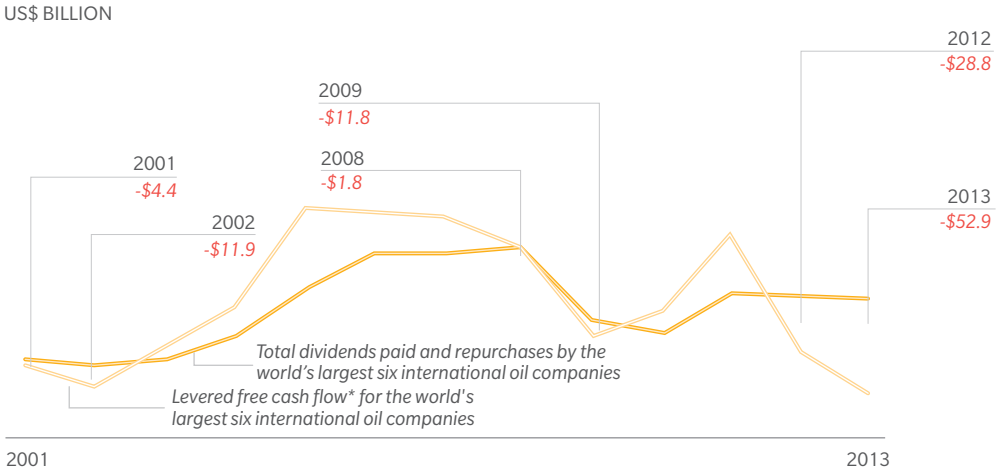


Source: Thomson Reuters: Datastream, Oliver Wyman analysis.

...OR DISINTEGRATE

Finally, international oil companies could divide up their business portfolios and put some of their assets up for sale. As more oil and gas firms attempt to expand their reach into more types of businesses, they are driving up the valuations of everything from gasoline stations to oil field service equipment. It may make sense for some supermajors to unlock

...AND MANY ARE PAYING DIVIDENDS TO SHAREHOLDERS THAT MEET OR EXCEED THEIR FREE CASH FLOW



Source: Thomson Reuters: Datastream, Oliver Wyman analysis.
* Levered free cash flow is defined as the amount of cash left over for stockholders and for investments after all obligations are covered.

value by selling some assets that do not work together or that could realize greater value by being combined with others to achieve economies of scale.

There is a historical precedent for following such a strategy. Seventeen years after the Standard Oil Company was dissolved in 1911, the total market value of the 30 surviving companies of the 33 that were divested had market valuations that were more than five times higher than the original company.

As the business landscape for oil and gas firms radically shifts, supermajors face difficult choices. But they are not impossible, and many companies are already taking action. The industry is in the throes of extreme change – and that calls for extreme measures. The sooner the Big Six can make the profound strategic and operational changes that will enable them to create greater value in a higher-stakes world, the better.

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MISSING LINKS IN ENERGY INVESTMENTS

A PORTFOLIO MANAGEMENT STRATEGY TO MAKE INVESTMENTS WORK

MARK PELLERIN
YANNIK THOMAS

Confronted with tighter profit margins and greater risks, energy executives are under more pressure than ever to deliver higher returns from their business portfolios. Consider: The return on invested capital at energy companies has been nearly halved on average, from 20 percent to 11 percent, over the past decade.

In response, companies are now weighing investments aimed at improving their performance. In the first half of this year alone, energy companies announced 1,479 mergers and acquisitions worth $218 billion, according to Dealogic.

But there is a real risk that energy companies will end up in the same predicament, if not worse off, unless they take a fundamentally different tack to evaluating investments.

Standard investment opportunity assessment tools based on hurdle rates (determined by weight-adjusted costs of capital) are proving to be flawed for several reasons. First, non-financial risk, which often accounts for more than half of net exposure, is not captured as part of cost of capital calculations. (See Exhibit 1.) Second, there is a tendency for energy majors to make capital allocation decisions on a

stand-alone basis, as opposed to examining their impact on their entire business portfolios. Third, many companies lack the capability to simulate their future corporate portfolio's performance under a range of market and strategic scenarios.

A PATH TO PROFITABILITY

We contend in this article that companies will only discover the surest path to profitability for their entire business portfolio if they address these three shortcomings in their investment analysis. A case in point is energy companies. Many appear to have grown their portfolios too quickly, inhibiting their ability to integrate new businesses and reducing their returns on invested capital.

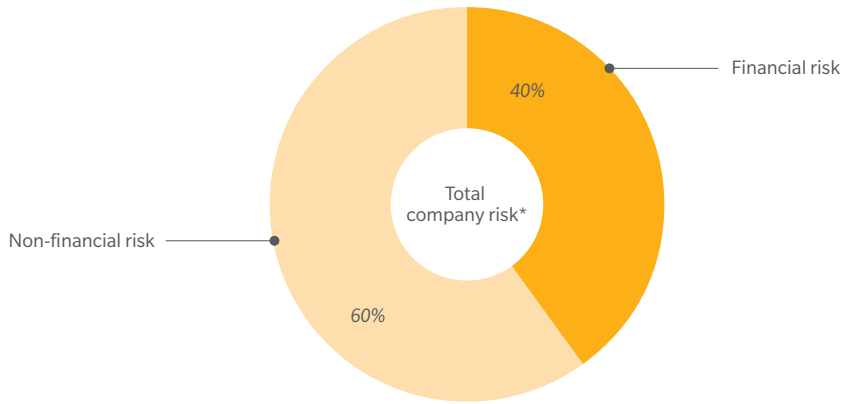
Indeed, when we examined the risk-return profiles of energy companies that make up the Standard & Poor's 500 index over a five-year time horizon, we discovered that the companies that more actively managed their portfolios by making greater capital expenditures or divestitures did not achieve superior returns. We estimate that 95 percent of these energy companies have the potential to improve their portfolio returns by at least three percentage points without assuming additional levels of risk if they follow the four steps outlined below. (See Exhibit 2.)

These results underscore the fact that companies must do much more than identify attractive assets. They must also prepare themselves for operating and managing the risks that accompany them. But before we examine potential solutions to these challenges more closely, let's look at why examples of the three blind spots mentioned above matter to the future of the energy industry.

BLIND SPOT #1
NON-FINANCIAL RISKS

Nuclear power generation is a sector that is subject to non-financial risks that can greatly alter the economics of the business. Chief among these are regulatory

EXHIBIT 1: NET RISK EXPOSURE OF INDUSTRIAL COMPANIES



Source: Oliver Wyman analysis.
* Net exposure.

changes, new technologies and laws addressing environmental and energy issues. Companies considering building new nuclear plants and decommissioning existing ones need to consider these non-financial risks carefully before making such important and long-term decisions.

For example, gas prices have fallen to record lows, giving gas-fired power plants a significant advantage over nuclear plants. This development has prompted some nuclear operators to consider decommissioning facilities.

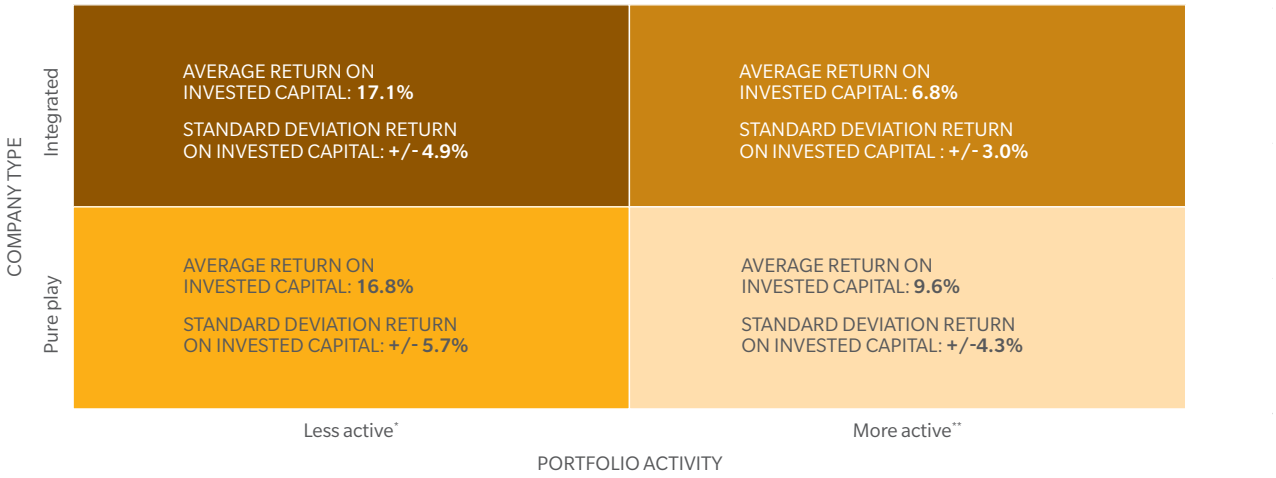
However, these multibillion dollar decisions could take over a decade to play out, with potentially poor results if executives do not carefully consider the non-financial risks that could materialize. Gas plants have previously not been widely used to replace the type of power produced by nuclear plants because they have not been able to cost-efficiently produce the reliable and uninterrupted "baseload" power that is generated by nuclear power plants, and it's unclear whether they will ever be able to do so. Changes in legislation and regulations around coal plants (the primary source of baseload power) and carbon emissions could also quickly alter the economics of the nuclear power business.

BLIND SPOT #2
GOING IT ALONE

It is well known that acquisitions can often be worth more as part of the organization's portfolio than on a stand-alone basis. However, what is less understood is that the "synergy" created by an acquisition is often from a different part of the organization than the primary operator of the asset.

EXHIBIT 2: MORE ACTIVE PORTFOLIO MANAGEMENT IS NOT A SUBSTITUTE FOR QUALITY INVESTMENT DECISIONS

THE 40 ENERGY COMPANIES IN THE S&P 500 THAT HAVE DEVOTED A LARGER PERCENTAGE OF REVENUES TO CAPITAL EXPENDITURES AND DIVESTITURES ARE UNDERPERFORMING THEIR PEERS...



Source: Oliver Wyman market analysis of industrial companies.
* Invest (or divest) less than 30% of annual revenue.
** Investment (divestment) activity = Balancing activity = [Absolute value (capital expenditures) + absolute value (divestitures)]/Revenue return on invested capital = Earnings before interest and taxes/(Total assets – cash – accounts payable – accounts receivable).

International oil companies are large organizations that often make decisions in "silos" that operate independently. The supply and trading arms of these companies typically have the best perspective on a company's potential opportunities to earn higher margins in the market based on the quality, location and timing of sales. However, they usually do not weigh in on decisions to invest in assets for operations, such as refinery upgrades.

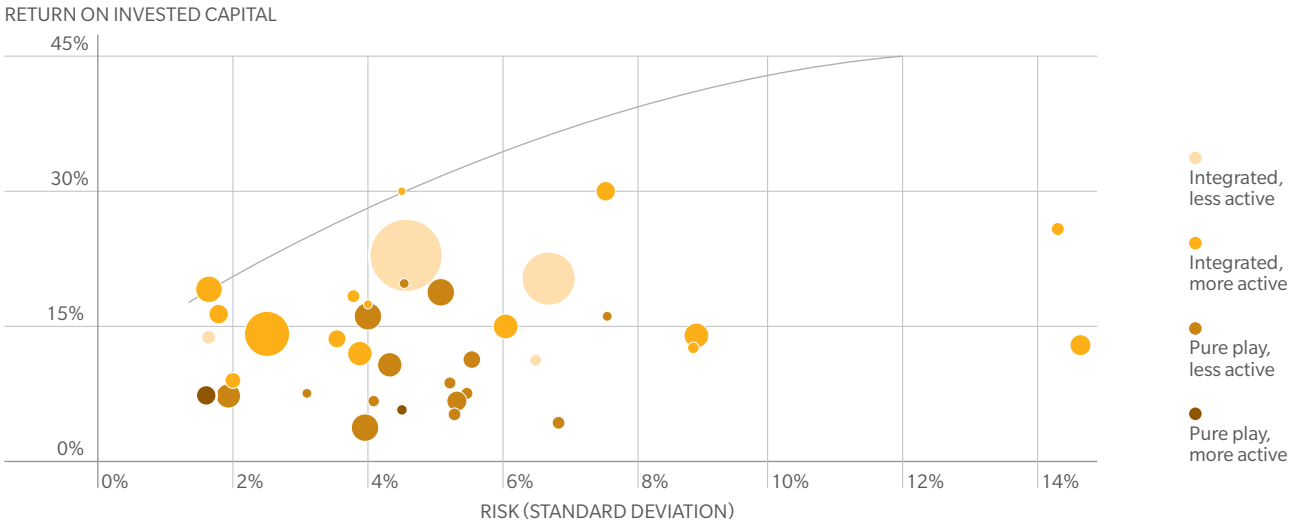
By breaking down these silos, companies can discover investments that add greater value. For example, if refinery operations work closely with supply and trading divisions to make investment decisions, international oil companies are more likely to identify additional marketing and trading opportunities that potential investments can create.

BLIND SPOT #3
TUNNEL VISION

No one can predict the future. Companies must build robust investment portfolios that can deliver returns in a wide range of alternative market and price scenarios. But many companies fail to consider alternative scenarios while constructing their portfolios and make investment decisions based on static views of the future, or consider only small subsets of possible outcomes.

With the growth of unconventional oil in North America, investments in midstream assets, ranging from pipelines to marine terminals, have become a hotbed of activity. But companies need to consider myriad alternative scenarios that could unfold before making these investments. For example, the outcome of the future of

...BUT THEY CAN IMPROVE THEIR PERFORMANCE BY OPTIMIZING THEIR PORTFOLIO ALONG A "RISK-RETURN EFFICIENT CORPORATE INVESTMENT FRONTIER"



Source: Oliver Wyman analysis. Dot size indicates total assets of the company.
* The "risk-return efficient corporate investment frontier" presents a series of potential options for a business portfolio to achieve its most attractive return for the level of acceptable risk.

pipelines to transport Western Canadian crude to refiners in the United States could seriously harm – or benefit – the value of investments in pipelines, rail and terminals in the region.

NEXT STEPS

The reasons why companies often fall short of evaluating the potential impact of investments on their entire business portfolios may seem straightforward. But in our experience, companies rarely address these challenges when they are making an investment decision. Instead, some executives use subjective judgment that reflects their strategic views. One Fortune 500 chief financial officer candidly summed up this approach by stating, "If I like the investment, the required return is 11 percent. If not, it's 14 percent." Or, in other cases, companies resist divestments for fear of signaling balance sheet weakness.

One way to avoid such pitfalls is for companies to develop competitive internal capital marketplaces. Below are four steps that we've observed enable companies to move forward.

ONE
DEFINE A TARGET STRATEGIC PORTFOLIO

Developing a multidimensional investment policy statement to guide portfolio investment and rebalancing decisions helps to align stakeholders about the future direction of the company.

86%

The percentage of senior finance executives who expect as much, or more, difficulty forecasting critical risks

Target portfolio returns assist executives in determining acceptable levels of risk. For example, an international oil major with a target return of 13 percent can more easily determine if it is willing to absorb a 3 percent variation once every five years if the trade-off is outperforming 19 out of 20 quarterly reporting periods. Portfolio constraints, such as the type of asset and liquidity, concentration of assets within the portfolio, geographic footprint and ownership structure, should be considered, as well as legal, regulatory and social considerations.

TWO
ESTABLISH AN ANALYTICAL RISK-RETURN FRAMEWORK

In many ways, the investment challenge that businesses face is analogous to how most people think about their personal investments within capital markets. Most individuals develop portfolios that include stocks (value, growth), bonds (treasuries, high-yield) and alternatives (real estate, private equity). An integrated energy company has even more diverse asset classes competing for capital to build out upstream (domestic, international, deepwater, unconventional), midstream (terminals, pipelines, rail transportation) and downstream (refining, supply and trading, retail) businesses. Indeed, a company might have more than 10 asset classes within its portfolio, each with a unique risk-return profile, and each requiring a unique risk-adjusted hurdle rate.

As a result, a framework for profiling individual assets within its portfolio, and ultimately for making trade-offs in a data-driven manner, is essential to determine the optimal mix of the portfolio. A corporate risk register should be used to identify and assess the key risks, drivers and root causes of variation in financial performance. Risk-adjusted hurdle rates should be developed at the asset class level.

THREE
MEASURE INDIVIDUAL ASSET PERFORMANCE

Companies need a quantitative and systematic way to quickly screen new portfolio investment opportunities as well as to monitor the performance of existing assets. While defining the target strategic portfolio establishes the company's direction, it does not make individual asset investment or divestiture decisions any easier, nor does it prescribe the timing, which will be based largely on market opportunities.

To achieve this, it's important to build a results-based culture and clear accountability for asset performance. At the same time, companies should leverage their IT organizations as a business partner to generate insights from big data, and track performance relative to their investment budget and investment plans.

FOUR
OPTIMIZE THE EFFICIENT CORPORATE PORTFOLIO FRONTIER

Unlocking incremental value within any portfolio typically requires rebalancing assets to realize higher returns for the same or less risk. Unfortunately, more and more financial executives are having trouble making financial forecasts. According to a recent survey of senior finance executives conducted by the Association for Financial Professionals with the Marsh & McLennan Companies Global Risk Center, 86 percent of those surveyed anticipate they will have as much, if not more, difficulty forecasting critical risks to their businesses over the next three years.

One solution is for companies to develop dynamic sets of tools and modeling capabilities that simulate the performance of various portfolio options under a range of commonly accepted stress scenarios. The outputs from this type of application can be invaluable in providing the company's executive team and board of directors with confidence in their portfolio decision making. This same type of optimization can be used at more granular levels within most organizations to evaluate customers, suppliers and products. No matter what the asset is, there is always an optimal mix that maximizes returns based on the appetite for risk.

Transforming a business portfolio requires the will and the ability to account for a wide range of critical risks and evaluate their impact on an organization's financial performance. But we believe those businesses that take the time to select the assets that best suit all of these needs will find the investment worth the effort. For they will likely be the organizations that improve their returns by the widest margins as the energy industry reshapes itself.

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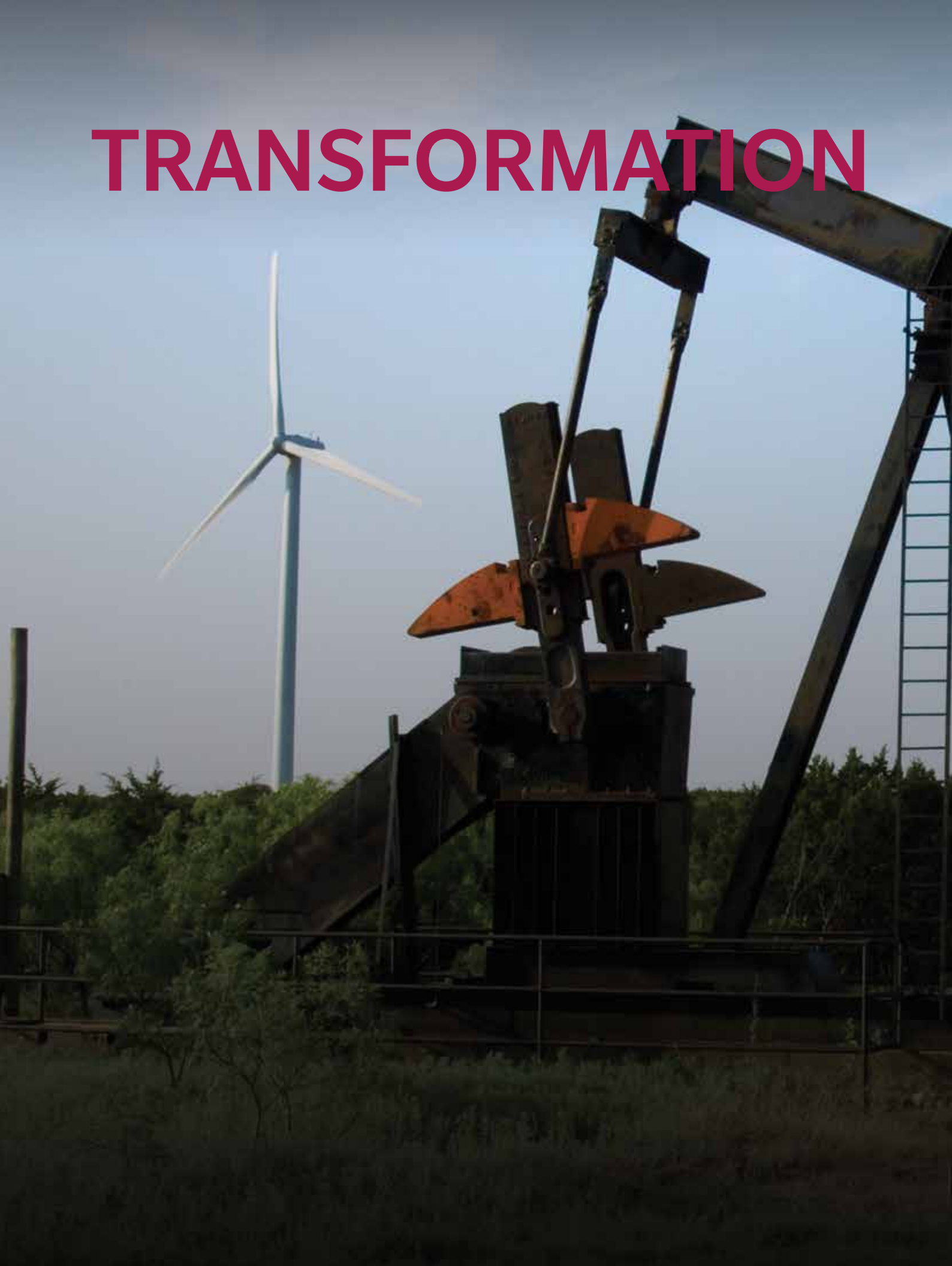
TRANSFORMATION



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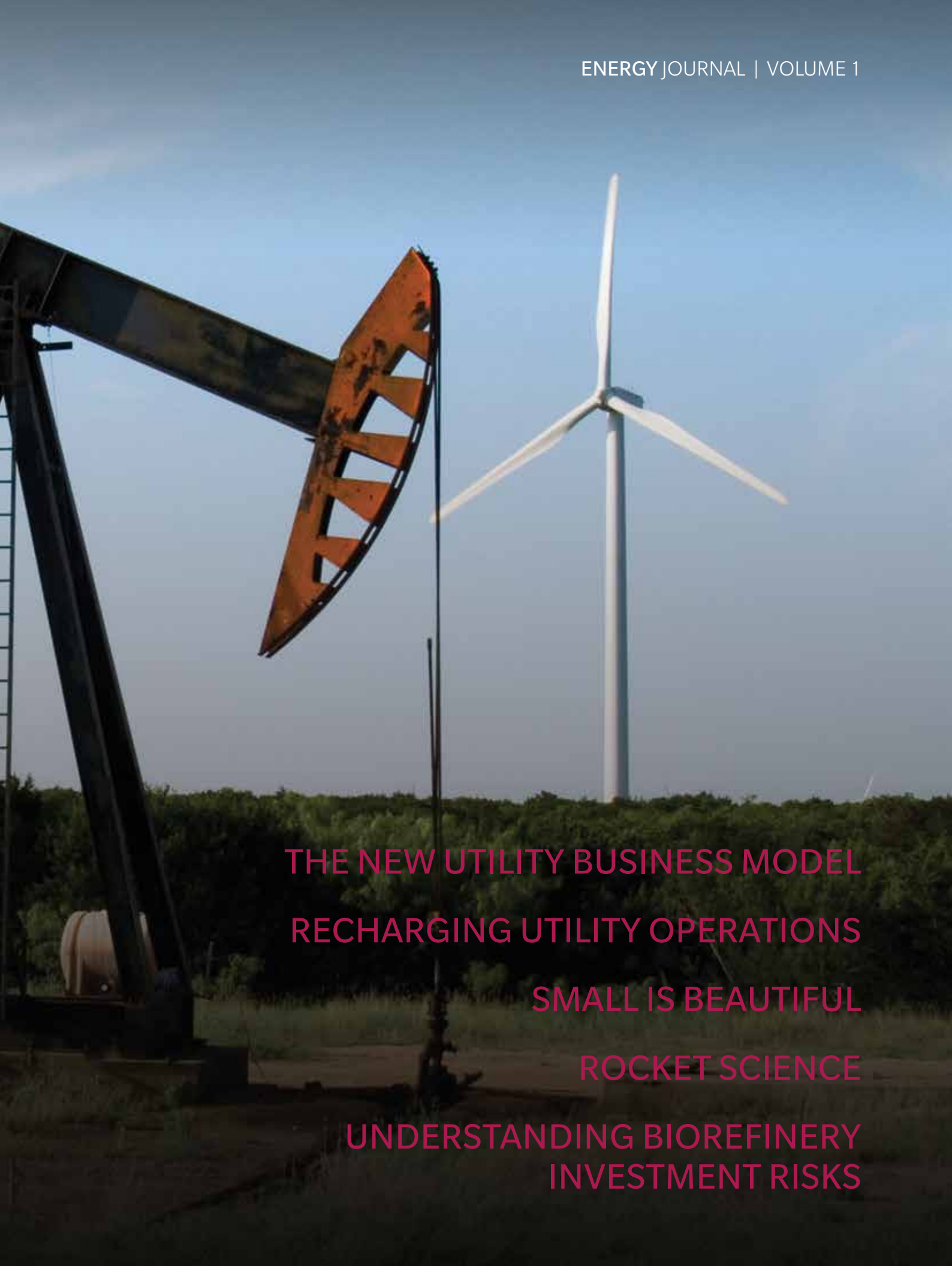


THE NEW UTILITY BUSINESS MODEL

RECHARGING UTILITY OPERATIONS

SMALL IS BEAUTIFUL

ROCKET SCIENCE

UNDERSTANDING BIOREFINERY INVESTMENT RISKS

THE NEW UTILITY BUSINESS MODEL

COMING TO A NEIGHBORHOOD NEAR YOU

JAMES BASDEN
ANDREW WILLIAMS
TIM WRIGHT

The rise in community initiatives to produce and distribute energy at a local level over the past decade is about to overturn most utilities' traditional business models. In geographies with competitive retail markets, customers are switching to more cost-effective and easily controlled distributed generation.

Peter Terium, chief executive of German utility RWE, summed up the importance of this trend at a recent earnings announcement, when he described his company's operating model as "collapsing under us. "

Utilities can no longer count on captive customers. As the technology develops to allow people to reduce dependency on traditional power grids, growing numbers of aggravated customers will abandon their energy companies.

However, what initially appears to be a problem for utilities might also offer a solution. Utilities that embrace the tenets of the community energy model to reconnect with customers have the opportunity to pioneer new offerings and partnerships that will not just enable them to survive, but to thrive.

FRUSTRATED CUSTOMERS

Customer frustration with utilities is growing in a number of developed markets globally. In the United Kingdom and Germany, customer dissatisfaction has risen to record levels for several reasons. First, higher energy prices have created a perception of profiteering by the major energy companies. Second, customers are upset by prolonged outages triggered by major storms and unpopular government policies that utilities must implement. Finally, many utilities have done little to communicate the initiatives they are undertaking to address the complaints of customers.

In Europe, the level of dissatisfaction has reached an extreme: Only half of customers in the UK are satisfied with their utility supplier, according to a report by the UK regulator Ofgem in March 2014. Just as worrisome, customer complaints have increased by more than 50 percent since the beginning of 2011. Customers are less content with utilities than they are with retail banks, mortgage lenders and insurance providers, according to 2013 data from the UK's National Customer Satisfaction Index. In Germany, a Kundenmonitor Deutschland customer satisfaction study showed that natural gas providers and power supply companies ranked 19th and 21st, out of 22 industries.

Customer satisfaction in the United States is faring better, in large part because cheap natural gas has kept electricity prices low. Satisfaction rates are improving steadily year-on-year. But the utility industry is still ranked sixth out of 12 industries in the 2013 American Customer Satisfaction Index, and future price increases could test the fragile customer-supplier relationship.

Customer discontent is already affecting the bottom line of many utilities. In the UK last year, customers switched utilities at the highest rate in five years, according to Ofgem. USwitch, a UK-based price comparison service and switching company, found that 22 percent of customers would move to a new electricity provider for improved customer service (all other factors being equal), while 13 percent would move just to get away from the Big Six incumbent utilities.

MAKING POWER

Increasing numbers of customers have started to make, rather than buy, their electrical power. Distributed generation (the production of energy at a local level, often via solar panels or onshore wind turbines) has become a practical option as solar and battery storage technologies become increasingly cost effective.

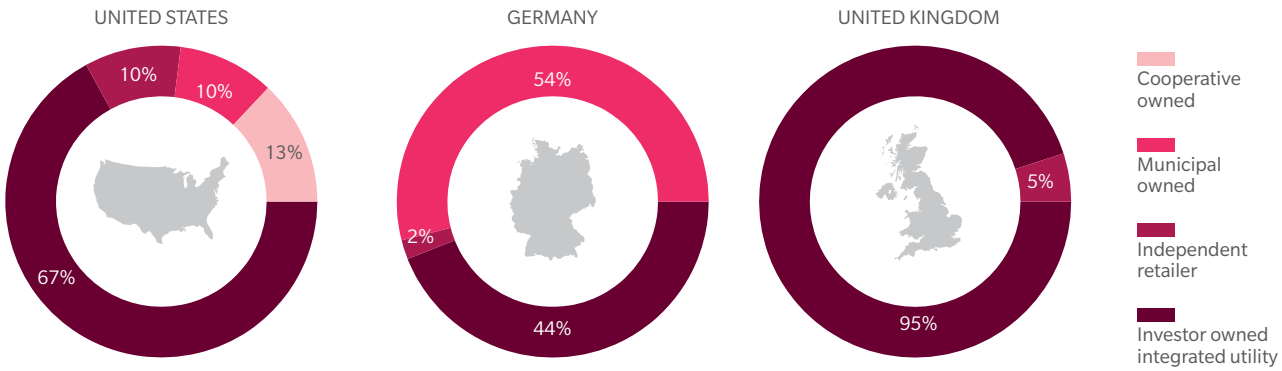
The German village of Feldheim, south of Berlin, illustrates how community generation can lead to self-sufficiency and marginalize a major energy company. In 2008, Feldheim established a joint venture with energy company Energiequelle to build a biogas factory that converts pig manure and corn into energy. The town also installed wind turbines and solar panels. Feldheim went on to gain independence from the grid, owned by energy giant E.ON, by building its own mini-grid. Locally produced heat and electricity are fed straight to consumers, who maintain control over their electricity prices, which are set at community meetings.

Some community energy initiatives go beyond generation to include wider demand-side management of energy needs at a local level. The UK government's Community Energy Strategy outlines innovative ways

EXHIBIT 1: A TALE OF THREE MARKETS

LOCAL UTILITIES ACCOUNT FOR THE MAJORITY OF GERMANY'S INDUSTRY, WHILE THEY REMAIN THE MINORITY IN THE US AND THE UK

PERCENT OF CONNECTED ELECTRICITY CUSTOMERS



Source: Oliver Wyman analysis: EIA, DECC, UKV.

to reduce energy usage, manage energy demand and purchase energy in ways that benefit the local community.

DECENTRALIZED MARKETS

We recognize that the speed of the industry's transformation varies by geography. But the trend is clear. Citigroup predicts the size of the European decentralized market could grow to around one-third of the total utility market within the next two decades, causing the market for traditional utilities to shrink by half. This change could lead to a significant shift from traditional energy companies to those that design, manufacture, install and maintain distributed technology infrastructure.

Consider: The Greater London Authority is already establishing its own energy supply company that will buy power from generators owned by London's boroughs and public bodies. The mayor of London, Boris Johnson, has set a target to procure 25 percent of the electricity the city government uses from local sources by 2025. To achieve this goal, the city will sell power at cost to other public sector groups such as the Transport for London and the Met Police. Operating under a junior electricity license, the new company aims to work with existing utilities to provide a wide range of back-office services.

For the longer term, the authority's electricity company plans to buy energy from private local generators. The mayor's office estimates that its scheme could stimulate up to $14 billion of investment in local, low-carbon generation by 2025.

On paper, the transition to locally produced power could happen faster in the United States. Analysis of data from the Energy Information Administration shows that 20 percent of the installed photovoltaic generation capacity is now owned by municipals and cooperatives, up from 18 percent the previous year. The presence of strong municipal and regional

energy suppliers has been a key driver of renewables growth in Germany, with more than half of all renewable capacity owned by farmers and cooperatives. In the UK, the dominance of the Big Six power suppliers and generators is seen by many as a barrier to the growth of community-led renewable schemes. (See Exhibit 1.)

COLLABORATIVE UTILITIES

The temptation for utilities would be to respond defensively to the dramatic shift underway in customer behavior. Instead, utilities should embrace the opportunities that local community energy initiatives offer. By adopting the populist principles of community energy, and applying the commercial skills of a corporation, traditional utilities can strike new partnerships ranging from joint ventures to community renewable generation to energy efficiency programs.

Some leading utilities already understand the power of a collaborative model. Investor-owned water utility Affinity Water in the UK is using its knowledge of the local community to help shape its offerings. Drawing on the community energy principles of transparency, collaboration and fairness, Affinity has been able to successfully involve customers in its business planning process. As a result, Affinity has one of the highest customer satisfaction scores and has been fast-tracked through the latest regulatory review process.

More utilities should treat their customers as potential producers of energy, not just as consumers. If this happens, utilities stand to benefit from the community energy trend because of their technical knowledge, investment capacity and access to customers. In the US, for example, Minneapolis-based electric and natural gas provider Xcel Energy Inc. offers customers a community generation program called Solar*Connect. Customers can buy or lease interests in a solar garden system and get credit on their power bills for the electricity produced.

NEW PARTNERSHIPS

Partnerships that bring together the enthusiasm of communities with the skills, resources and risk-hedging ability of investor-owned energy companies are not just a sound defense, but a smart offense for utility companies. Vast shifts are under way in everything from customer expectations to new technologies and energy prices, to weather patterns that demand large-scale alterations to utilities' strategies. Those companies that develop concerted, focused plans to work with communities to conquer such problems will improve not only their ability to respond to these challenges, but the possibility of avoiding them. The utilities left standing will be those that build longer-lasting collaborative enterprises.

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RECHARGING UTILITY OPERATIONS

THE RISING IMPORTANCE OF BEING AGILE AND EFFECTIVE

MICHAEL BRITT

Utilities that defend the status quo are almost assuredly going to miss emerging opportunities, delaying their evolution to operating models that serve changing markets. You can't reverse macroeconomic trends or shifts in market demand. To compete with a new breed of energy service providers armed with rapidly advancing technology requires flexibility in operations, simplified workflows, investment in the IT foundation, accountability in the organization and a hard-nosed, competitive approach to the market.

Utilities have taken action over the past few years to address some of the challenges. As these issues evolve, however, complacency is not a strategy for success. Given the recent structural and market changes in utility distribution environments across the world, we recommend utility executives take a fresh, comprehensive look at their strategies. Below are some actions that, in our experience, can make a difference:

Review or recast your corporate strategy. If you have not undertaken a comprehensive review of your corporate strategy in the past two or three years, it is long overdue. Too many fundamental changes have occurred in the industry to rely on a 2012 vintage strategy.

Align your operating model to the corporate strategy. An updated strategy often requires new ways of working and a new operating model (or an interim model).

Build your future capabilities today. The revised operating model may expose gaps in capabilities. Fill the gaps by hiring, training and grooming the next generation of utility leaders. Many utilities have not hired significant numbers of young workers in several decades, despite a looming wave of retirements. Executives must make utility opportunities interesting enough to attract the best and brightest of the next generation of employees, while protecting the best elements of the corporate culture to retain the most experienced people.

Manage risk more effectively. Utility executives will have to make some big bets in the next few years. Now is the time to put the right level of risk management in place to mitigate, allocate or accept the risks they are prepared to manage.

Simplify, simplify, simplify. Examine all aspects of the business, including technology and key operational and support processes. Streamline and simplify the work, outsourcing non-core activities and eliminating or automating low-value tasks. This will allow your employees to focus on higher-value work. Often, extra steps in key processes may have been required to meet regulatory compliance or temporary needs, but once those issues were resolved, the process ceased to evolve. Enormous latent value is locked in highly manual and overly complex processes.

Harden the infrastructure. Improve utility infrastructure with investments that increase security, reliability, flexibility and speed, while also reducing future maintenance costs. Information is the backbone of today's utilities, and increasingly will be the case among the utilities of tomorrow. Yesterday's pattern was to invest primarily in wires and pipes. The future will require significant investment in the bits and bytes required to increase operational responsiveness to changing market needs.

Focus on core strategic assets. Build on areas of historic strength and eliminate investment of time and attention in geographies or functions. Divesting non-core assets and operations that are not core to the new corporate strategy will permit increased investment in new capabilities and functions that position the company for success.

Increase accountability. Manage performance and hold your team accountable for delivering key metrics. Holding people accountable for results, while positioning them for success, is critical to increasing employee morale and retaining talent.

By developing enterprisewide strategies for change, utilities can strengthen their core businesses, build the speed and agility needed to pursue new opportunities, engage with customers to create channels for new products and services and increase the ability to respond to challenges. The executives that broaden the view of the business they are in (serving customers' energy needs versus franchised regulated distribution) and refine their strategy accordingly, will improve both performance and shareholder value.

MOUNTING UTILITY CHALLENGES: FROM SOLAR TO SHALE TO GOOGLE

REGULATORY UNCERTAINTY

Environmental regulations related to water, emissions and incentives for renewables are uncertain.

US regulations are uncertain. EU hasn't yet agreed to new targets for 2030.

The EU set emissions targets for 2020 (reduce emissions by 20 percent). But the 2030 standards are still being negotiated. The US Environmental Protection Agency proposed reducing carbon dioxide emissions by 30 percent below 2005 levels by 2030, but firm targets haven't yet been set.

ELECTRICITY DEMAND

Demand is bifurcated between developed and developing nations.

Electricity demand in developed nations is flat or falling. Industrial and commercial use slowed with the economy, and users have become more efficient. By contrast, demand in developing nations is rising as new consumers plug in to the grid and economies grow.

US annual growth of 0.7 percent is expected through 2020. Japanese demand is seen as growing 2 percent a year through 2030. Meanwhile, German demand is expected to contract by 0.2 percent every year. Conversely, demand in developing nations is growing rapidly, with Indian demand forecast to double. Chinese demand should rise by 115 percent through 2030.

DISTRIBUTED GENERATION

Solar panel costs are falling. Incentives and third-party financing and operation for renewables have emerged. The cost is shifting to non-users.

Distributed generation is rapidly increasing and peak demand is eroding, putting more stress on the distribution grid.

In the US, distributed generation could represent 2 percent of capacity by 2016. More than 290 gigawatts of Europe's capacity is expected to come from small-scale, household solar installations by 2030.

AGING WORKFORCE

Utilities face a massive skill gap, with most of the workforce set to retire in coming years.

In the US, 30 percent of utility employees are eligible to retire in less than five years. In the EU, 30 percent of utility workers are older than 50.

In response, utilities are outsourcing more, simplifying and automating processes, and reinvigorating recruiting.

RISING OPERATING COSTS

The unit cost of electricity is rising due to required investments in major initiatives related to infrastructure, regulatory compliance and cybersecurity.

Retail electric rates are up due to storm response and catch-up infrastructure investments.

Global investment in transmission and distribution infrastructure is forecasted to grow annually by 5 percent through 2016.

UPGRADING INFRASTRUCTURE

New technologies and patterns of generation create demand for different types of infrastructure.

Utilities are making new, large-scale investments for needs that may not be timely.

The US needs to spend $1.5 trillion to $2 trillion to modernize its power grid by 2030. The EU must invest $1.35 trillion by 2020 to modernize its grid.

RENEWABLE ENERGY MANDATES

Standards and regulatory mandates are driving investment in renewables.

Investment in renewable generation is rising.

Investment in renewables is expected to increase exponentially. Through 2030, the Americas are expected to invest $816 billion while the EU will invest $961 billion.

UTILITY EARNINGS PROSPECTS

The North American utility sector has delivered strong, high-quality earnings and dividend growth. In Europe, new market dynamics have destroyed much of the value of utilities.

Most US utilities meet targets by investing in infrastructure and building their rate base. In the EU, large-scale renewables and distributed generation have hurt utility earnings.

US utilities are expected to deliver the 4-6 percent annual earnings growth. As renewables proliferated during the past five years, the top 20 utilities in Europe lost half of their value as they shuttered and wrote down many of their coal- and gas-fired assets.

NATURAL GAS PRICES

With the advent of shale gas in the US, supply issues in Europe and higher demand in Asia, gas prices in recent years have bucked historical trends.

The US will spend 24 percent of its investment in new power capacity on natural gas assets through 2026. In Asia, gas capacity is forecast to double through 2030. This is still less than coal-fired growth, as high gas prices prevent a larger build-out. In the EU, gas generation is forecast to shrink through 2030, from 25 percent of generation to just 17 percent, given the low cost of renewables and high gas prices.

EMERGING COMPETITORS

As telecom and cable companies battle for home Internet market share, home energy management is becoming an attractive service offering.

Siemens, Schneider and SAS are ahead of utilities with their home energy management offerings. Google paid $3.2 billion for Nest to pursue the $400 billion retail energy market.

Source: Oliver Wyman analysis.

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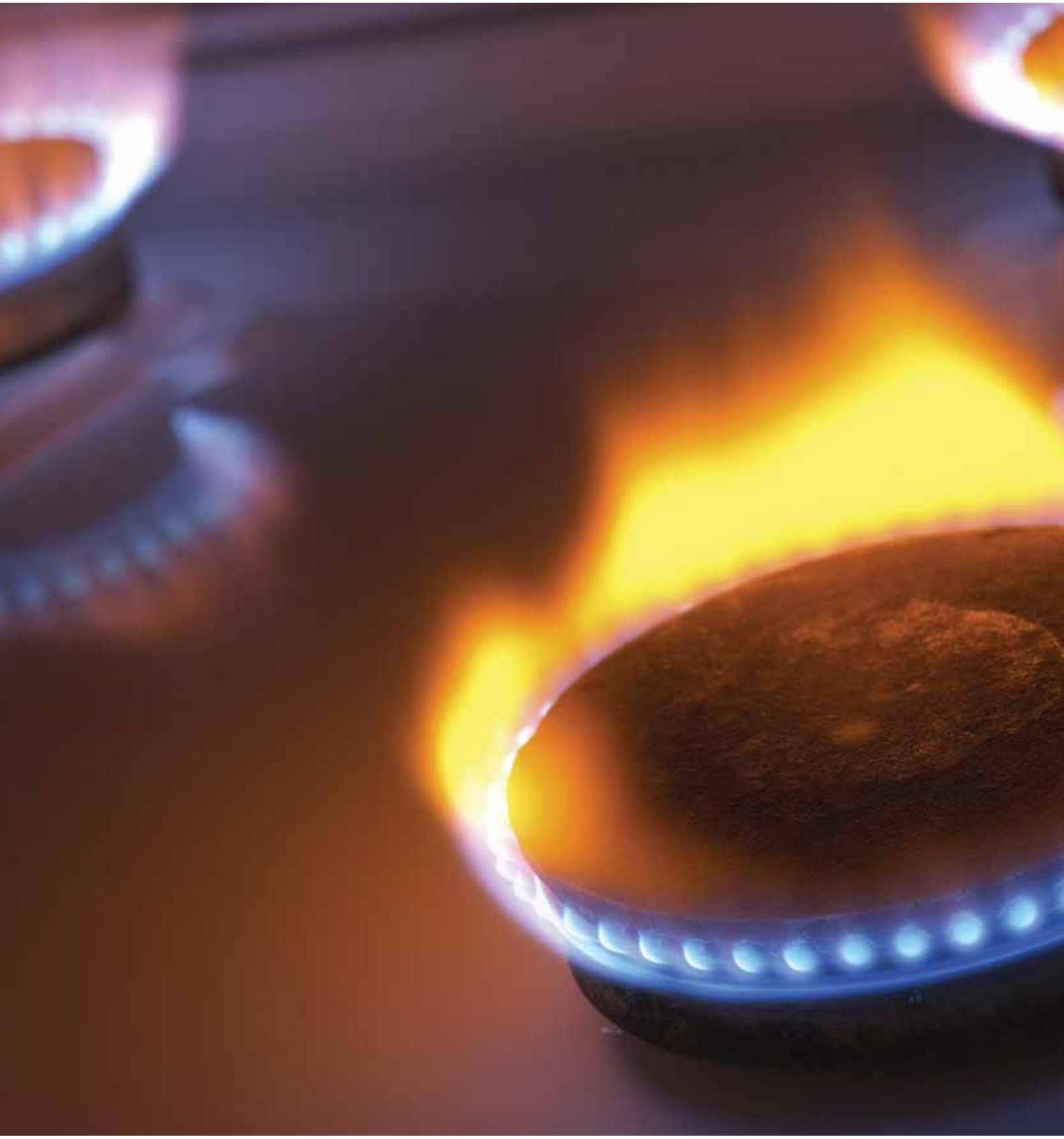


SMALL IS BEAUTIFUL

WHY BUYING SMALL UTILITIES YIELDS BIG RETURNS

GERRY YURKEVICZ

As more utilities overhaul their business models, utility executives and energy-investors should consider this new truism for the utility business: thinking small can produce big results. Small utilities can offer attractive growth opportunities for large utilities and infrastructure funds scouting for future earnings growth.

Utilities face limits on how much and how quickly they can grow their rate bases. New products and services typically do not contribute enough to move the needle. So it's no wonder that almost 8,000 utilities worldwide worth $1 trillion have been acquired during the past five years. (See Exhibit 1.)

Utilities can pursue megamergers. But recent history suggests that the regulatory approval process bogs down these deals and strips away value. As a result, more companies, such as Algonquin Power & Utilities, Gaz Metro and SteelRiver Infrastructure Partners, are pursuing smaller utility acquisitions.

The market for small utility acquisitions is actually quite big. There are about 175 investor-owned electric and gas utilities in the United States that have net property, plant and equipment (considered a proxy for rate base) values of less than $500 million. In addition, there are more than 3,000 municipally and government-owned utilities. Together, these smaller utilities have net property, plant and equipment worth more than $45 billion.

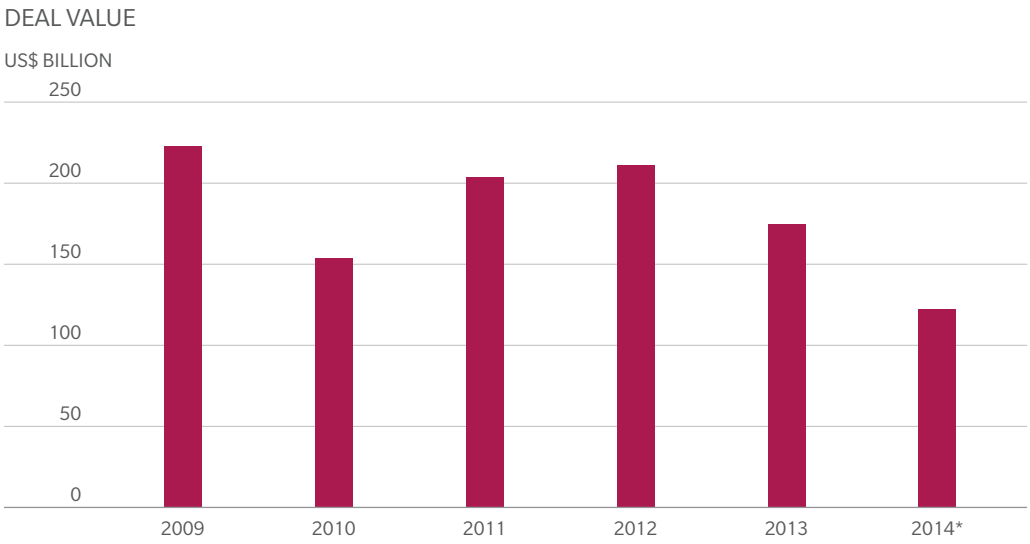
BEING PREPARED

There are many reasons why smaller utilities present opportunities to unlock value. First, small utilities often do not receive much management focus or investment. Some are smaller parts of bigger energy companies that are focused on higher growth or return businesses, such as natural gas and oil pipelines or exploration and production. Others represent fractions of their parent companies' utility holdings. As a result, growth in net property, plant and equipment is below average for half of smaller utilities, but for only one-quarter of larger utilities.

Small utilities often offer greater opportunities to improve the local customer experience and state regulatory relations. Regulators and politicians crave local relations and local jobs created by new offices and call centers. Instead, many larger utilities have focused on functional consolidation and standardization.

In addition, many smaller utilities distribute natural gas. With sustained lower gas prices expected in North America, gas utilities offer substantial upside for fuel conversion and gas system expansion.

EXHIBIT 1: UTILITIES ACQUIRED IN THE PAST FIVE YEARS



Source: Dealogic, Oliver Wyman analysis.

* As of October 17, 2014.

Investors considering acquiring a utility need to be prepared to pay market multiples that reflect the company's enterprise value as a percentage of its net property, plant and equipment or as a multiple of earnings. However, 85 percent of smaller utilities are sold for slightly below the market multiple. By contrast, only 33 percent of larger utility acquisitions or mergers are conducted at a slight discount to the market.

Finally, there are fewer management issues to address. As opposed to big mergers which often fall apart after senior teams meet and fail to reach agreement, smaller acquisitions involve far fewer issues. Many can be win-win asset purchase transactions that offer career growth or cash-out opportunities for senior managers.

THINK SMALL

Some argue that smaller transactions are not worth the effort. Bigger transactions may create greater value sooner, while smaller deals often require a similar level of resources such as management time, advisory and due diligence costs. However, a fresh, focused and disciplined approach to acquiring a small utility can be cost effective. Furthermore, utility roll-up opportunities exist in every region of the United States. Over time, a robust strategy of many smaller utility acquisitions, coupled with first-class acquisition integration efforts, can yield value equal to – if not greater than – one big deal.

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ROCKET SCIENCE

AIRPLANES WILL FLY ON WEEDS AND WASTE SOONER THAN YOU THINK

GEOFF MURRAY
ERIC NELSEN

Will the aviation industry soon feel the winds of change when it comes to fuel? Ground transportation is transitioning to lower-emission fuels such as natural gas and electricity. But nearly all airplanes still run on petroleum-based jet fuel, due to a lack of commercial options. Many hands are at work on this pressing issue: Airlines, original equipment manufacturers, fuel suppliers, airports, government agencies and researchers are coming together in working groups and coalitions with exotic monikers like SAFUG, CAAFI, MASBI and SAFN to develop options that may finally enable the industry to move beyond its current predicament.

Airlines know that alternative fuels are essential for the industry's long-term viability. Presently, they are at the mercy of rising and volatile petroleum prices, spending as much as 40 percent of their annual budget on fuel. In addition, the industry will need to ramp up reductions of greenhouse gas emissions and pollution in response to regulatory pressures, given that the European Union has added domestic aviation to its Emissions Trading Scheme and the United Nation's International Civil Aviation Organization has set a goal of carbon-neutral growth for international aviation from 2020 on. Importantly, without alternative fuels, both fuel budgets and emissions will continue to rise, given that aviation transport demand is projected to double in the next 20 years.

EXHIBIT 1: POTENTIAL ALTERNATIVE FUELS FOR AVIATION

SHORT-TERM

HEFA PROCESS
(conversion of natural oils and animal fats into hydroprocessed esters and fatty acids)

Advantage: Already used at commercial scale at several biorefineries.

Challenge: Facilities tend to favor biodiesel production for subsidized ground transportation markets. Jet fuels are produced more opportunistically. Need to reduce refining and conversion costs.

FISCHER-TROPSCH PROCESS
(synthetic fuel from biomass or fossil fuels)

Advantage: Used at commercial scale, with coal and natural gas as feedstocks.

Challenge: Has not yet been proven at commercial scale using biomass as a feedstock.

MEDIUM-TERM

ALCOHOL-TO-JET
(jet fuel from alcohols such as ethanol)

Advantage: Feedstocks include corn, sugarcane, wood chips and agricultural waste.

Challenge: First-generation feedstock supply chain is mature. Additional research and development needed to bring to economic viability. May also require sustainability-certified feedstocks in the future.

CRYOGENIC FUELS
(such as liquefied natural gas)

Advantage: Could cut aviation carbon emissions by about 15 percent and reduce nitrogen oxide pollution by 40 percent.

Challenge: Would require new engines and substantial infrastructure upgrades at airports.

LONG-TERM

ELECTRICITY

Advantage: Lower-cost option; could significantly reduce carbon and pollution from planes, depending on the fuel used to generate electricity.

Challenge: Would require development of electric propulsion systems, sufficiently powerful batteries, airport recharging systems.

Source: Oliver Wyman analysis.

DISRUPTIVE TECHNOLOGIES

Increased focus and higher levels of government and private investment in fuel research and development in recent years are bearing some fruit: Two technologies that have been approved to produce fuels that can be blended with petroleum for use in flight rely on hydroprocessed esters and fatty acids (HEFA) and Fischer-Tropsch processes. Some 1,500 commercial flights have been flown using such blended fuels, and airlines such as KLM, United and Alaska Airlines have made multiyear commitments to buy biomass-based fuels.

We doubt the industry will switch to one, breakthrough alternative. Instead, after careful review of fuels in development, and based on our work with airlines, original equipment manufacturers and suppliers, Oliver Wyman expects several alternative fuels could prove to be feasible in the next few decades. (See Exhibit 1.)

In the short term, HEFA and Fischer-Tropsch processes that convert biomass into fuel have potential, as their outputs have been certified by ASTM International. While both technologies face significant economic hurdles, large subsidies in developed markets are likely to remain in place for as long as five years, which will allow

these processes to become economical. In addition, both are already currently producing small (but larger than pilot) levels of fuel for discrete offtake agreements.

While fuels produced from both HEFA and Fischer-Tropsch processes currently have a competitive advantage due to technology maturity and established government subsidies, both face scaling challenges. Key hurdles for converting oils and fats are feedstock cost and availability, in large part due to land competition with food crops and competition between jet biofuel and other oil uses (such as in feed for cattle production). Research is ongoing on more sustainable feedstocks, such as those that could use brownfields or waste land, as well as algae as a feedstock. But economical scalability is a long way off. A sustainable Fischer-Tropsch process can use plant waste, but faces challenging economics due to the high capital costs and large project sizes required to generate economies of scale.

In the medium term, we believe alcohol-to-jet technologies could have potential, due to the low cost and high availability of feedstocks. Alcohol-to-jet fuel could use sustainable energy crops such as miscanthus and switchgrass, low-cost agricultural and forest waste, and municipal solid waste. Prices for cellulosic feedstocks such as forest waste are not correlated to food since they are not tied to existing farmland.

In addition, the aggregate volume of feedstock is much larger and presents a greater opportunity to create meaningful quantities of fuel. Alcohol-to-jet fuel is expected to be certified for use in aircraft by ASTM in 2014, according to the International Air Transport Association. Traditionally, however, alcohol (in the form of ethanol) has been more valuable to blend into gasoline than to convert to jet fuel. The use of cellulosic waste for alcohol-to-jet fuel also faces technological and economic hurdles that will need to be solved.

Longer term, technologies such as alcohol-to-jet and pyrolysis may also provide impactful quantities of economically priced fuel. "Third generation" algae fuel and electricity could be viable future options as well. But based on what is known today, those listed are likely to be the most viable options.

REACHING COMMERCIALIZATION

To reach commercialization, all renewable fuel pathways require continuing research, investment and a consistent, supportive policy environment. (See "Understanding Biorefinery Investment Risks" on page 54.) Critically, feedstocks must be identified that are themselves sustainable, to reduce greenhouse gas emissions across the life cycle of facilities and equipment.

The industry will need new planes and engines to accommodate some alternative fuels, as well as changes to fueling infrastructure. Developing these fuels, however, is a question of "when, not if" to ensure the long-term health of the aviation industry.

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UNDERSTANDING BIOREFINERY INVESTMENT RISKS

THE CHALLENGES TO REACHING CRITICAL MASS

DAMIAN BLAZY
BRUNO MILLER
ERIC NELSEN
MATTHEW PEARLSON

A corollary issue to which renewable fuels will likely be adopted by the airline industry – and indeed may be a driver of that adoption – is what fuels are likely to achieve competitiveness at commercial scale. Oliver Wyman, in conjunction with researchers at the Massachusetts Institute of Technology and Metron Aviation (a leader in air traffic management systems research), has been working to assess renewable fuel refineries from just such an investment perspective.

Recently, this team developed a methodology to value hydro-processing refineries producing aviation-grade biofuel and renewable diesel, which could aid prospective investors in determining under what market conditions a profitable refinery could be constructed. Most critically, this methodology includes an analysis of fuel price uncertainty and uncertainty around government mandates and support, using the United States Biodiesel Blender Tax Credit and Renewable Identification Numbers as examples of the latter.

To "build in" uncertainty, the team constructed uncertainty profiles for each key input to a discounted cash flow model previously developed at MIT. They then used Monte Carlo simulations to calculate ranges of a project's net present values.

Scenarios were constructed around a potential facility's size, price correlation and working cost of capital.

The analysis determined that a medium-size refinery (producing 4,000 barrels per day with a cost of capital of 16 percent and medium price correlation between commodity inputs) operating today would require government subsidies for a minimum of nine years to achieve an economic return (that is, for three years of construction and six years of operation). Otherwise, the risk of the refinery losing money over its 20-year lifespan would be large enough to make financing prohibitively expensive.

Indeed, after performing 20 million years of simulations, the team found that the likelihood of any discrete year showing positive value generation was less than 15 percent, indicating that some sort of financial externality would be required for the lifespan of the refinery – or it would close as soon as subsidies expire.

While a larger facility offers a higher likelihood of producing greater value, given the uncertainty surrounding the price of inputs and products, our analysis showed that the risk and magnitude of a loss or shortfall also increases. Clearly, then, until the industry achieves critical mass and some level of stability in terms of supply, demand and government support, investors would be wise to carefully weigh the issue of uncertainty when considering biorefinery investments.

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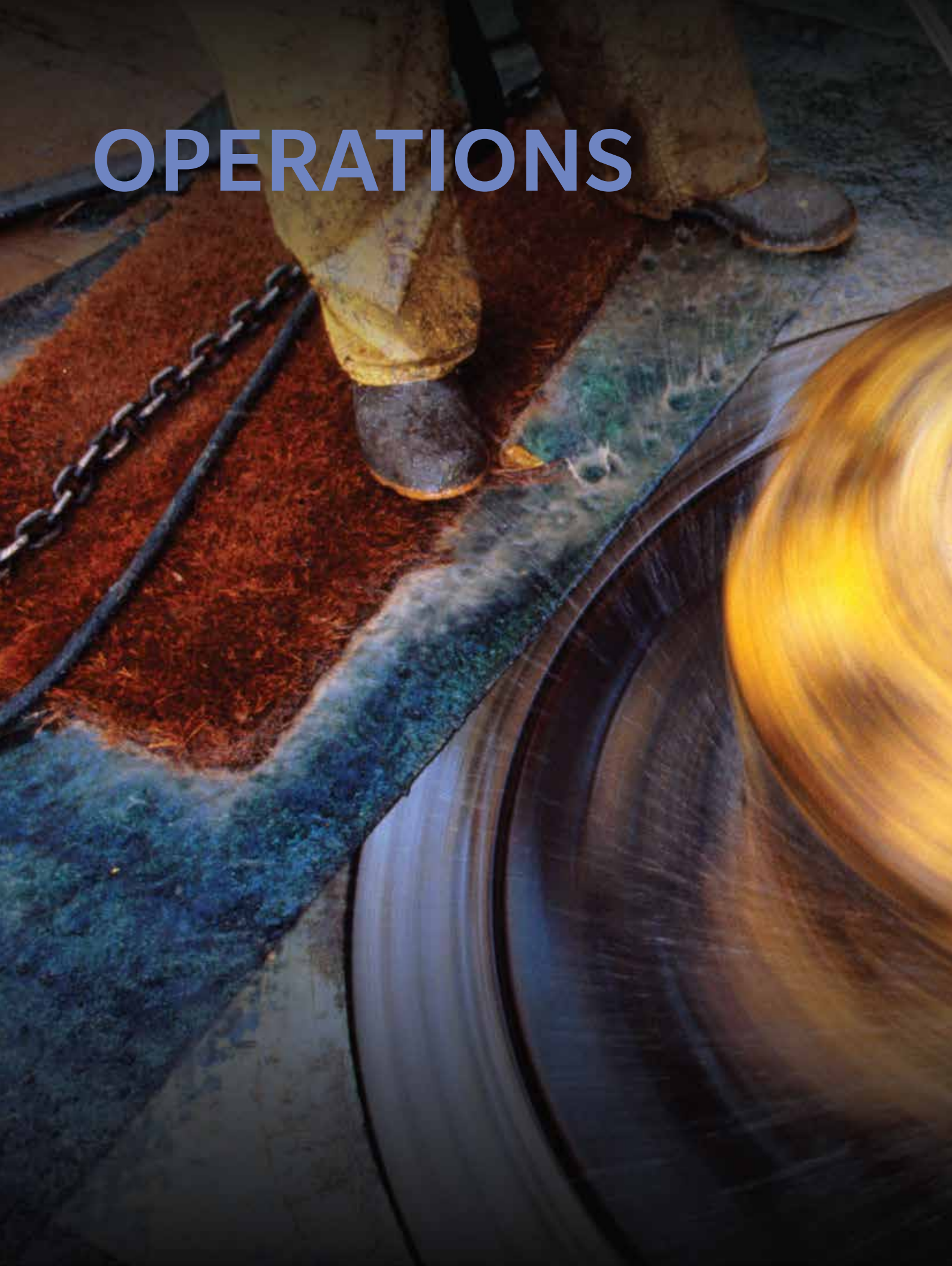
OPERATIONS



ENERGY JOURNAL | VOLUME 1

GAINING THE OPERATIONAL ADVANTAGE

THE DOWNSIDE OF RISING INTEREST IN PROCESS SAFETY

BIG DATA

SURVIVAL LESSONS

GAINING THE OPERATIONAL ADVANTAGE

RISKS ARE REWRITING THE RULES FOR COMPETITION

BILL HEATH
RYAN MCMASTER
DAMIAN WEST

Hundreds of offshore drilling platforms and refineries worldwide are reaching – or have surpassed – their design life. Oil and gas firms are drilling at unprecedented depths with new technologies and lack needed experienced operators and engineers. At the same time, penalties for environmental and regulatory violations are climbing. In the past five years, enforcement actions by the United States' Occupational Safety and Health Administration involving penalties of more than $1 million have risen. Last year, Canada raised the liability for oil spills to $1 billion, up from $30 million in the Atlantic and $40 million in the Arctic.

On many fronts, oil and gas firms are experiencing unprecedented operational hurdles, creating an urgent need for them to develop the ability to understand and reduce variability in their performance. Unfortunately, most are ill-equipped to evaluate the trade-offs that are involved in meeting the challenges of today's much harsher operating environments.

An unintended consequence of the energy industry's increased focus on process safety over the past decade has been that managers now equate operational risks solely with safety. (See

"The Downside of Rising Interest in Process Safety" on page 63.) Process safety has been separated from operational performance as a whole within energy companies, with the former managed by safety professionals and the latter by operational professionals.

As a result, companies have lost sight of the full breadth of the operational risks affecting site performance. To be sure, process safety (that is, the means of operating hazardous equipment without a major incident) is a natural part of operational excellence. But operational risks range from staffing to maintenance regimes to supply chains. Each of these risks needs to be analyzed and its impact on operations understood as an operational risk, rather than just as a safety agenda item. More important, the analysis should be viewed as all-encompassing, rather than through a purely safety or operational lens.

Many oil and gas firms also fail to examine explicitly the trade-offs involved in managers mitigating operational threats. Consequently, companies are missing opportunities to improve their operating performance by addressing risks that fall short of being catastrophic but that could still have significant impact.

FOLLOWING A DIFFERENT TACK

To address these challenges, companies need to pursue a profoundly different tack to managing operational risks. They must develop a comprehensive view of the company's tolerance for risks to its operations strategy, implement effective barriers to the threats considered unacceptable and create a corporate ecosystem capable of controlling them in a higher risk environment.

Companies in the vanguard of this paradigm shift, such as Exxon Mobil Corp. and Chevron Corp., already identify and manage sources of volatility to the operational performance of certain platforms and refineries within their diaspora. We believe that more companies need to evaluate the trade-offs involved in managing risks across an entire plant, along with multiple critical strategic considerations such as cost management, safety management and long-term aspirations.

By following three steps listed below, oil and gas firms can manage their operational risks effectively and, in so doing, improve both their process safety and operational performance.

STEP 1
DEFINE THE APPROPRIATE LEVEL OF RISK

Determining whether or not a risk should be mitigated is becoming an increasingly important front line for competition. Firms are embarking on more complex new projects at one end of the spectrum and coping with aging assets on the other. Leaders and managers must define the level of operational performance that is desirable and then analyze the extent to which the company can, and is willing to, manage the associated risks.

Leaders and managers need to develop their operations strategy from a risk perspective. Some threats, such as a corroded seal that could cause a catastrophic incident, clearly should be managed. Other risks, such as so-called "turnaround activities," which entail

downtime for extensive maintenance and repair work, may or may not be acceptable.

To be effective, a view of acceptable risk must be developed across organizational boundaries. For instance, organizations should prioritize staffing needs across their overall business even though different parts of the business will believe their staffing gaps are the most important. But this can only be achieved if there is an explicit understanding of operational risks and consequences as a whole.

Reaching such an understanding is complicated. It requires a deep examination of the impact of different risks on the performance of a platform or refinery not just today, but across an asset's entire life cycle. For example, many organizations consider the cost of construction to be the primary operational risk to building a plant. But the materials specified in the plant's design can have an enormous impact on levels of maintenance required (and availability) over the course of an asset's life.

STEP 2
IDENTIFY THE MEANS TO MANAGE OPERATIONAL RISKS TO THE APPROPRIATE LEVEL

Once organizations have agreed on the appropriate levels of risk, they need to understand the actions required to manage risk effectively. Safety professionals talk about putting "barriers" in place to manage risk. We believe this concept should be broadened beyond safety to all operational risks. Such barriers will be specified in most operations, though the extent to which they succeed varies considerably.

Operational and safety data needs to be combined and analyzed collectively

To fully grasp performance characteristics and identify improvement opportunities, operational and safety data needs to be combined and analyzed collectively. Much of the expertise needed to drive optimum operational risk performance exists within oil and gas firms. The trouble is that most organizations lack the appropriate data and governance structures to develop the required analytical capability.

Mitigation measures should be tested for effectiveness both in terms of how well they are managing the risk and how well they are being maintained. Otherwise, companies rarely grasp how frequently barriers are breached or how close operations approach a loss of control.

At the same time, organizations should identify significant opportunities for improving their operational performance as their assets are redesigned and degrade over time. Many companies get trapped in a vicious cycle of expensive reactive maintenance to mitigate threats.

Often, companies could more effectively head off predictable problems by considering benchmark data. For example, such data could inform a company's decision to remove non-core alarms from control panels so that operators can focus on certain critical measures and alarms.

STEP 3
BUILD A CULTURE OF ENQUIRY

Most important, energy businesses need to develop an operational culture that encourages employees to continually seek areas for improvement. Once the 'obvious' areas for better managing operational risk are addressed, it becomes more difficult to identify further opportunities.

A culture of enquiry demands that staff always challenge themselves and others as to whether the appropriate risks are being managed adequately. It is easy for operations staff to accept the status quo (such as out-of-date engineering drawings). It is harder to create a culture that challenges the received wisdom and does something about it.

Without an ongoing culture of enquiry, organizations will see diminishing returns from their efforts to improve their operational performance. That is one reason why only 40 percent of performance improvement programs are able to sustain benefits after their completion.

But this is usually much more easily said than done. At a high level, senior leaders must demonstrate commitment to operational excellence and assess each business through a risk-based lens. They need to reach agreement on how to develop and implement systems that will assess risks, prioritize them and manage projects and initiatives as well as resources across all businesses. There must also be a system in place to monitor and report conformance.

Senior leaders should also be prepared to communicate and engage staff at all levels to support the company's new culture, values and processes through workshops, road shows and one-on-one meetings. At the same time, handbooks that describe how the management system is operationalized locally within functions must be developed along with multiyear plans to achieve conformance to key requirements.

A QUIET REVOLUTION

The practices we've described above add up to a quiet revolution that will help energy businesses gain significant operational advantages over their competitors. A perfect storm of operational risks threatens to exacerbate the present volatility in the operational performance of many companies.

But we believe those energy players that set operational priorities and change the manner in which safety and operational managers interact with each other will significantly improve their operational performance.

Management teams will also be better able to reward shareholders, employees, customers and communities.

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THE DOWNSIDE OF RISING INTEREST IN PROCESS SAFETY

HOW DID WE GET HERE?

BILL HEATH

Process safety became part of the vernacular of the energy business with the release of the Baker Report in 2007, following an explosion at the Texas City refinery that killed 15 people and injured 170. The report noted that BP, which owned the refinery at the time, had lost the culture of process safety, thinking that a culture that protected an individual from accidents (such as being hit by a falling object) would also stop explosions and leaks. By extension, areas such as maintenance and good operations, which impact both safety and operational performance, had been neglected.

A huge amount of good has followed from the Baker Report. In 2013, the number of hydrocarbon releases from platforms off the shores of the United Kingdom reached a record low, according to the British watchdog agency Health and Safety Executive, and the commitment to reducing incidents seems to be more than rhetoric.

However, it has also led to a reduction in responsibility and understanding of operational risk by operations staff, and with this a fall in the ability of operations departments to manage themselves effectively. In other words, operational risk has come to mean process safety and has been separated from operational performance as a whole, with the former managed by safety professionals and the latter by operational professionals.

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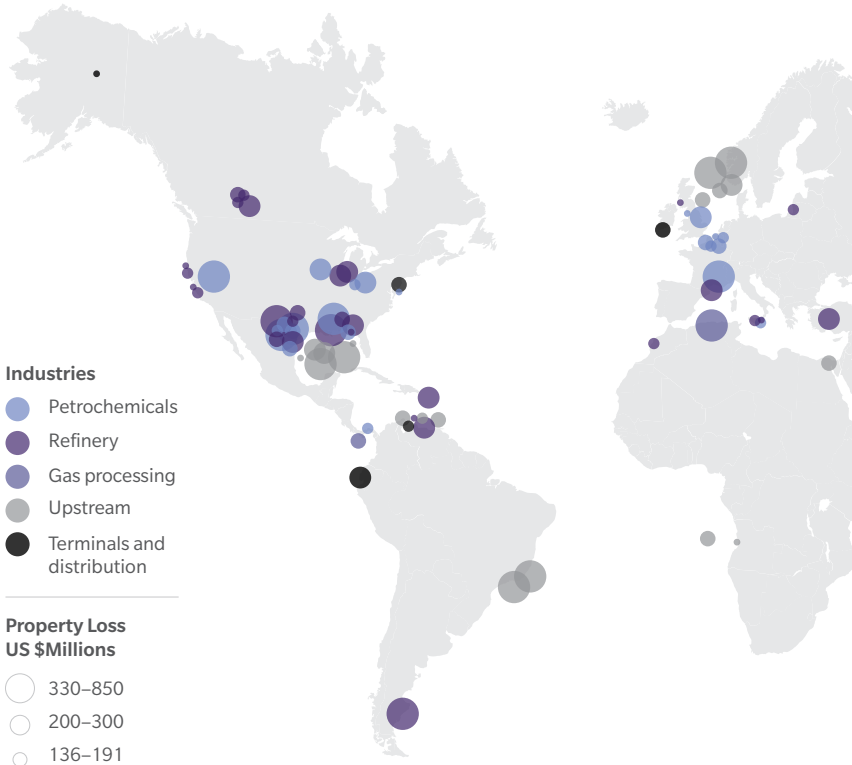
THE 100 LARGEST LOSSES

For the 23rd edition of ***The 100 Largest Losses report for the hydrocarbon industry***, Marsh, like Oliver Wyman a subsidiary of Marsh & McLennan Companies, examined the property damage losses suffered globally by the energy industry over the past four decades. These pages summarize the results.

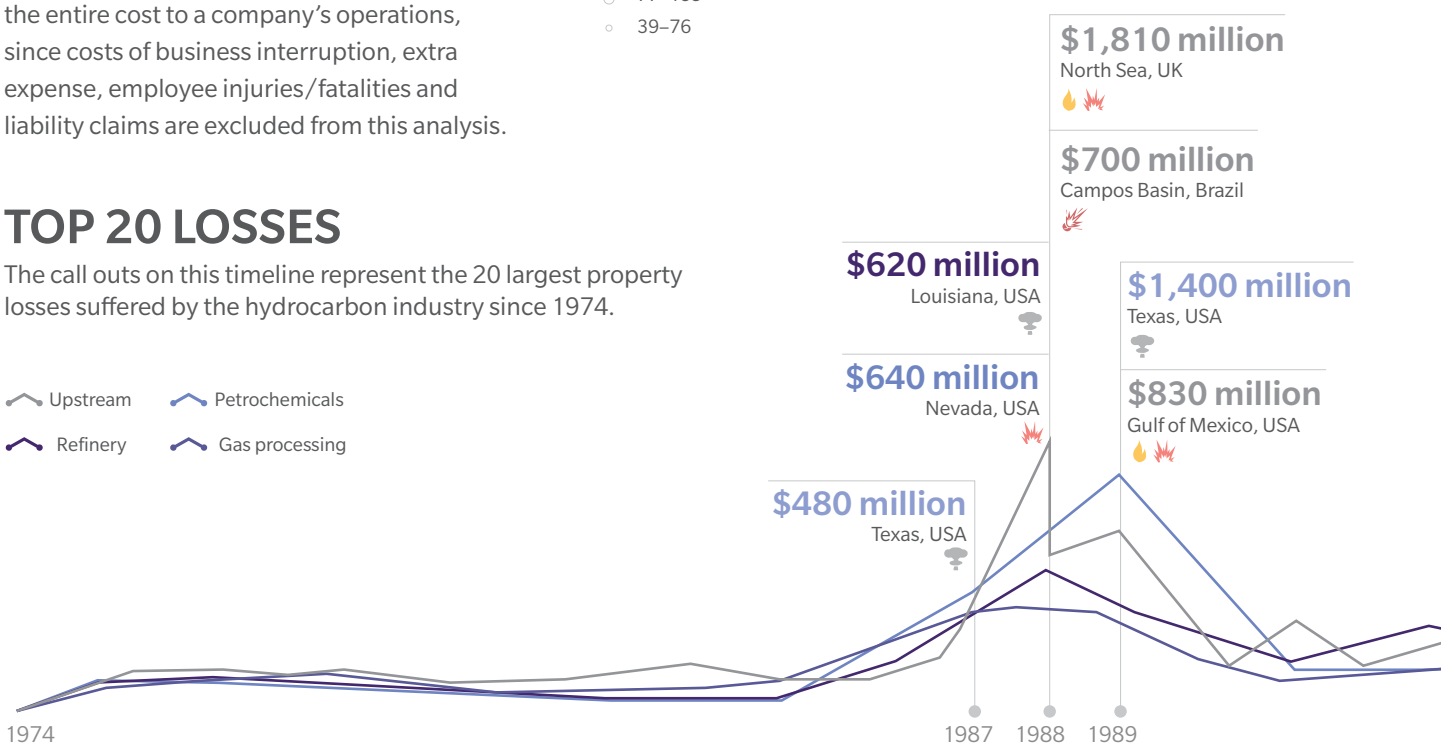
Marsh discovered an outsized concentration of incidents resulting in more losses exceeding $130 million after 1999 than in the preceding three decades. Since 2011 alone, eight new losses have entered the 100 largest losses list. Most of the largest losses did not result from so-called "black swan" events, but instead from the failure of prevention and mitigation measures taken to manage operational risks.

Note that the loss values have been adjusted to reflect the equivalent value of the loss at the end of 2013. And yet, they do not reflect the entire cost to a company's operations, since costs of business interruption, extra expense, employee injuries/fatalities and liability claims are excluded from this analysis.



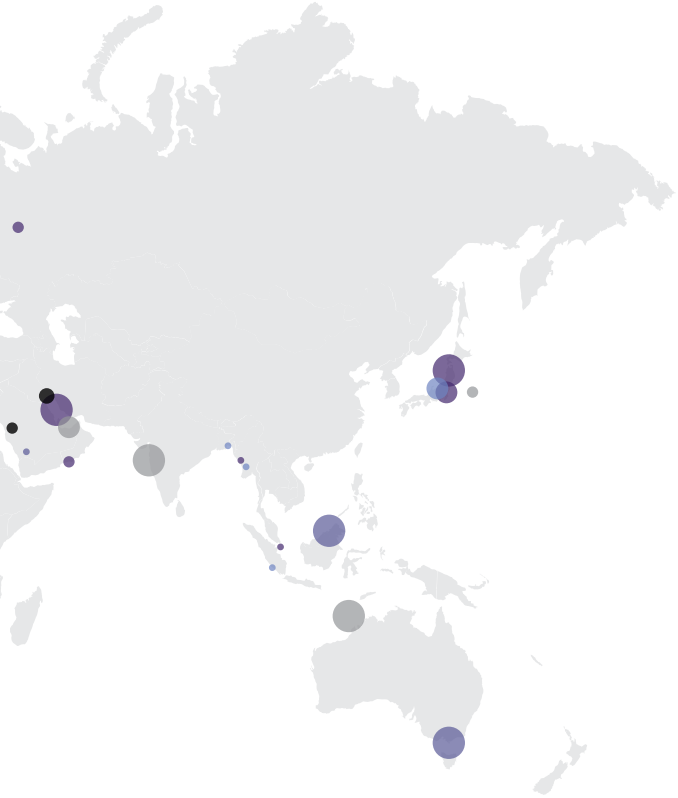
TOP 20 LOSSES

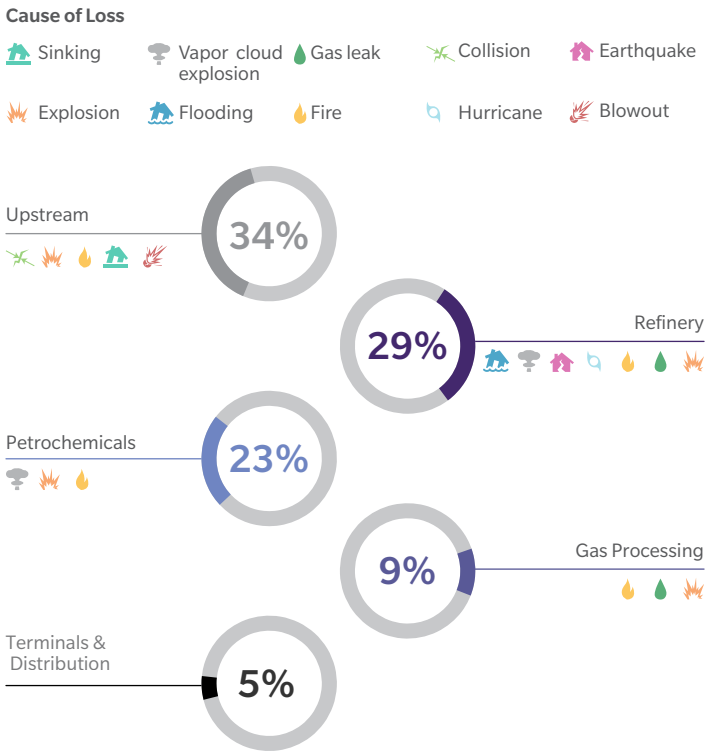
The call outs on this timeline represent the 20 largest property losses suffered by the hydrocarbon industry since 1974.

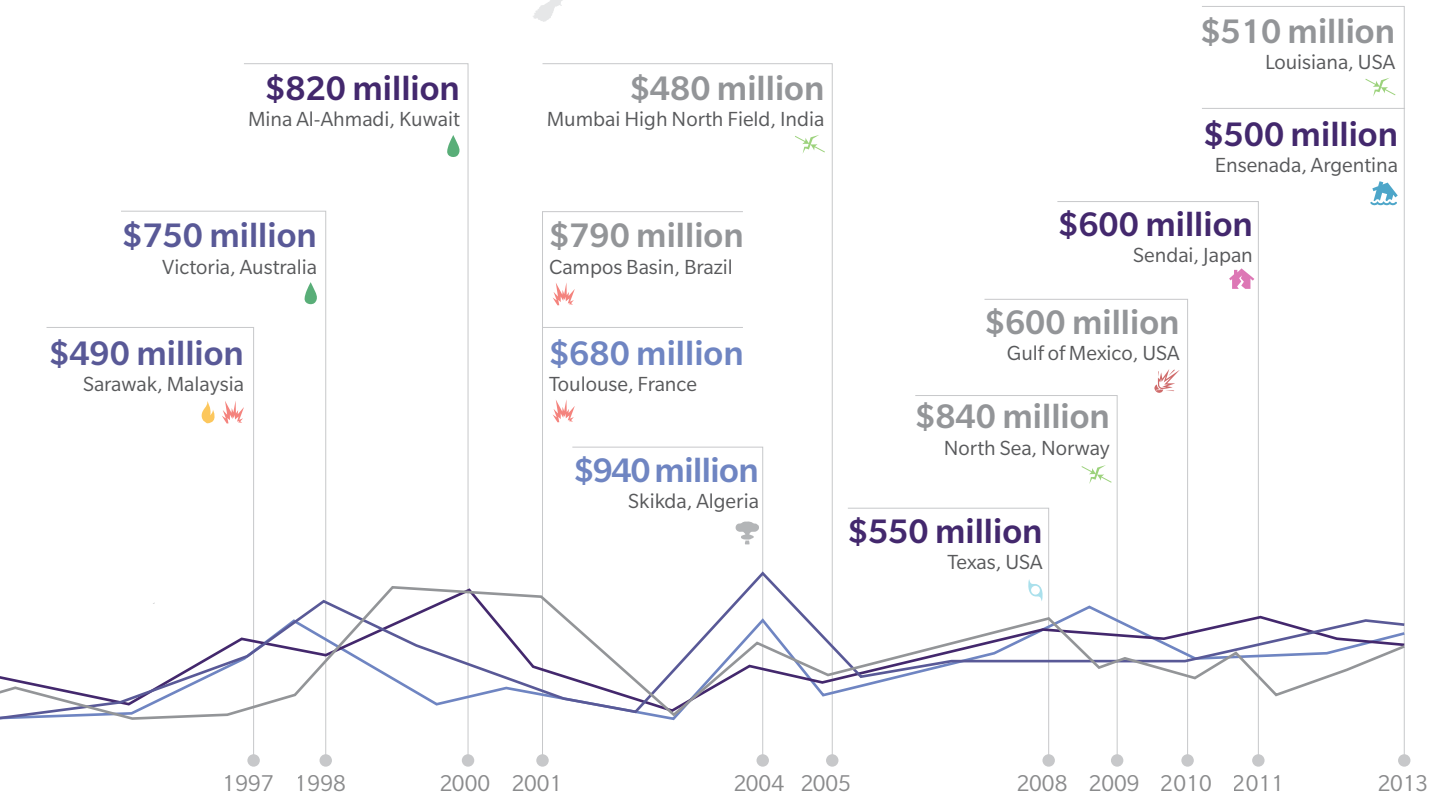


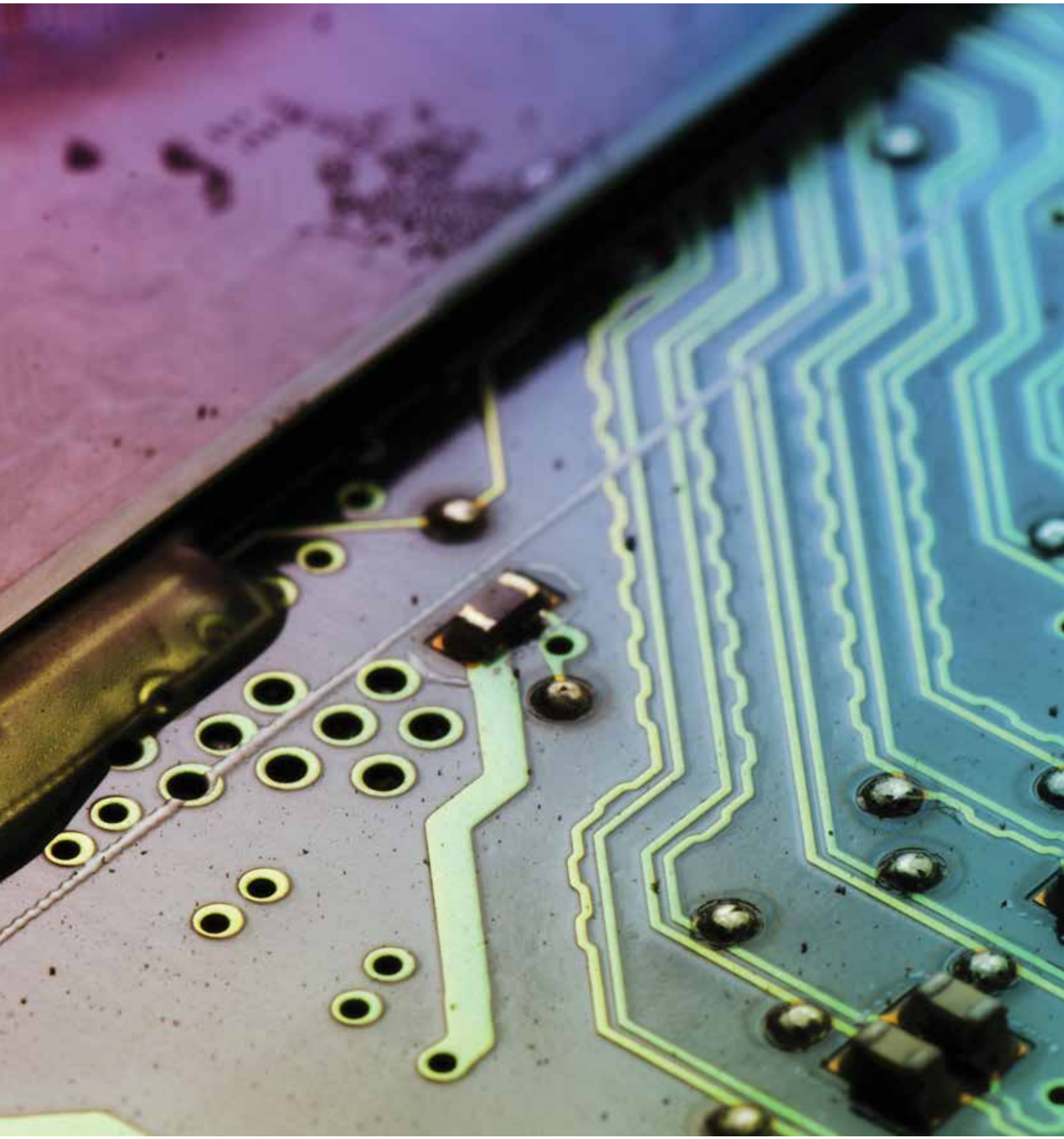
Source: The 100 Largest Losses: 23rd edition, Marsh. Marsh, like Oliver Wyman, is a subsidiary of Marsh & McLennan Companies.

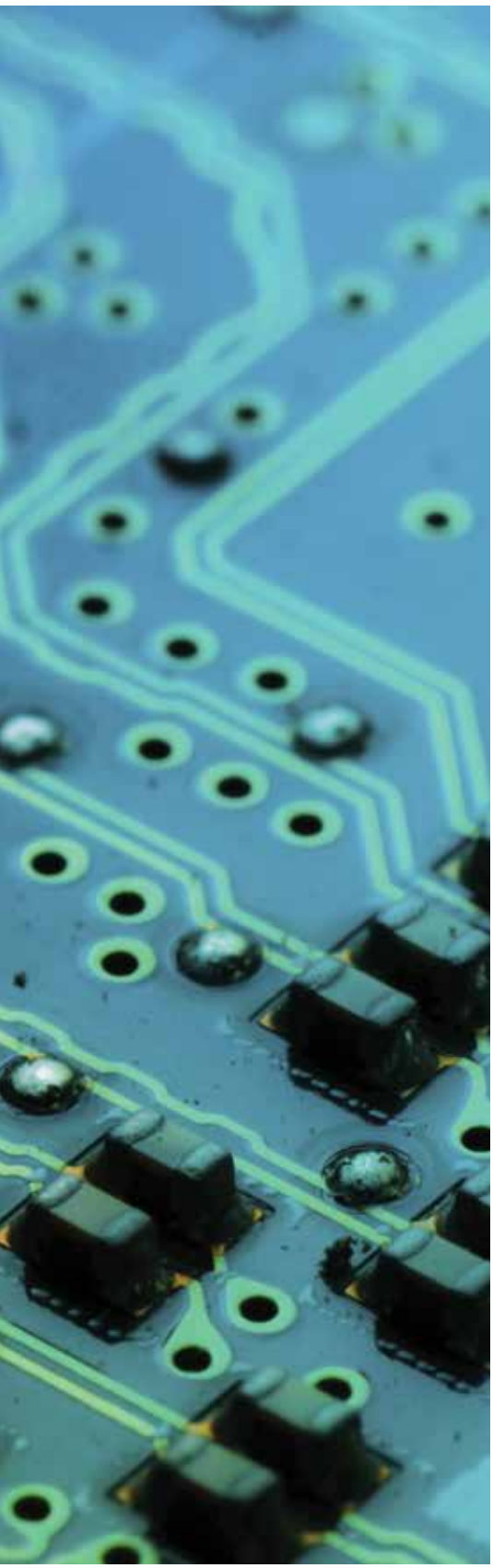
LARGEST LOSSES BY SECTOR











BIG DATA

TURNING A TIDAL WAVE OF INFORMATION INTO A COMPETITIVE EDGE

ALAN FEIBELMAN
RYAN MARKLE

As the strategic, operational and financial challenges facing utilities become more complex, these companies are finding it increasingly difficult to make informed, data-driven decisions in a timely manner. The ability to quickly consolidate, analyze and distribute business-critical information to key decision makers is the foundation of an effective data-driven culture. Such a capability could enable utilities to drive improvements in operations, reliability and customer service – leading to more attractive returns on investment.

The digital universe of information stored by utilities in the United States is expanding by an estimated 40 percent per year. This means that from 2013 to 2020 alone, it is estimated that the amount of data available to utilities will increase tenfold. Utilities that can successfully draw insights from the deluge of information can turn their data into assets at a time when they face threats to their core business.

Yet many utilities are historically ill equipped to tackle such enormous amounts of data. While utilities often use large customer and operational datasets, this information frequently is scattered across numerous information systems and organizational departments. Resource-constrained IT organizations are generally responsible for maintaining underlying systems, and these technical resources are often segregated from the subject matter experts who can put the information to use in improving operations.

10x

How much utilities' data will increase by 2020

CONNECT THE DOTS

The real value of stored data, of course, is in linking information across disparate systems and databases to generate targeted insights that drive value. For utilities, this means using their stored data to understand customer behavior more holistically across channels and interactions and to disaggregate complex operational issues, such as outage restoration.

Too often, however, companies try to aggregate their data and simply end up with larger, more confusing and unmanageable data sets. The key to creating value from stored big data is to develop projects with well-defined objectives that focus on addressing questions, and then to build targeted data sets to answer those questions. This requires the involvement of business-line employees and managers charged with the development of business solutions (not just IT professionals) to ensure the creation of a usable system for gathering and analyzing data. Finally, the analytics made possible by the project must be both backward- and forward-looking, providing a better understanding of past actions and a greater ability to predict likely wins.

Harnessing the power of big data in this way can significantly boost a utility's performance. Recently, we helped a utility improve customer satisfaction and deliver higher service levels more economically by developing insights that were only accessible after linking more than 20 different systems. Many utilities face these challenges, since customers are demanding more services across multiple touch points and communication channels, while cost pressures continue to rise. Marketing departments also struggle with matching up the right customers with the right offering and what programs should be directed to which customer segments at what time.

By "connecting the dots" through a directed, collaborative process that involved both business line units and IT, our client obtained a holistic view of its customers, across multiple interactions, different departments and different channels for the first time in its history. This view enabled the client not only to improve customer satisfaction, but also to unearth a number of multimillion dollar cost savings opportunities: The company identified a segment of high-value (and likely receptive) customers who had not yet been moved to electronic billing – representing millions of dollars in annual savings – and then produced the customer-level detail needed for the marketing department to effectively target them.

RIGHT PEOPLE, RIGHT SCOPE

The right subject matter experts (typically business or operational users, not just IT) need to be involved intimately in the design of the analytic scope and implementation of targeted databases. In too many cases, we have seen big data decisions driven by IT, with limited involvement of end users. Without business users engaged early in the project, the end result will lack the structure, clarity and ease of use critical to timely, effective decision making. Throughout the development and implementation process, business users should continue to use two considerations as guideposts: "What problems will this project address?" and "What outputs do you need to solve this problem?"

Harnessing the power of big data can significantly boost a utility's performance

Big data issues do not arise from a lack of information, but from an abundance of inputs. Deciding which inputs are necessary is critical to initial planning and to enable quick identification of scope creep. In addition, understanding where potential data linkages can be made between systems, even if these links are not perfect, allows business users to pose questions that previously could not be answered.

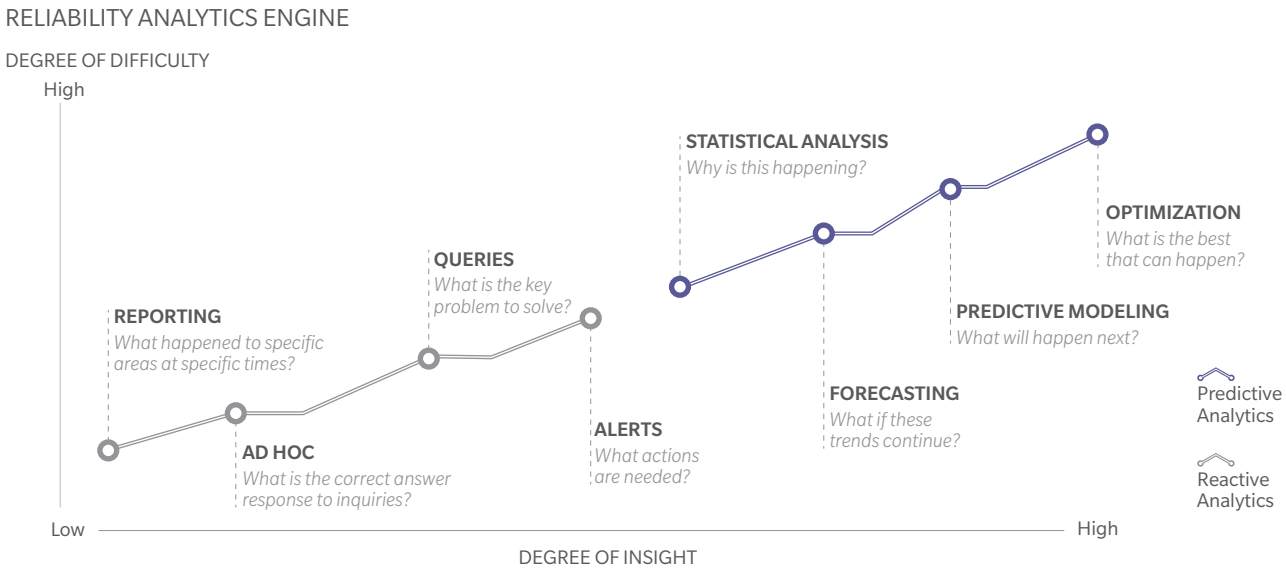
The scope of big data projects tends to grow as people attempt to encompass all possible information. This can lead to an overly complex, hard-to-use IT "solution" focused on the mechanics of data storage, rather than the end uses of the information. This risk must be recognized and addressed, as the inclusion of multiple data sources increases the complexity of project implementation as well as the effort required for ongoing maintenance, all while generating limited value for the organization.

PREDICTIVE AND REACTIVE VIEWS

Utilities should develop analytics using big data that allow them not just to react to problems – but also to steer clear of them. Making use of big data is like driving a car at night: The headlights represent predictive analytics and the rearview mirror represents reactive analytics. You need both to drive sensibly, although the choice of how much to rely on each will depend on the situation. Similarly, for utilities, both predictive and reactive information is necessary, but the right blend depends on the company and the task. (See Exhibit 1.)

The problem is that many utilities right now are driving blind, or nearly so. Utility "data marts" tend to be geared toward rearview metrics, and the IT function generates reports that track past performance, such as monthly trends or year-over-year comparisons. But a utility can make use of its stored data to develop predictive analytics, which can allow users to quickly test "what-if" scenarios and identify or improve opportunities that complement existing systems. Rearview analyses can then be

EXHIBIT 1: PREDICTIVE AND REACTIVE ANALYTICS



Source: Oliver Wyman analysis.

used to monitor performance against new opportunity areas and tweak future opportunity identification.

This blended approach requires an iterative process to determine how the different pieces of information can work together. Reactive methods can draw on past lessons to influence future decisions, while predictive methods can send the utility in new directions, tempered by reactive input.

DEVELOPING SOLUTIONS

In summary, ensuring real insights into complex business questions requires analytics that put business solutions – not data or systems – at the forefront. The right decision-support tools can empower users – with help from IT – to continue evolving analyses and reports as business issues change. Utilities do not need to cross an ocean to find opportunities to improve returns. They just need the right tools to unleash the power of the tide of data coming their way.

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SURVIVAL LESSONS

WHAT UTILITIES CAN LEARN FROM THE AUTOMOTIVE INDUSTRY

THOMAS FRITZ
AUGUST JOAS
JOERG STAEGLICH

As utilities in more countries face threats to their business models, one industry offers survival lessons: automobiles.

The core of the traditional utility business model is under siege and pressure on performance is increasing – especially as renewables gain ground and regulatory pressure rises. Unfortunately, the top-down performance improvement measures that utilities have followed in the past are not working.

We've seen this story before. When automotive companies faced similar threats to their business, they changed – dramatically. As a result, the companies not only stayed in business, but also discovered new opportunities and revolutionized manufacturing. The best-in-class have repeatedly and sustainably improved their performance by establishing new business designs, making efficient investments, reducing total costs and increasing flexibility. Their cultures were also realigned so that they could sustain these advances.

The automotive industry's continuous performance improvement is characterized by three key characteristics: a more holistic perspective, portfolios of smaller initiatives and continuous performance dialogue aimed at permanently integrating

improvements into the company's operations. Below we explore how each of these tenets could help utilities to thrive in spite of a business landscape that is undergoing dramatic change.

CHANGING PERSPECTIVE

Most utilities' performance improvement projects focus on costs and growth. But ultimately they result in little more than an incremental improvement.

Instead, utilities should adopt what we call "a business model perspective." Utilities must change their viewpoint significantly so that they can abandon their familiar environment. Like automotive companies, utilities should take into account both new and existing business areas as well as both external and internal customers. (See "A Business Model Checklist" on page 77 for 10 questions that we suggest managers ask themselves to determine where their perspective could be strengthened.)

By adopting a more holistic view of how to improve operations, utilities can unlock new and far-reaching profit potential. For example, after conducting an extensive examination of current and future business models, a utility was able to both reduce costs in its customer service department

by 25 percent and formulate a new value proposition based on the actual needs of internal customers. Before switching to such a business model outlook, the customer service department had identified potential savings of only 10 percent based on a traditional cost reduction approach.

At the same time, companies should link financial and operational outlooks. Before embarking on new improvement initiatives, managers need to determine if operational changes are meant to improve their costs, profit, cash or debt. Next, they should draw up plans for how to measure their operational improvements and benchmark themselves against competitors. Automotive companies, for example, often use benchmark analyses, such as the Harbour Report, to help them define appropriate targets for improvement.

There should also be a strategy for how the company's business model will continue to develop and a broad understanding of what that will mean for both operational management and its financial performance. For example, automotive companies have improved their key performance indicators and operating results substantially, in large part because they consider almost every aspect of their business before making critical decisions – their value chain, marketing, quality, productivity in production, supply chain, as well as technical assistance and administration. More recently, some even involve their suppliers and service providers both in production and in supporting functions such as contract manufacturing and pre-assembly, or as system suppliers.

A PORTFOLIO OF INITIATIVES

It is counterproductive to carry out "big bang" initiatives in environments with constantly increasing market pressure. Traditional stand-alone isolated, cost reduction projects have a defined end, and thus cannot create sustainable profitability.

A better approach, and one pioneered by automotive companies, would be for utilities to implement permanent programs with multiple initiatives. In the automotive industry, individual improvement steps may assist with a new production plant or the launch of a new product. But permanent improvement measures that range from material cost reductions to better utilization of materials and capacities to the construction of new production plants, deliver the most significant progress. Indeed, projects like these can lead to not just one-time cost savings in the range of 10 to 15 percent, but also annual improvements in the range of 3 to 5 percent.

One reason a portfolio of smaller initiatives is preferable for a utility is that it lets the company avoid disaster should one big initiative not work out. To make a major contribution to sustainable performance, each smaller initiative must be integrated into a program portfolio and fulfill a specific requirement. Multiple initiatives, such as purchasing process improvement or group-wide liquidity management, often impact the program's goals in new ways. Every initiative must also have a clear focus and a clearly defined objective.

A succession of different initiatives also enables companies to achieve improvements driven from top-down as well as up from a grassroots level. The focus, for instance, can

begin with costs, and then move on to cash. At times, groupwide global issues, such as a utility's information technology infrastructure, could take priority. At other times, targeted initiatives at the individual stages of the value chain can be the focal point.

PERMANENT INTEGRATION

Automotive companies have shown that performance improvement programs can only reach their full potential with consistent management. Ideally, a continuous performance dialogue will be established that extends from the board of directors and management team (with quarterly performance reviews for each business area) down to an operational team level (with team performance reviews at much shorter intervals).

Individual employees also must be motivated to participate in the improvement of the company's performance. This means involving people starting from when problems are first identified, through the generation of ideas, to the detailed development of a solution. In addition, it is important to adapt both employee incentive systems and career paths, so that each employee finds it personally worthwhile to contribute.

A utility can start a program at any level. These programs, however, are usually most effective when someone is given the authority to manage the initiatives and to define clear targets for them. With the help of management tools, it is possible to monitor the results of performance improvement initiatives and to spread those successes throughout the organization. Operating divisions can also be helped in optimizing the results of performance improvement initiatives by providing them with a few flexible tools.

BREAKOUT PERFORMANCE

Automotive companies have proven that it is possible for manufacturing industries to achieve breakout performance. While it may not at first seem intuitive, we believe utilities have a real chance to benefit from the auto industry's experiences. By combining a "business model" performance orientation with a diversified, long-term improvement program, utilities can also systematically prepare themselves for future challenges. Like automotive companies, they will gain financial leeway for strategic realignment and, consequently, foundations for successful and continued development in a rapidly changing market environment.

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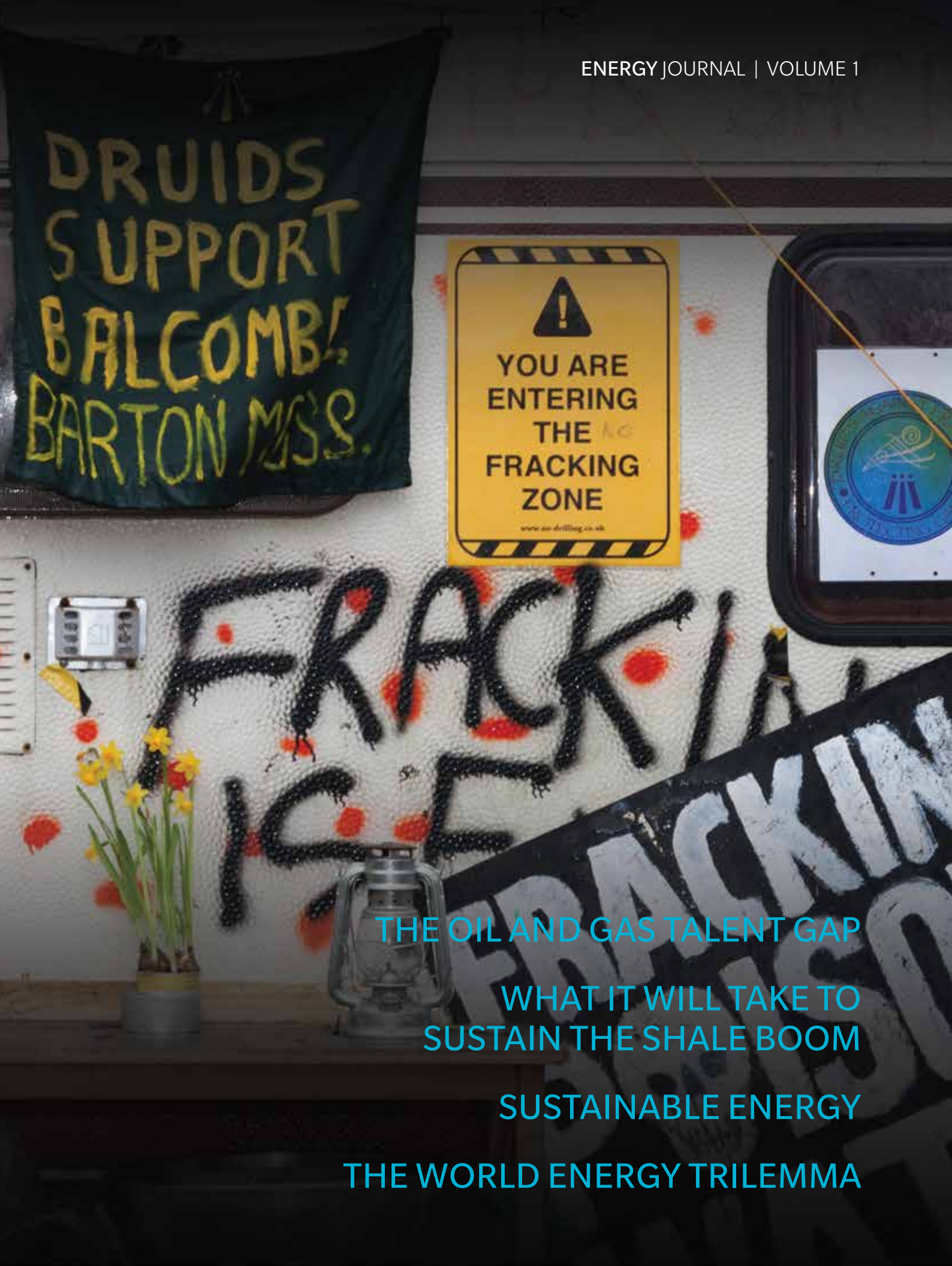
"BUSINESS MODEL" CHECKLIST

The following 10 questions can help managers at utilities evaluate what improvements may be possible:

1. What is the business and the role of the individual units?
2. What are the scope and features of the products that we offer? What features do customers value most?
3. Who are the internal and external customers and which segments exist?
4. How do the products address the challenges customers face?
5. How do products reach customers, and what do customers expect?
6. What internal core processes must the units master?
7. How much do core processes cost?
8. Which processes are sourced out?
9. How does the offering differ from other market offerings, and why should the tasks be solved by this unit and no other? Why not choose an external alternative?
10. How much do core processes cost?

Source: Oliver Wyman analysis.

RISK



THE OIL AND GAS TALENT GAP

WHAT IT WILL TAKE TO SUSTAIN THE SHALE BOOM

SUSTAINABLE ENERGY

THE WORLD ENERGY TRILEMMA

THE OIL AND GAS TALENT GAP

PREPARE FOR A CHRONIC SHORTAGE IN EXPERIENCED EMPLOYEES – NOW

JOHN KOOB
KERIC MORRIS

Oil and gas executives won't be prepared to meet tomorrow's production demand if they don't quickly address the one asset about which they know the least: their people.

Today's most commonly used solution to fix workforce shortages is to hire top talent away from competitors. But this approach amounts to little more than an industrywide addiction to reshuffling the same thinning deck of cards.

A recent oil and gas talent outlook survey of more than 100 oil and gas managers in 50 countries conducted by Oliver Wyman's sister company Mercer revealed that most energy industry managers anticipate a significant, and growing, talent gap in the next five years. Many believe their companies could yield meaningful returns if they can solve their talent challenges — in the form of greater productivity, lower rates of attrition, increased production and decreased operating costs.

Unfortunately, these goals are not achievable on a sustainable basis if every company resorts to poaching in order to replace their retiring baby boomer workforce, driving up labor costs for the entire

150,000

The number of years of experience that the oil and gas industry will lose over the next five years

industry. Raiding is an increasingly difficult and expensive option – in large part because rapidly expanding national oil companies, refiners, international oil companies and new entrants are all competing for employees with similar skills in what is now a fluid international market. And yet, a majority of the respondents who employ more than one million workers in the aggregate say they hire workers from outside the organization versus promoting, training and transferring existing employees.

So what can be done?

CAST A WIDER NET

For starters, human resources executives should expand their scope and cast a wider net. When considering the core qualities and traits needed to fill many of the vacancies, executives will find that workers in other adjacent professions may be excellent candidates. For example, certain oil and gas roles would be ideal for employees who once were firefighters, police officers or automotive technicians; served in the military; or worked in prison support roles and manufacturing. Certain civil, chemical and electrical engineering professions also have viable transferrable skills.

Social technologies can assist oil and gas companies with tapping into a larger pool of candidates. With the aid of cutting edge social data technology, oil and gas firms can sift through tens of thousands of candidates to find an ideal group of 300 to 350 candidates with the right motivational and behavioral characteristics and appropriate work history to fit their cultures relatively easily. They can also take their typical employee referral programs to a higher level by asking top employees for permission to access their Facebook or LinkedIn profiles to uncover great leads and excellent co-workers.

At the same time, some companies should consider implementing apprentice programs. While these types of initiatives might not be a short-term solution to their problems, companies might be able to partially bridge their gaps by offering alternative paths to college. In addition, they should ramp up recruiting efforts aimed at rekindling interest and excitement in the energy industry at target universities.

CODIFY UNWRITTEN KNOWLEDGE

Companies would also be wise to take the time to capture the unwritten knowledge of employees readying for retirement and offer flexible workweeks and phased retirement programs. Our survey shows that within the next five years, oil and gas companies could lose 50 to 80 percent of workers age 55 and older, which equates to 150,000 years of experience.

This is not a simple task. These soon-to-be retirees' unwritten knowledge from years of experience needs to be captured and codified, either on the job or in a classroom, and transferred to the rest of the organization, so that less experienced workers are prepared to move into the senior ranks. For this to happen, retirees need to be trained and incentivized to be teachers and coaches. This can require helping many to learn how to connect with the younger generation.

DEVELOP A WORKFORCE STRATEGY

Finally, companies should invest in modeling scenarios of what their workforce strategies are going to look like. They need to create better professional development paths to improve the "hit rate" of both producing and retaining great staff. One way to achieve this is for companies to plot optimal paths in their organizations to enhance the development of both technical and managerial staff, potentially shortening the journey to senior positions.

Without this data, energy executives are blindly placing bets in the hope of landing the necessary talent. Perhaps the roulette wheel will land on their numbers. But this is a dangerous gamble, given that the ability of oil and gas companies to secure talent will have as great an impact on the investments they pursue as other key strategic considerations like the quality of potential assets and access to funds. Human resource executives need to step up and provide clarity around both the talent gaps that are developing and the creative workforce-building techniques that can solve them. Only then will future wagers be sound.

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THE OIL AND GAS TALENT GAP

Mercer, like Oliver Wyman a subsidiary of Marsh & McLennan Companies, recently conducted a landmark study of the talent outlook and workforce practices in the oil and gas industry.

Mercer's study showed that the industry is confronting a chronic, global talent shortfall, especially among the more experienced workers. To fill that gap, many companies plan to recruit workers away from their competitors. But it is unlikely that this approach will be sufficient to meet demand. Not only is the strategy impossible to sustain, but oil and gas is in competition for the same pool of talent with other industries.

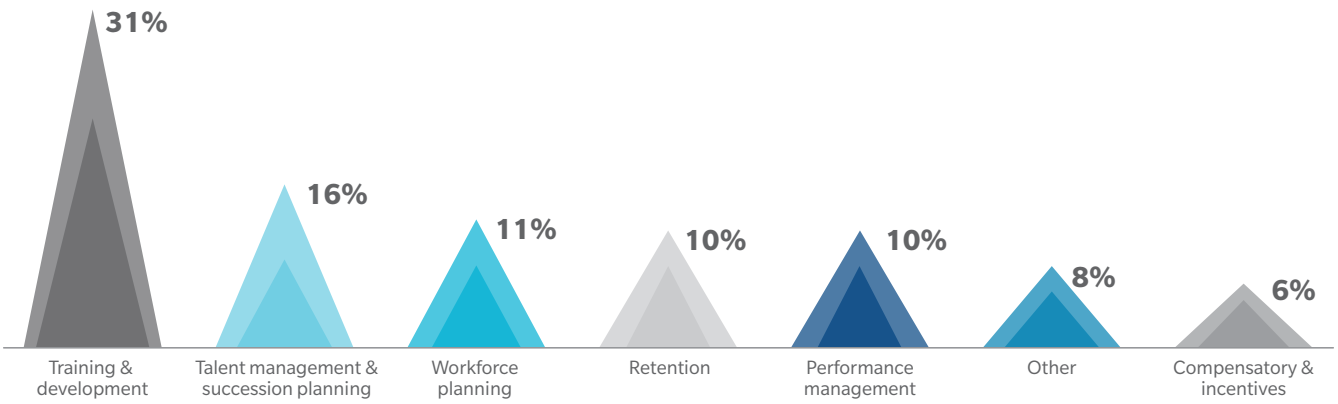
Addressing the talent gap will require industrywide solutions that start with companies understanding the internal and external market forces at work. To that end, these pages summarize the results of the survey that consisted of 126 participants from 112 organizations with more than one million employees, representing a cross-section of company types in 50 countries.

SKILLS GAPS IN EXISTING WORKFORCE

Percentage of respondents facing a gap in the skill set identified

TOP TALENT MANAGEMENT INITIATIVES UNDERWAY

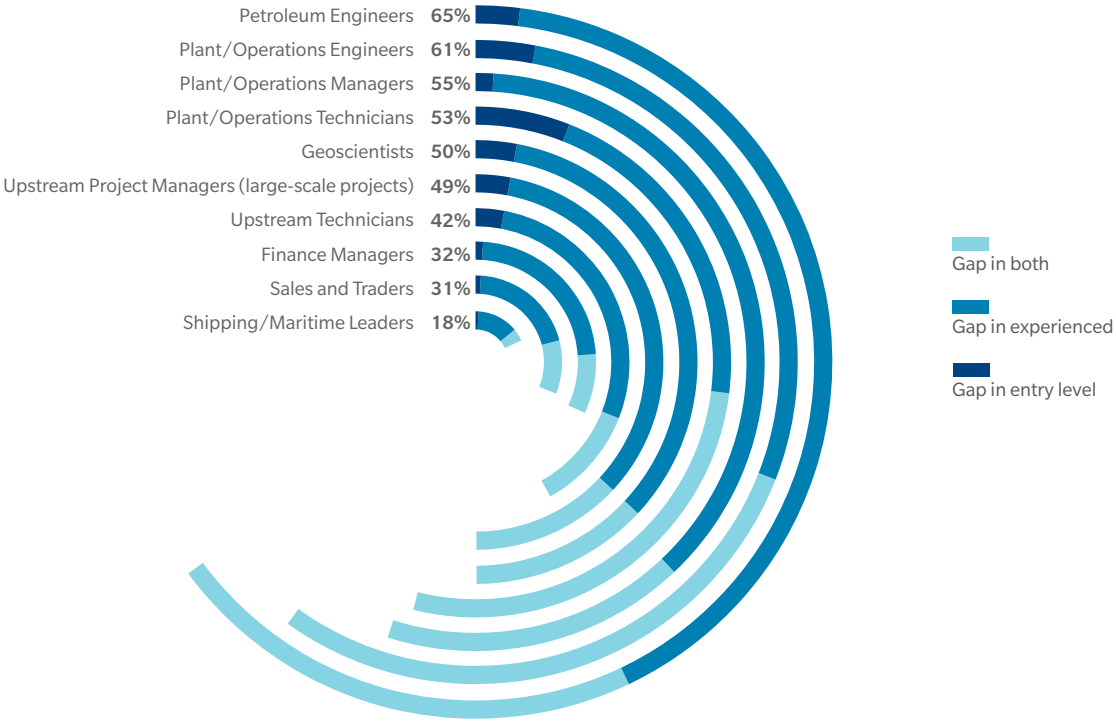
Percentage of respondents selecting initiative



Source: Mercer's Global Oil and Gas Talent Outlook and Workforce Practices Survey. Mercer, like Oliver Wyman, is a subsidiary of Marsh & McLennan Companies.

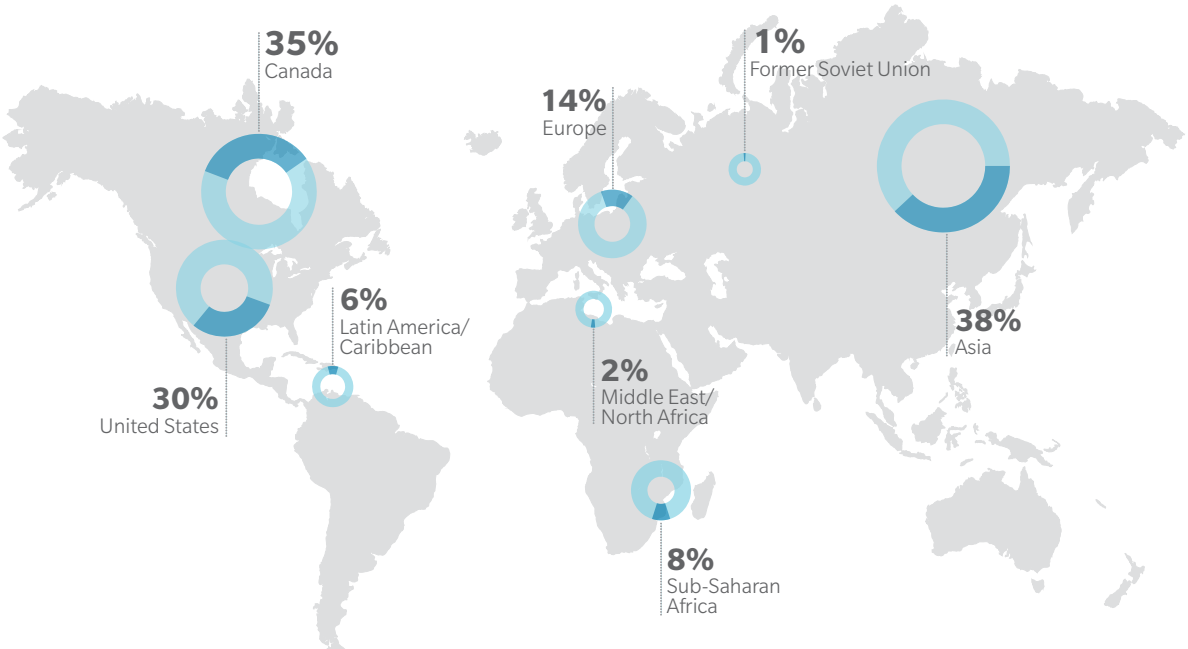
PERCENTAGE OF COMPANIES ANTICIPATING A TALENT GAP

Industry perception of pending talent gaps across occupational groups



REGIONS WHERE OIL AND GAS FIRMS FACE SIGNIFICANT TALENT MANAGEMENT CHALLENGES

Respondents were asked to indicate the regions in which they face their toughest challenges. Below are the percentage of respondents who are experiencing difficulties meeting manpower needs in a particular region. Multiple selections were possible.



WHAT IT WILL TAKE TO SUSTAIN THE SHALE BOOM

GETTING AHEAD OF OPERATIONAL RISKS AND MISCONCEPTIONS

IRFAN BIDIWALA
BOB ORR

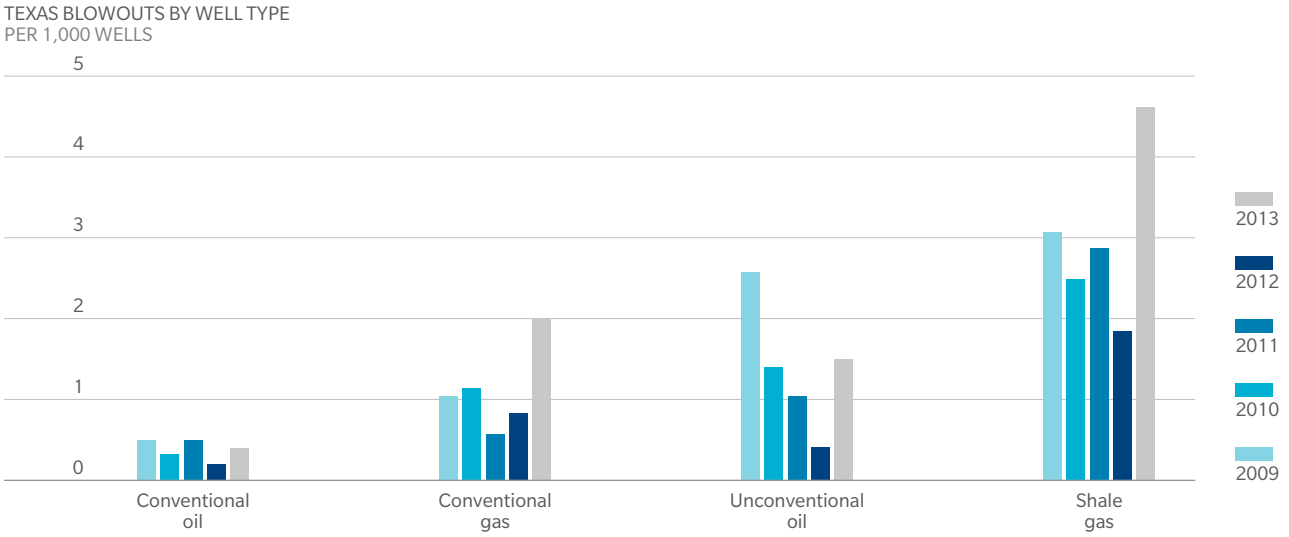
Producers using new technologies to drill oil and gas wells in shale fields face special environmental and safety risks that, left unmitigated, result in more safety incidents than conventional operations.

That presents the industry with two problems, each of which is capable of burying the shale business under lawsuits and regulations. First, there are real safety and environmental risks that oil and gas companies must address by adapting their existing operational risk management systems. Second, there is a perception of risk among local people and environmental activists that isn't always justified. Thus far, however, energy producers lack an approach that satisfies this concern.

Oil and gas companies urgently need to get ahead of these challenges. The industry's fortunes are at stake. The United States is on track to reclaim its rank as the largest oil producer in the world as early as 2015, thanks to shale technology. Such a development could transform the US economy, its fuel security and global politics. But knee-jerk policies based on fear, rather than actual risk, could derail this energy revolution.

EXHIBIT 1: BLOWOUTS IN TEXAS

TEXAS HAS MORE BLOWOUTS IN SHALE VERSUS CONVENTIONAL OPERATIONS...



Source: Railroad Commission of Texas, EIA, Oliver Wyman analysis.

Oil and gas industry officials point out that, so far, shale drilling has not caused any catastrophic environmental incident. Further, industry insiders say no conclusive studies prove that shale exploration and production can cause more environmental harm than conventional operations.

Nevertheless, it is true that the maturing shale industry is experiencing more safety and environmental incidents than traditional operations. Oil and gas companies must grapple with – and master – complex geology, large-scale operations and complicated new technology, given the growing reliance over the past two decades on shale drilling.

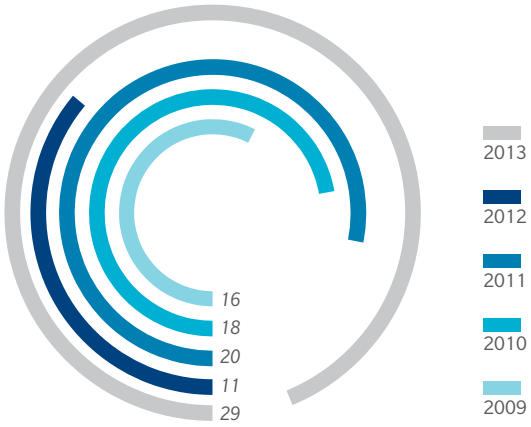
BLOWOUTS

As a result, the number of blowouts from 2009 to 2013 for unconventional oil and shale gas wells was higher than for conventional wells in Texas, the largest oil and gas producing state in the country. The rate of blowout incidents in 2013 for shale gas wells was approximately twice as high as conventional wells, and for oil, the rate was three times higher. (See Exhibit 1.)

This indicates that oil and gas companies need to adopt safety systems that address the special risks inherent in the new technology used to drill wells in shale fields, just as they have safety management systems for their conventional operations. Companies could significantly improve their safety, regulatory and financial risk profiles

...AND THE NUMBER OF BLOWOUTS IS DRAMATICALLY INCREASING.

TOTAL BLOWOUT INCIDENTS IN TEXAS



2.6x

How much the number of blowout incidents in Texas increased from 2012 to 2013

Source: Railroad Commission of Texas, EIA, Oliver Wyman analysis.

by adopting a more customized mitigation approach that evaluates shale drilling risks in comparison to the risks of traditional operations.

Just as important, the oil and gas industry must allay local concerns to maintain the social license to explore and produce from shale resources. Oil and gas companies are increasingly at odds with many communities where people have little experience with drilling and are concerned about health and safety risks.

Blowouts and environmental incidents increase the risk that regulators will impose onerous rules or shut down production. This has already happened in the most likely and unlikely of places, from the state of New York to the city of Dallas. Groups pushing for stiffer regulation worry about environmental and health issues ranging from deforestation and air pollution, to water contamination and earthquakes.

To understand the popular misconceptions at the heart of the debate, we examine three of the chief concerns about shale drilling below and suggest steps to address them.

CONCERN 1
SHALE EXPLORATION AND PRODUCTION IS LARGELY UNREGULATED

There is a widespread, false perception that oil and gas companies operate in shale fields without regulatory oversight. It is true that some regulators were initially caught off guard and could not keep up with advances in drilling technologies and practices.

But, as the industry has matured, a number of state and federal regulatory agencies have stepped in to develop regulations and areas of jurisdiction. Regulators need to continue to ensure environmental safety, with rules that allow operational flexibility and economic profitability of shale exploration and production.

CONCERN 2
CHEMICALS USED IN HYDRAULIC FRACTURING CAUSE LONG-TERM ENVIRONMENTAL DAMAGE

This is perhaps the most controversial issue in the whole debate. There are two fundamental concerns: chemicals in hydraulic fracturing (fracking) fluid could cause long-term environmental damage to underground formations, and these chemicals could contaminate underground water aquifers.

The industry is too young to have a full sense of the long-term environmental impact of fracking chemicals. Still, the initial reluctance of some companies to disclose the chemicals used played on the public's worst fears. The industry has since made progress on public disclosures, but state regulatory requirements are inconsistent and the debate continues over just how much disclosure is enough.

Both sides raise valid points about the contamination of underground aquifers. Critics of fracking point to contaminated water samples taken near oil and gas wells. Industry officials argue this contamination was pre-existing, and not the result of hydraulic fracturing chemicals.

Stakeholders must agree on a better approach. One step that could reassure the public and protect producers is baseline testing of water sources prior to drilling. Compare those results to post-drilling samples, and disclose the results in a transparent manner.

CONCERN 3
WATER USED FOR HYDRAULIC FRACTURING IS DEPLETING RESERVOIRS

A third criticism of hydraulic fracturing is that using 4 million to 6 million gallons of water per well is a significant depletion of already stretched water resources. Some say it is particularly irresponsible to use so much water for drilling during a drought in several states, including Texas.

The amount of water actually used for hydraulic fracturing is a small percentage of total water use. It is less than 1 percent of the

The oil and gas industry must ease popular concerns to maintain the social license to explore and produce from shale resources

total volume in Pennsylvania and Texas, for example. If droughts continue, however, the water-use debate will continue as well. One way to ease concerns is to improve water recycling in oil and gas fields.

CREDIBILITY IS CRITICAL

Neither an individual company nor the industry can afford public misunderstanding of shale drilling. Establishing a solid and transparent safety record, together with evolving safety practices as risks are better understood, will bolster public confidence. Environmental groups and non-governmental organizations that serve the critical role of representing the public interest should also carefully distinguish between real and perceived risks to maintain credibility and a feasible agenda.

The stakes are high for all involved. But by keeping shale production clean and safe, producers can support a sustained economic boom for themselves and others.

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SUSTAINABLE ENERGY

FINANCING GERMANY'S ENERGY TRANSITION

THOMAS FRITZ
DENNIS MANTEUFFEL
JOERG STAEGLICH

Germany's attempt to rely on renewable sources of energy for 80 percent of its electricity demand by 2050 is one of the most ambitious economic ventures in the nation's history. It requires the utility industry, which has relied heavily on conventional energy in the past, to undergo a fundamental change. In addition, the investment costs involved in this project are enormous. Our projections show that it remains uncertain whether there will be sufficient financing to meet the investment needs of both Germany's transmission network and its conventional power generation. As a result, it is important for the government and regulatory bodies to adopt countermeasures – otherwise the energy transition may fail.

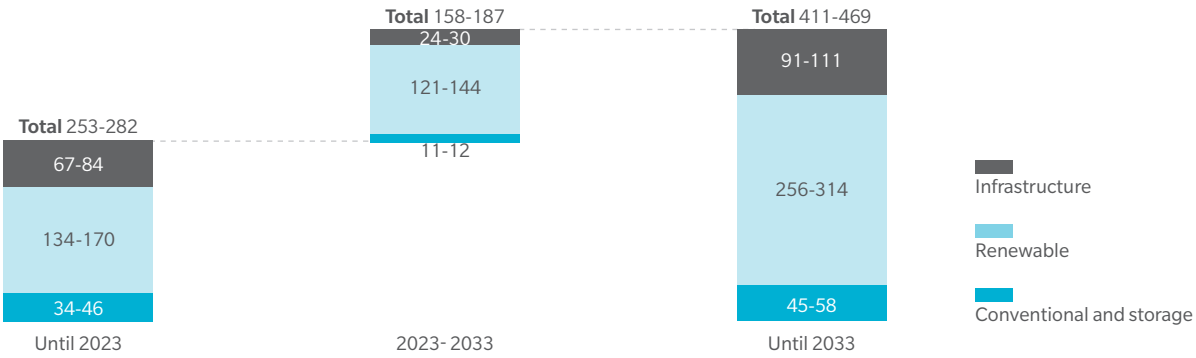
According to Oliver Wyman's calculations, the investments required to realize Germany's energy transition may come to as much as $469 billion by 2033. Out of this amount, up to $282 billion will be needed as soon as 2023. Renewable power generation will be the largest cost item followed by investments in expanding transmission and distribution networks (including the introduction of smart meters), which will likely require $111 billion. Conventional power generation and storage will need investments on the order of $58 billion. Both are necessary to secure energy supply in Germany, given the uncertainty of the availability of renewable power sources. (See Exhibit 1.)

At the same time, because of the stagnating energy business in Germany, the earnings base for utilities is fundamentally shifting from

EXHIBIT 1: INVESTMENTS REQUIRED FOR GERMANY'S ENERGY TRANSITION

RANGES FOR INFRASTRUCTURE, RENEWABLE POWER AND CONVENTIONAL POWER AND STORAGE, REFLECTING MULTIPLE SCENARIOS MODELED BY OLIVER WYMAN

ESTIMATED COSTS BY INVESTMENT AREA IN BILLIONS OF DOLLARS



Source: Network development plan 2013, 2nd draft, DENA distribution network study, Fraunhofer study "Electricity production costs of renewable energies" (2012), Oliver Wyman analysis.

$469 billion

Oliver Wyman's estimate for how much investment is needed by 2033 for renewable sources of energy to meet most of Germany's electricity demand by 2050

centralized to decentralized activities. This significantly limits the freedom of traditional players to make investments. Consequently, if current conditions and goals remain the same, the utilities' market share in power generation capacity will probably decline by one-third, to less than 50 percent by 2033. New players, such as private individuals, banks and private equity investors, will enter the energy market as competitors. Even with these additional players, it won't be possible to cover the investments needed for the energy transition in all areas. There will be considerable gaps in the financing of the transmission network, conventional generation and storage, as well as offshore wind, until 2023.

When we examine the risk-return profile of individual sectors, most of the areas in which investments are needed for the power transition should see returns of between 4.5 to 6.5 percent, with low to medium risk. Conventional generation and storage, as well

as offshore wind farms, are an exception. The latter have the potential to generate above-average returns of up to 10 percent.

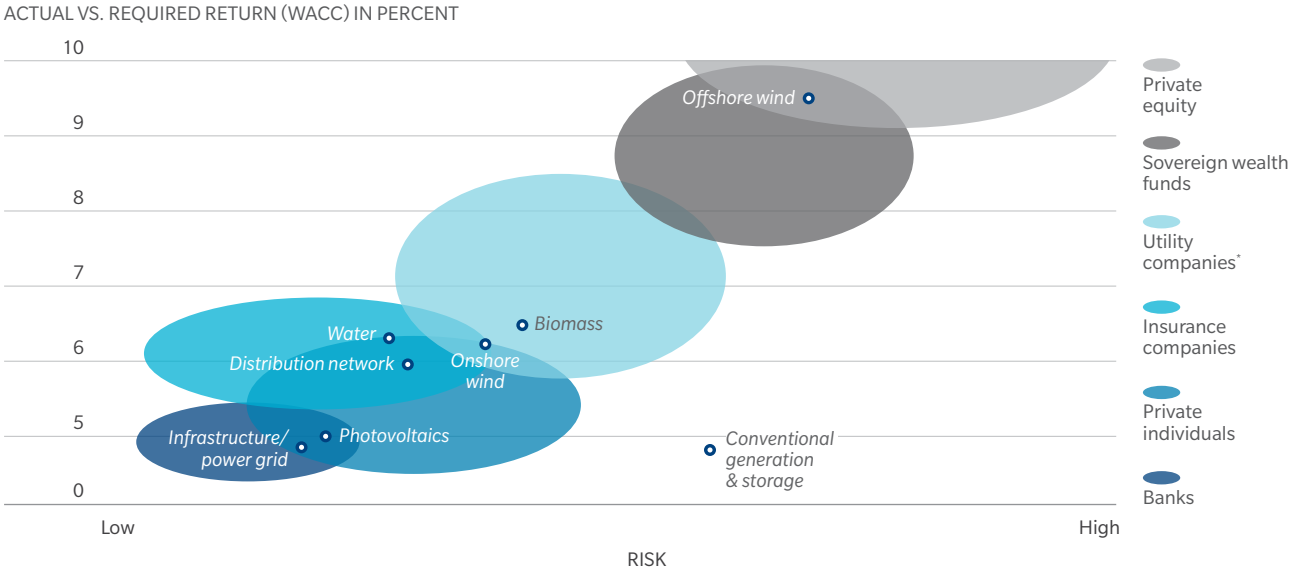
HIGHER RISKS

Nevertheless, at the same time, offshore wind and conventional energy generation and storage also bear the highest risk for investors. The situation of conventional generation and storage has deteriorated significantly in recent years. In the past, the risks were moderate and returns were high. In recent years, however, profits have shrunk considerably because of falling wholesale prices. At the same time, economic and political risks have become greater.

A comparison of the risk-return profile of the various investment areas with the willingness of investor groups to take risks reveals that investments in conventional generation and storage are currently not attractive to any market players. Only traditional utility companies are still investing in the sector today.

However, those investment decisions were made at a time when the market environment was entirely different, and most of the decisions cannot be reversed. Nevertheless, numerous utilities have since broadened their portfolios and are extremely active in almost all areas of the energy market today. (See Exhibit 2.)

EXHIBIT 2: LIKELY CORE INVESTORS FOR EACH TECHNOLOGY BASED ON THEIR RISK PROFILES



Source: Various publications, publicly accessible company data, Oliver Wyman analysis.

* Mean of the risk-return profile, investments in higher risk (offshore wind) as well as lower returns (distribution network) are common.

FINANCING GAPS

If one compares the investments needs for expansion and how much investment is expected, it comes as no surprise that the largest financing gaps are in the area of conventional generation and storage. By 2023, the gap between the amount of investment required and the amount of investment expected for conventional generation and storage will reach $22.4 billion – and $10 billion by 2033. By contrast, transmission networks and offshore wind farms will suffer from financing gaps of only between $3.7 billion and $15 billion respectively through 2023.

The persistent financing deficit for conventional generation and storage is all the more worrisome because, alongside the network, conventional power plants are key to ensuring an adequate power supply in Germany. (See Exhibit 3.)

Some politicians already recognize this problem. That's why there has been substantial discussion around the possibility of incentives for utility companies to provide power plant capacities that currently do not generate profit in the regular market but are needed to assure the future stability

EXHIBIT 3: ESTIMATED FINANCING GAPS FOR GERMANY'S ENERGY TRANSITION

EMERGING FINANCING GAPS
US$BILLION

Source: Oliver Wyman analysis.

of the network. The German government has also decided to reduce the targets for offshore wind farms, which will help close the financing gap.

However, no appropriate solutions have yet to be identified for closing the significant financing gaps for conventional generation and storage. As a result, the whole energy transition has been put into question. For it is not investments in renewable energies that are at issue, but rather conventional power generation investments.

Discussions about how to address the challenges in conventional power generation have so far primarily focused on capacity markets. But these proposals fall short of the mark. Instead, a wider range of approaches is needed to find an ideal social, political, legal and economic solution with as little intervention in the market as possible. Changing market rules by extending the allowed price range and allowing for extreme price peaks may be important first steps in the right direction.

RESOLUTE ACTION

Germany's transition to a more sustainable energy system can only succeed if all of the energy market's supporting pillars are stable. These include a reliable transmission network, renewable power generation and conventional generation and storage. If significant financing gaps in the conventional segment remain, then one of the pillars for success will crumble and the sustainability of Germany's power supply will be in doubt. Resolute action is critical.

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THE WORLD ENERGY TRILEMMA

THREE CONDITIONS TO ATTRACT ENERGY INVESTMENTS

LUCY NOTTINGHAM
DAMIAN WEST

Germany's struggle to finance its transition to a more sustainable energy system is emblematic of a global challenge. Around the world, nations are confronting financing gaps as they seek to build energy systems that are secure, affordable and environmentally sustainable. Yet balancing these three dimensions of what the World Energy Council and Oliver Wyman define as the world's "Energy Trilemma" is critical for global growth and prosperity.

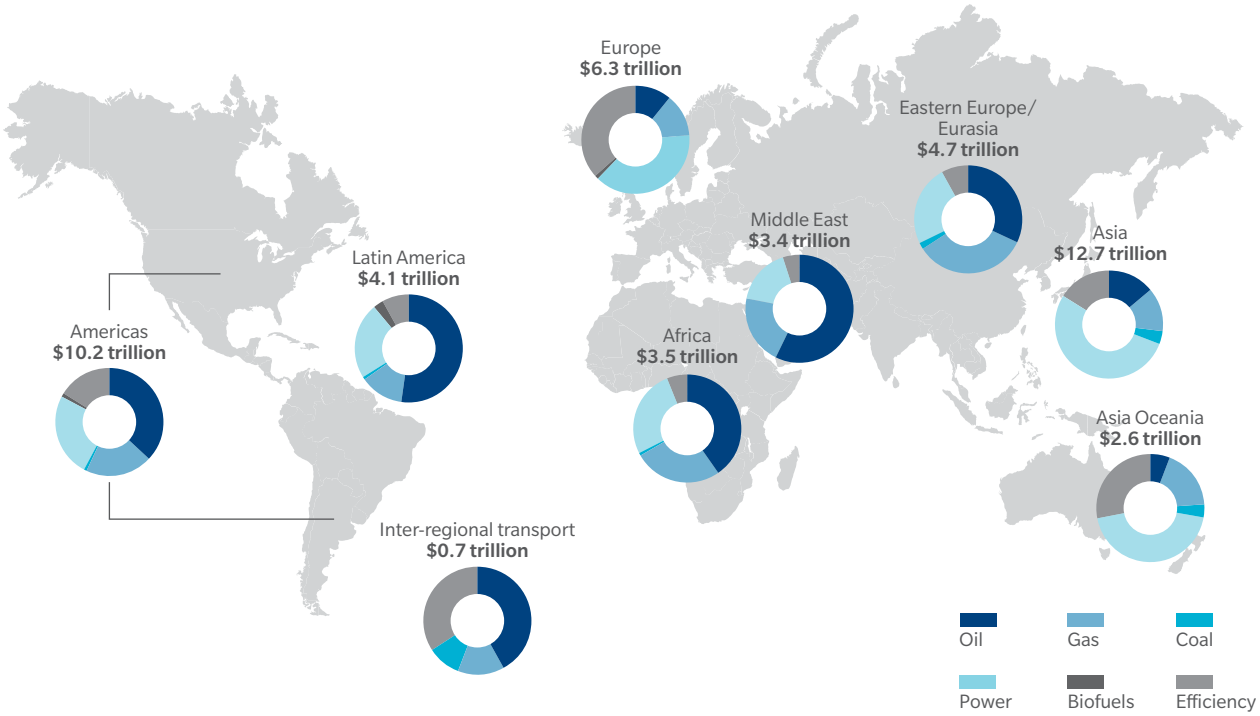
A minimum of $40 trillion will need to be invested in energy infrastructure and an additional $8 trillion in energy efficiency initiatives by 2035, in order to meet rising global demand for energy, according to the International Energy Agency. The problem is that uncertainty around technological changes, energy politics, climate framework negotiations, underdeveloped economies and volatile energy and commodity prices are all adding a significant risk premium to the cost of capital for energy investments. In some cases, they are discouraging needed investment altogether. (See Exhibit 1.)

Investors' concerns are well founded. The impact of policy pronouncements can be severe for energy companies and investors – even when they are merely proposals. For example, the market valuation of United Kingdom-based energy firm Centrica shrunk by $1.7 billion within 24 hours after the leader of the UK's

EXHIBIT 1: MEETING THE WORLD'S ENERGY FINANCING NEEDS

THE WORLD NEEDS $48.2 TRILLION IN ENERGY INVESTMENTS BY 2035

INVESTMENT NEEDED BY REGION
US$TRILLION



Source: World Energy Investment Outlook, IEA 2014.

main opposition, Ed Milliband, pledged in September 2013 to freeze consumer energy prices for 20 months if his party won the 2015 general election. The stock price of another UK-based energy firm, Scottish and Southern Energy, fell by 5 percent.

It's clear that governments and the energy industry can't permit the present status quo to continue. To build the sustainable energy systems of the future, they need to work together to discover a risk-return equation that will drive the investment needed. Most theories are developed at a macroeconomic level for what the right balance may be. But to truly understand how investors evaluate energy investments, you need to speak with the people who actually invest in, manage and govern the energy sector.

Over several years, together with the World Energy Council, Oliver Wyman has invited energy industry chief executive officers, key policymakers and leaders of the financial community to help identify the critical factors for attracting sufficient investment to deliver on the world's energy requirements. Our discussions with energy industry stakeholders quickly focused on three basic conditions that must be met to attract greater investment in energy. Unlike complex macroeconomic forces, all of these

conditions, while challenging, are still well within the control of energy companies, governments and investors. Below are the three keys that in our view are necessary to securing the investment needed in the sector:

CONDITION 1

Policymakers must clearly signal their future strategies and put in place lasting policy and regulatory frameworks. Investors consider coherent, long-term, accessible, predictable and transparent energy policies and regulations as a prerequisite for investing. These policies must also be coordinated with other energy-related areas such as transportation.

CONDITION 2

Adequate financial infrastructure must exist for funds to flow easily to the energy sector. This is especially true for developing countries and emerging technologies. Today, approximately 70 percent of investments are made in fossil fuel-related projects that are familiar to investors. Overcoming this bias toward established energy systems and driving investment in emerging markets will require new approaches to opportunity assessment and greater use of targeted financing mechanisms such as project finance as well as infrastructure and green bonds.

CONDITION 3

The energy sector must bring clearly bankable projects to the market. Today, preparing a project and arranging for funding can account for 5 to 10 percent of a project's costs and add several years to the project's development. But this gap could be narrowed if project capabilities were more widely available and governments, energy companies and investors embraced more standardized and transparent procedures. Already, there seems to be broad agreement on the basics required for projects to be supported, such as adequate financial and technical information, as well as participants with sufficient technical and management skills.

The message from Germany and elsewhere is clear. We face a considerable challenge in building the energy systems of the future. But if the energy industry's stakeholders can find ways to drive the investment needed to take advantage of newly emerging approaches and technologies, the opportunities for growth are great.

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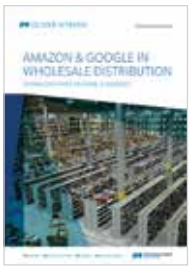

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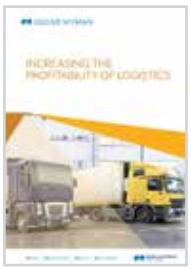

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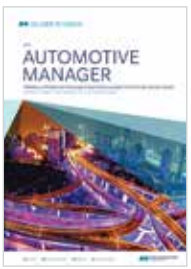

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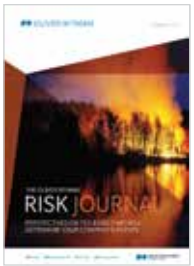

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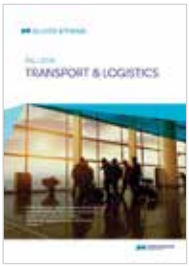

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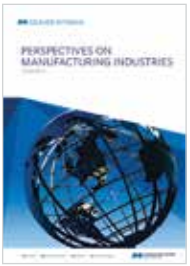

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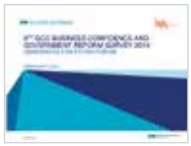

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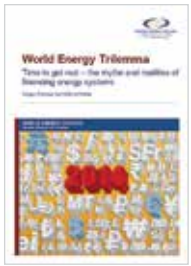

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