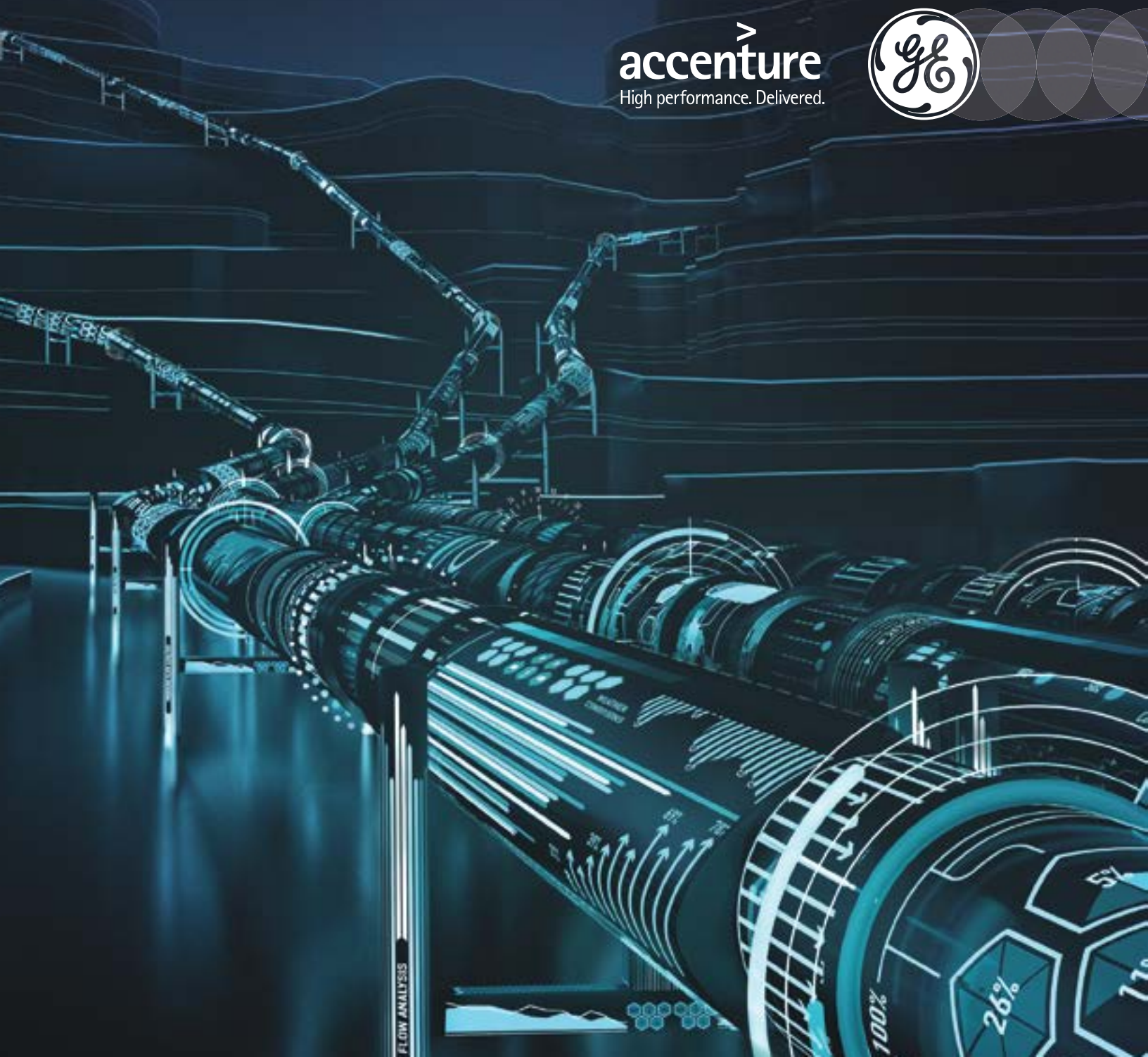
Digital Oilfield
Outlook Report

Opportunities and challenges
for Digital Oilfield transformation

imagination at work

accenture
High performance. Delivered.

junewarren-nickle's
energy group



Key insights

New research from JuneWarren-Nickle's Energy Group, with partners GE and Accenture, shows that Canadian oil and gas professionals see a great deal of potential in adopting Digital Oilfield technology across industry verticals. Industry-wide, they rate the perceived rate of return on investment in a broad spectrum of digital technologies as comparable to or stronger than other investment opportunities, and regard the vast majority of Digital Oilfield technologies presented as mature and ready for testing or deployment today. Perceived challenges to adoption are not technological readiness as much as budgetary constraints, organizational barriers and cybersecurity concerns. The findings point to the need for a greater level of awareness of the potential benefits of the Digital Oilfield and for increased receptiveness to collaboration and organizational change.

- Companies in the oil and gas industry are responding to low oil and gas prices with a renewed focus on improving efficiencies and cutting costs. Industry leaders are citing the use of innovation and technology to deliver significant performance improvements.

- Digital Oilfield encompasses a wide range of innovations such as fleet management and predictive maintenance. These innovations are a direct result of the maturing of enabling technologies such as low-cost sensors, big data analytics and cloud computing.

- Under development for well over a decade, many Digital Oilfield technologies are field proven and already paying dividends for early adopters, offering not only improved efficiencies and cost savings but additional benefits in areas such as health and safety and environmental compliance.

- Despite the benefits they offer, Digital Oilfield technologies have not penetrated deeply into the otherwise highly innovative oil and gas industry. Overall awareness of the technologies and benefits are low. However, when surveyed, the professionals with greater understanding of Digital Oilfield technologies have indicated that potential returns on investment may be higher than other options for capital.

- While they differed among industry verticals, survey respondents overall saw fleet management, field productivity, production asset optimization and predictive maintenance as the top four (of 10) priorities among Digital Oilfield technologies.

- Survey respondents ranked budget constraints, organizational barriers and cybersecurity concerns as the major barriers to adoption of Digital Oilfield technologies.

- Based on the findings, it is highly recommended that industry professionals engage with and acquire greater knowledge about these innovations and the applications for their organizations.

- As organizations look toward investment, it is recommended that they identify the Digital Oilfield technologies with the greatest potential to increase efficiency and competitiveness and provide leadership at all levels to drive the cross-organizational collaboration needed to derive maximum benefit from them. External collaboration with technology providers—entering into joint industry projects, piloting new techniques and developing new business models—can help to allay security concerns and accelerate implementation of potentially transformative new digital technologies.

PHOTO: ©ISTOCK.COM/ZORANDIMZR

Contents

Message from

imagination at work

Producers, suppliers and employees are all experiencing the effects of the current economic environment in the oil and gas industry. Within the Canadian marketplace, organizations that are especially affected are those in the upstream and midstream markets. To address these effects, the *2016 Digital Oil Outlook Report* illustrates the immense opportunities for businesses to drive their operational effectiveness through deployment of innovative digital solutions aligned to business outcomes.

Organizations are examining what their future possibilities are in Digital Oil, and are seeking solutions that provide real-time, complete and accurate views of their equipment and assets—both machine and non-machine. To solve this, businesses are engaging with GE to help them achieve success. GE's Unified Operations solution for the oil and gas industry provides a holistic single-pane-of-glass view on improved equipment reliability and availability and operations optimization.

With organizations developing their path to success through digital innovation, businesses have identified opportunities for less downtime, lower operational costs, better maintenance, optimized plant production, and increased safety and environmental performance through digital oil solution adoption.

Through incorporation and alignment with the identified opportunities contained in this report, businesses can achieve success. Organizations that will have the best chance of thriving and surviving in this challenging market are retooling and streamlining their operations. As such, there is an urgency to implement innovative operational best practices, reflecting the new realities of what it now takes to be successful in this new economic reality and outlook we face today. Through Digital Oil innovation from the reservoir to refinery, organizations are reimagining what is possible in oil and gas.

Message from

accenture
High performance. Delivered.

At a time when the oil and gas industry is responding to the reality of lower crude prices, the *2016 Digital Oil Outlook Report* is a renewed call to action for businesses to drive a higher level of productivity using digital innovation.

Specifically, now is the time to embrace digital, to use new technologies and processes to drive financial and operating performance and to emerge from the oil price slump stronger than ever. Whether organizations are embracing digital to better manage a fleet, be more productive in the field, optimize their production assets or handle predictive maintenance, the case is clear for digital innovation. One recent example of such innovation is the Intelligent Pipeline Solution by Accenture and GE, the first-ever Industrial Internet offering to help pipeline operators make better decisions concerning the condition of their critical machines and assets in the oil and gas pipeline industry.

The line between digital and profitability is sharper than ever: Accenture's recent CIO Mobility Survey found that 51 per cent of Canadian organizations considered to be less profitable have not yet started to think about becoming a digital business.

Organizations with a strong understanding of Digital Oil will be able to rise to the challenges and opportunities before them. As this report shows, it all starts with aligning an organization to become digital—to break down silos, integrate a digital culture, and reimagine processes with digital technology that is supported and led at the highest levels of the organization.

About JuneWarren-Nickle's Energy Group

THE COMPANY

JuneWarren-Nickle's Energy Group (JWN) is the most trusted provider of information, intelligence and insight about Canada's energy industry.

CUSTOM REPORTS AND CONSULTANCY

Need specific research? The JWN analysis team can build custom reports focused on market intelligence, company benchmarking, cost studies and more. For more information please visit us at junewarren-nickles.com

junewarren-nickle's energy group

Executive summary

In the oil and gas industry, prices rule. The run up in crude oil prices from $40/bbl WTI in 2009 to a sustained $80–$110 range in the three years before the price collapse in the second half of 2014 provides the narrative for the shocks that have resonated through the industry then and now. It is the story of a revolution in oil production technology abetted by high prices and the subsequent plummeting of prices after those technologies helped create a market oversupply. And it foretells the story of the coming technological transformation triggered by today's low price environment—the melding of information technology and the Internet of Things with operational technology to create the Digital Oilfield.

It was advances in operational technologies that unlocked unconventional production in both the oilsands of northern Alberta and shale and tight oil plays across North America, helping create today's market imbalance. Sluggish global economic growth, the international battle for market share and the lower cost of extraction are expected to keep a lid on prices for years to come.

These factors have created a new paradigm, one in which competitive advantage will stem not from who can produce the most oil the quickest, but from who can best optimize the means of production to drive down costs. And the technologies best positioned to achieve that goal are digital.

Under development for well over a decade, many Digital Oilfield technologies are field proven and already paying dividends for early adopters, offering not only improved efficiencies and cost savings but additional benefits in areas such as health and safety and environmental compliance. In a cost-constrained environment, increased efficiency is all the more critical as a means to survive through a prolonged down cycle.

But despite the benefits they offer, Digital Oilfield technologies have not penetrated deeply into the otherwise highly innovative oil and gas industry, where innovation has traditionally been confined within departmental silos and horizontal, cross-organizational solutions have tended to be subordinate to development of production technologies.

A survey of Canadian oil and gas industry professionals found that they are optimistic about the potential for the Digital Oilfield. When presented with 10 different technology use cases, they evaluated each one to have superior investment potential to other areas of investment.

While they differed among industry verticals as to which technologies are most market ready and have the greatest potential for success, respondents saw fleet management, field productivity, production asset optimization and predictive maintenance as the top four priority areas for the industry as a whole.

However, the survey revealed a significant gap in oil and gas industry professionals' knowledge about digital technologies and how they might be applied in the industry. On average, respondents opted out of almost half the questions about Digital Oilfield technology use cases. This presents a potentially significant upfront barrier to adoption, since knowledge of the technologies and their benefits is a prerequisite to considering them for adoption. At a time when the industry is facing a skills shortage due to aging and an unstable workforce environment, the industry needs new digital/software skill sets more than ever. When asked to rank the largest barriers to adoption, respondents listed budget constraints, organizational barriers and cybersecurity concerns as the top three.

Going forward, industry professionals identified some of the actions that can be taken to advance the Digital Oilfield:

- **DEEPEN AWARENESS:** Developing a better understanding of Digital Oilfield technologies and benefits among industry professionals is a critical first step to ensuring those technologies will be considered for adoption.

- **IDENTIFY CHAMPIONS:** The nature of Digital Oilfield innovations is that they cross departments, from IT to operations. Leaders at all levels, including executive sponsorship, will be needed to focus efforts and deliver results.

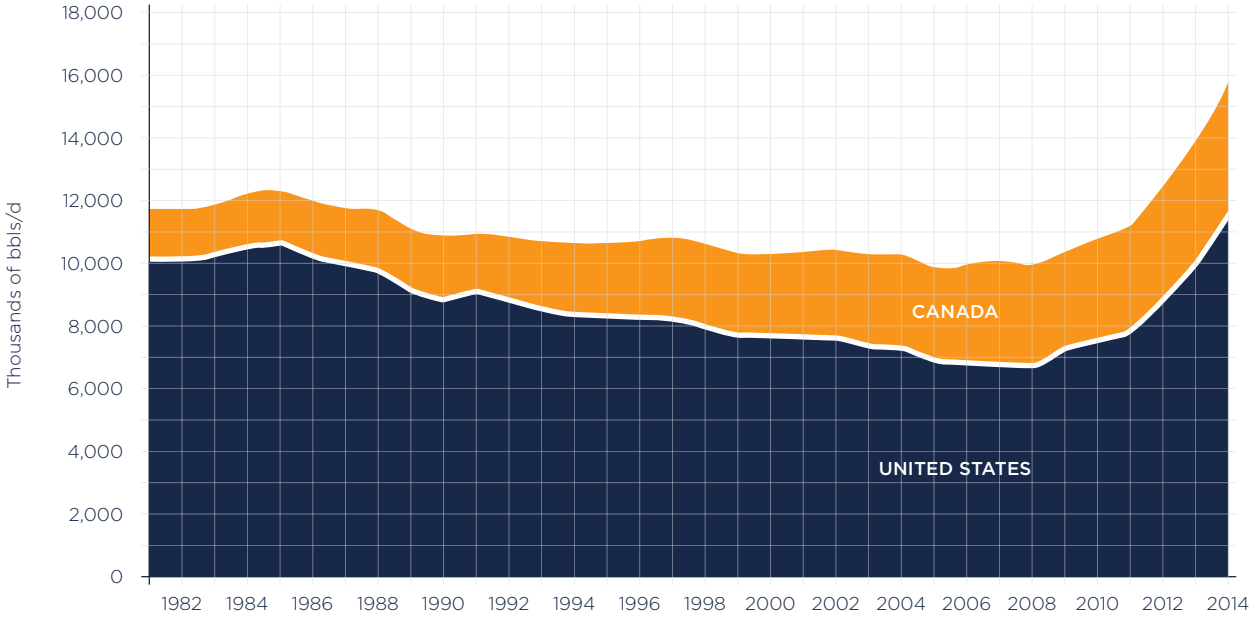
- **ENCOURAGE COLLABORATION:** A greater level of collaboration both within organizations and among them is needed to take full advantage of the transformative opportunity offered by the Digital Oilfield.

- **EXPAND THE CONVERSATION:** Opportunity exists for technology vendors and oil and gas companies to share knowledge, to better understand the industry pain points and the innovations available to overcome them, and to jointly develop new applications for emerging digital technologies.

Innovation urgency: **business as usual no longer**

An oversupply of oil and gas and an expected sustained price downturn is forcing the industry to think differently about cost and productivity.

NORTH AMERICAN DAILY OIL PRODUCTION (1981-2014)

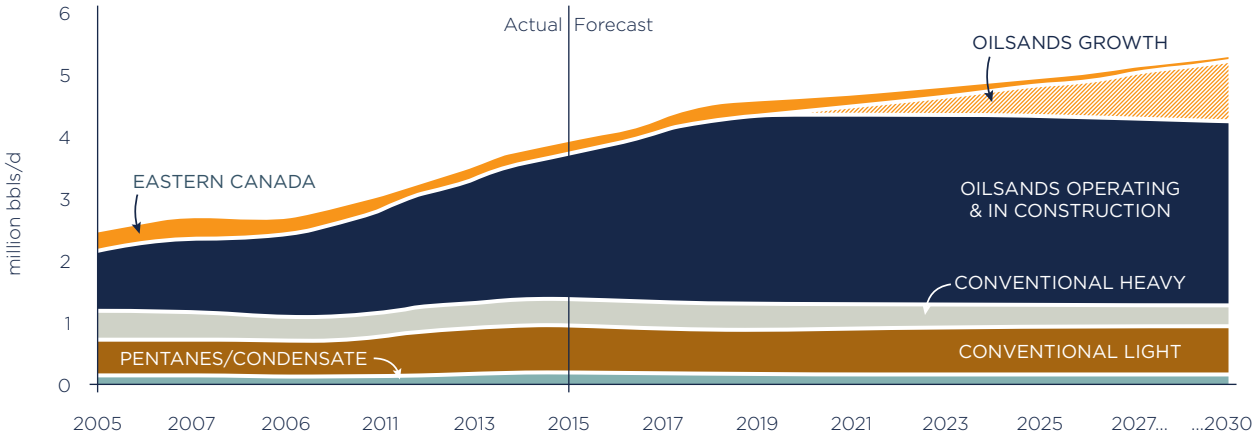


SOURCE: BP'S 2015 STATISTICAL REVIEW

The oil and gas industry has always been highly innovative. In the face of repeated predictions that it would run out of oil and gas to produce (peak oil), it has repeatedly proven the ability to develop the technologies necessary to discover new resources and to economically produce ever more difficult-to-extract hydrocarbons.

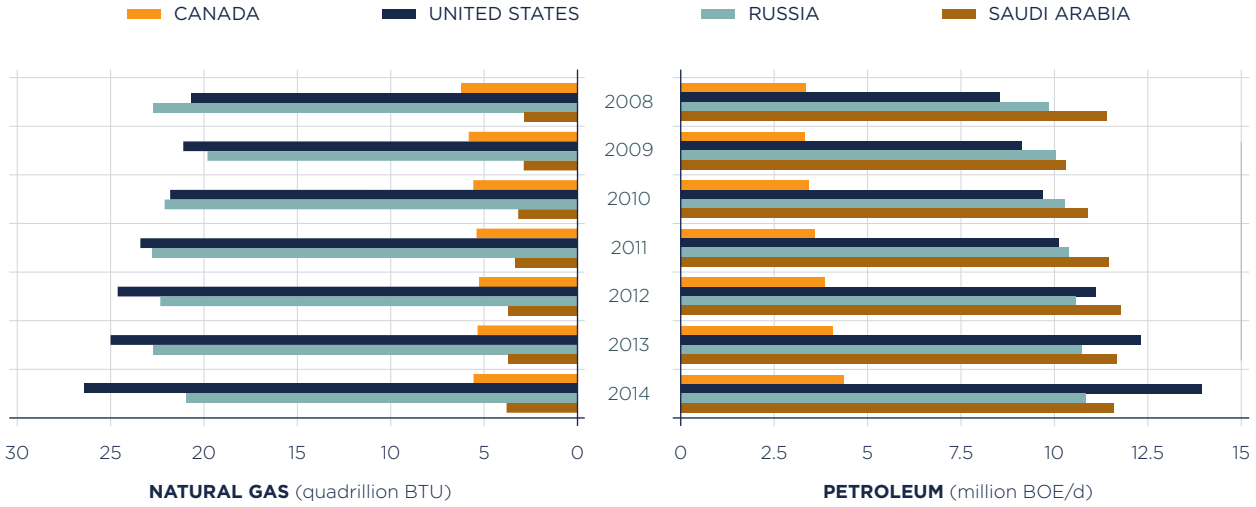
In recent years, the focus on innovation has given rise to game-changing production technologies that unlocked the oilsands—through surface mining and in situ techniques such as SAGD—and tight oil and shale gas reserves using horizontal drilling and multistage fracturing. The impact of these technological advances has been transformational. Once a declining oil and gas region all but abandoned by the supermajors, North America's onshore has undergone a technology-driven revolution to become the world's pre-eminent oil and gas producer.

CANADIAN OIL PRODUCTION FORECAST



SOURCE: CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

OIL AND NATURAL GAS COMPARISON OF MAJOR PRODUCERS



SOURCE: U.S. EIA - TODAY IN ENERGY

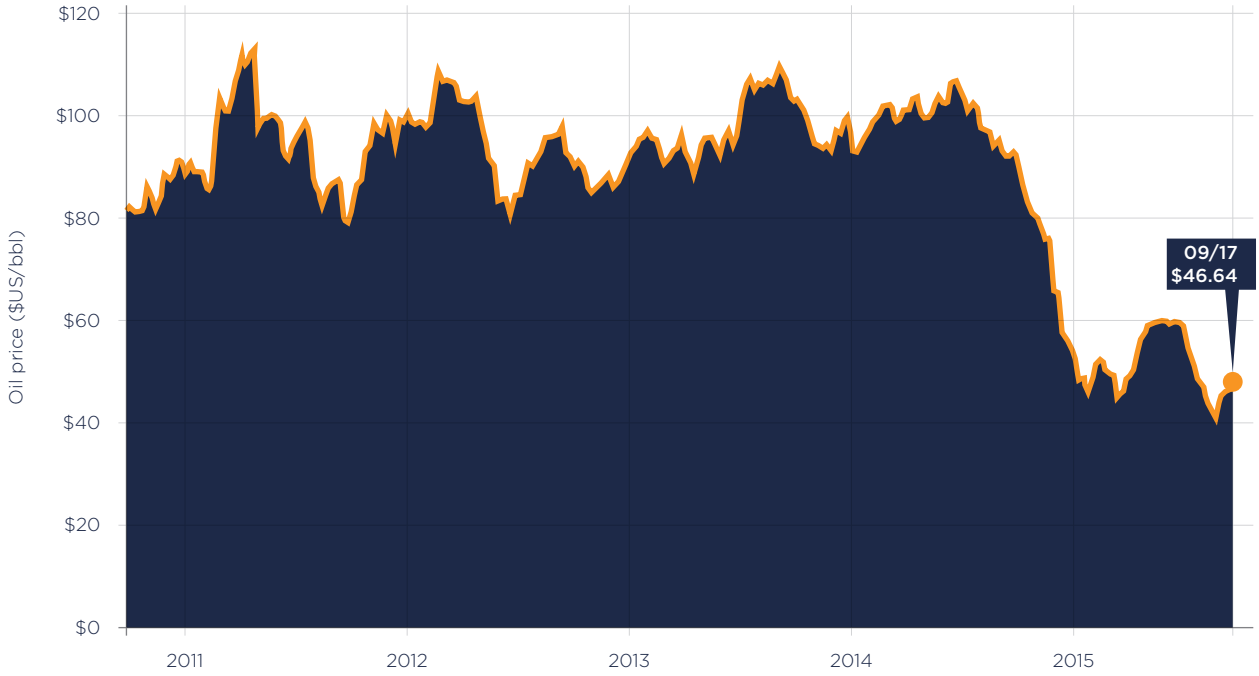
U.S. shale gas and tight oil output has soared by more than six million boe/d from 2008 to 2014, propelling the U.S. ahead of Russia and Saudi Arabia to become the world's top combined oil and gas producer, according to U.S. Energy Information Administration estimates. Despite the plunge in oil prices in the second half of 2014, U.S. oil production still rose by 1.6 million barrels per day (mmbpd) last year, nearing the 10-mmbpd peak the U.S. registered in 1970.

Its own tight oil and gas boom and the technology-driven growth in oilsands production has enabled Canada to become the fifth largest world oil producer, ahead of countries often cited as energy powers, such as Venezuela, Iraq, Kuwait and Brazil. Oilsands production has climbed from less than one mmbpd when SAGD became commercial in 2001 to 2.2 mmbpd in 2014, and output is expected to climb to as high as four mmbpd by 2030.

Victims of their own success

While the gush in North American production bolstered U.S. and Canadian economic growth and energy security, the flood of new oil and gas amid a slowing global economy has created a persistent glut in supply, leading to a 50 per cent collapse in oil prices since mid-2014. It has altered the global geopolitical balance and prompted low-cost OPEC producers like Saudi Arabia to open their own taps to protect market share. These factors have combined to create a crude oil price downturn—on the heels of the longer-standing price slump for natural gas—that is now is expected to continue much longer than initially projected. Even when a demand/supply rebalance takes place, a return to over $100/bbl oil experienced at the height of the tight oil boom is unlikely any time soon. Even a modest price recovery to over-$60 oil will revive shale drilling and bolster supply once again, creating a ceiling on oil prices. All this points to the urgent need for producers to shift the technology focus from producing more oil and gas to producing it at lower cost.

OIL PRICE OVER THE PAST FIVE YEARS



SOURCE: BLOOMBERG

"This isn't a price war but a cost war, and the weapon of choice is innovation."

— Mark Salkeld, chief executive officer, Petroleum Services Association of Canada

Innovation—**new solutions to new challenges**

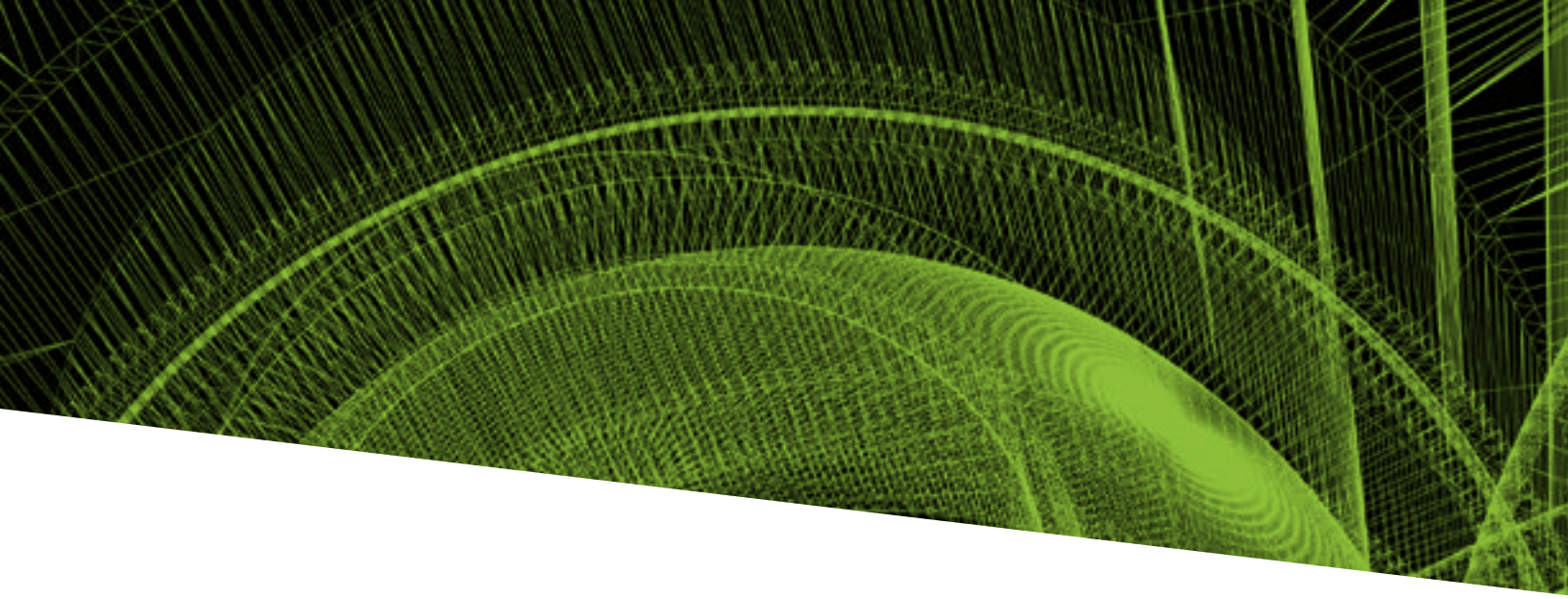
Technology comes in as many forms as there are challenges to solve. In the oil and gas industry, it has traditionally revolved around advances in engineering and the geosciences focused on discovering and maximizing reserves, areas in which the industry can rightly be described as technology innovation leaders. Examples of new technologies and processes that have demonstrated the ability to find and extract increasingly challenging oil and gas resources include:

DRILLING TECHNOLOGIES:
customized high-performance drill bits, extended-length horizontal drilling, increasingly automated drilling rigs.

COMPLETIONS TECHNOLOGIES:
multistage plug-and-perf and sliding sleeve fracturing completion techniques, dissolvable frac balls, advanced electrical submersible pumps.

HYDROCARBON PROCESSES:
in situ reservoir management such as non-condensable gas reservoir pressure management and solvent co-injection to increase oilsands production, and more efficient waterflooding in conventional oilfields.

PROCESSES:
pad drilling and “walking” drill rigs enabling multiple laterals to be drilled from one location, real-time microseismic monitoring, 3-D seismic imaging and reservoir modelling.



The Digital Oilfield **opportunity**

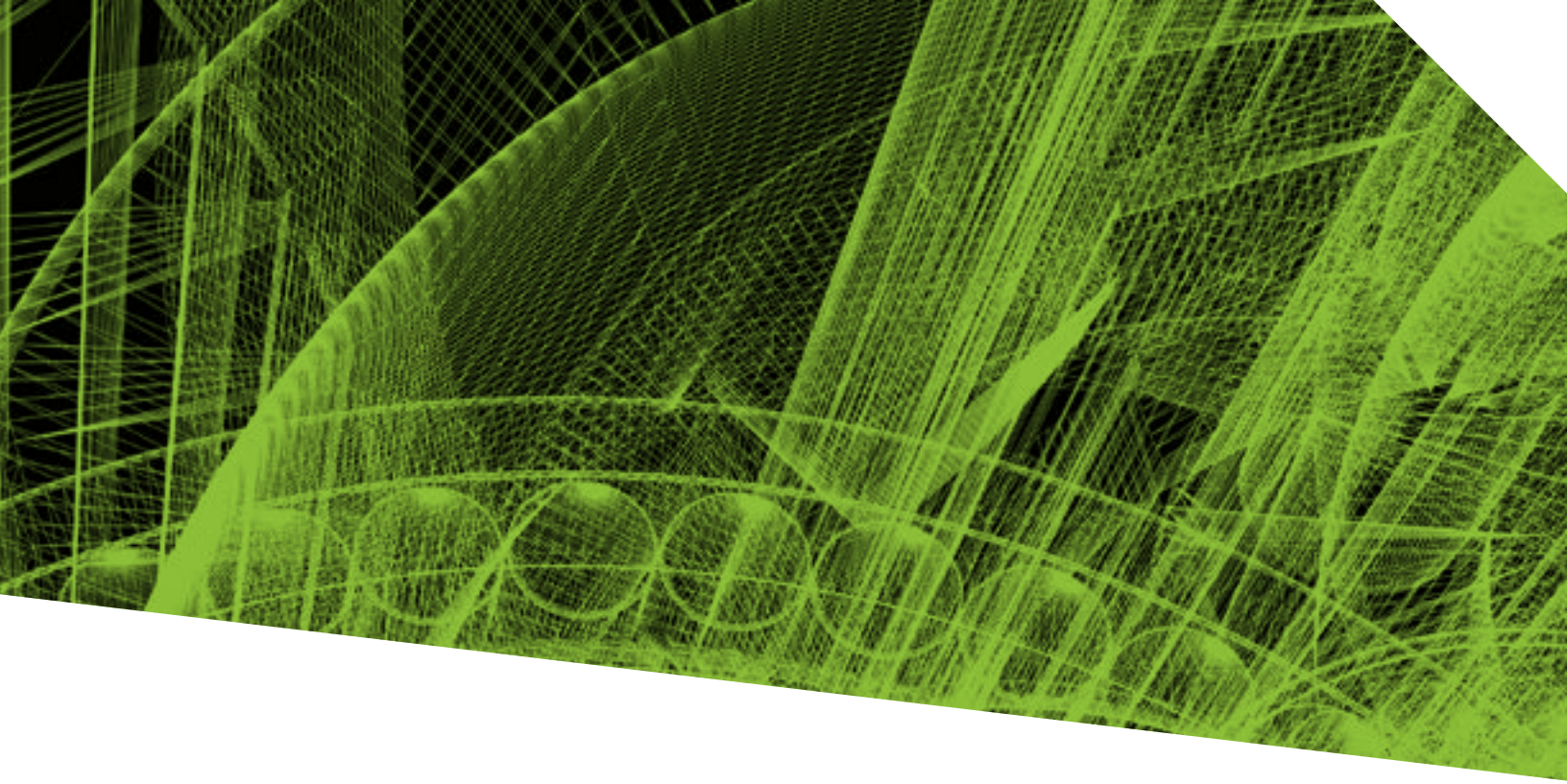
Such technologies solved the problem of a decade ago: dwindling production across North America. But they have also led to today's supply glut and low oil and gas prices. In this new price environment, incremental improvements in productivity will not be enough. The production transformation of the last decade will need to be repeated in a business transformation not unlike those taking place in other industries that have embraced the digital revolution.

As the digital revolution swept through many industries, it has disrupted established business models and created new winners and losers as fast movers have leveraged the digital age to gain competitive advantage. Just as the Internet has transformed the information and media industries, smartphones have revolutionized communications and social media, and the Industrial Internet has turned assets like jet engines and locomotives into data churning "smart" machines that "talk" to each other and self-diagnose problems, the Digital Oilfield is poised to transform the oil and gas industry.

The Digital Oilfield represents a business-wide reimagining of the oilfield. It requires business leaders to step back from the traditional view of technology advancement—siloed within individual departments—and adopt a cross-organization approach.

"The true realization of the Digital Oilfield vision comes not in the field, but in head office, and how producers change their business processes to leverage analytics and to integrate the silos that can exist, for example, between the exploration and production sides of the business. Unlocking this potential is as much about people and process as it is about technology."

— James Freeman, chief technology officer, Zedi



The Digital Oilfield is not merely about computer chips, processors and software. It is about the melding of operations technology with information technology and the Internet of Things. It involves a powerful combination of distributed network sensors, ubiquitous mobile connectivity, cloud computing, advanced big data analytics and artificial intelligence. It has the ability to "learn" from what works in the best producing wells and apply those learnings to entire fields. It will predict equipment breakdown before it happens and bring about "condition-based" maintenance rather than "schedule-based" methods. It will track workers in the field, feed them the data they need via various platforms, "coach" their work in real-time and remove them from hazardous situations. Ultimately, it will produce more oil and gas for less cost.

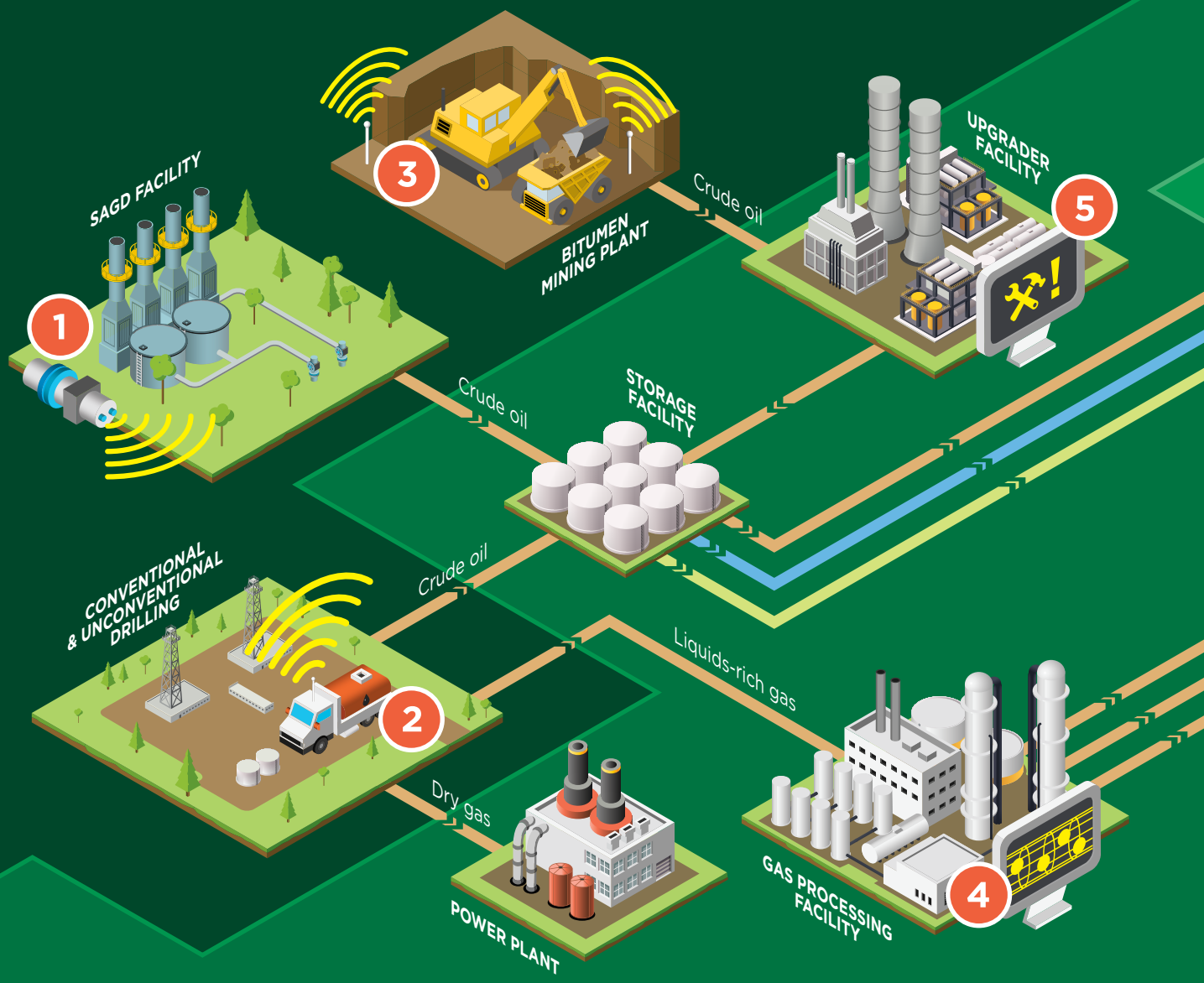
"Innovation is much more than just electronic devices. We have achieved amazing cost savings inroads for our clients by focusing on improving our core processes [e.g., supply chain and procurement]. To that end, digital technologies that can enhance process improvement, well, now you have something."

— Morgan Rodwell, director, process technology, Fluor Canada

The Digital Oilfield is not a technology play but the combination of several technologies in innovative ways to utilize technology to drive productivity. In short, it requires taking a different company-wide approach to today's challenges, sums up John Elmer, executive vice-president of Endeavor Management, a Houston-based consultancy to the oil and gas industry. "You can't expect a sensor or a communications network to produce results; organization change has been the bigger determinant of success. People have to work together in order to capitalize on the new knowledge that is streaming in at a much faster time scale."

What is the **Digital Oilfield?**

One way to understand the Digital Oilfield is to describe the use cases



1

Improve SOR, asset reliability and optimize production through increased use of improved sensors, automation and connectivity to remote experts.

2

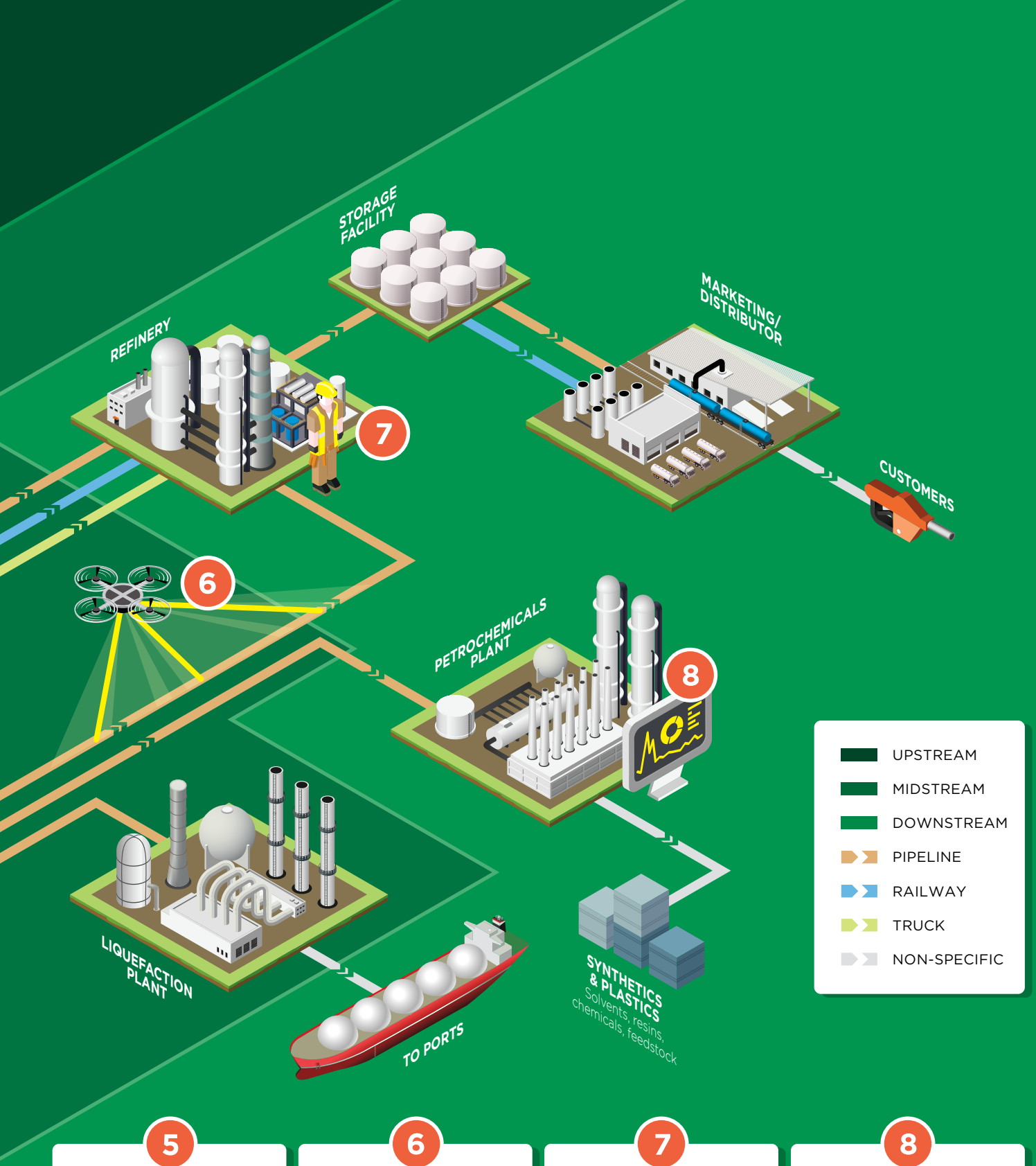
Improve fleet efficiency with vehicle identification, logistics optimization and automated loading using pervasive wireless and real-time sensor and video data analytics.

3

Provide pervasive wireless connectivity to support collaboration, knowledge access and personnel welfare in the field.

4

Use remote monitoring and inspection applications to improve security and environmental protection with predictive intrusion, leakage and deformation detection.



5

Reduce downtime and improve asset integrity with predictive maintenance using real-time analytics and immediate virtual expert support.

6

Remote monitoring of assets such as pipelines, gas plants and storage facilities via smart video surveillance, self-navigating drones and satellite.

7

Improve personnel safety and optimize processes with wireless real-time tracking, video analytics and automated incident response.

8

Perform analytics on collected data to identify operating insights that can be used to enhance decision making.

Digital Oilfield **successes**

The Digital Oilfield has been gaining traction and delivering results over the last 10 years. It has leveraged advancements in the technologies it utilizes, such as the exponential growth in computing power, data storage and analysis, ever cheaper and smarter sensor technologies and artificial intelligence.

According to IHS CERA, which has been tracking Digital Oilfield performance for over a decade, its implementation has led to production increases of two to eight per cent, operating expense reductions of five to 25 per cent and capital expenditure reductions from one to 10 per cent, depending on the project.

The energy services industry has been among the fastest adopters:

- Precision directional drilling—enabled by logging-while-drilling and measurement-while-drilling systems for real-time data transmission, formation evaluation and precision geosteering—has played a critical role to unlock the oilsands and shale gas/tight oil. These approaches have been enabled by Digital Oilfield technologies and the innovative changes in how the technologies were used.

- Fleet tracking: GPS and digital communications have allowed service companies to better manage their assets and relay critical information from the field to their offices and their clients' offices. This has become increasingly valuable as unconventional oil and gas extraction requires large fleets of vehicles to transport pumping equipment, water and other items necessary for large-scale fracturing operations.

These innovations have happened quickly and have produced benefits that have helped unlock the growth in unconventionals over the last 10 years.

Producers have also successfully innovated with the Digital Oilfield, particularly with offshore oil and gas because of physical constraints and safety considerations. The small size of and distance to offshore platforms drives the need for innovation:

- BP has installed sensors and fibre optic networks across its North Sea, Gulf of Mexico and other assets to collect and interpret immense amounts of data in over three dozen advanced collaborative environments around the world. Among the benefits, it estimates it has added 3,000 bbls/d to the Schiehallion Field in the North Sea, 10,000 bbls/d higher production at the Thunder Horse Field in the Gulf of Mexico and bolstered recovery at its Prudhoe Bay Field in Alaska from 40–60 per cent.

- Shell says implementation of Smart Fields can increase the total amount of oil recovered from a field by 10 per cent and gas by five per cent, as well as boost the rate of production. The technology allows sensors with fibre optic cables to relay digital information on temperature, pressure and other field conditions to control centres where engineers continuously monitor production and make quick decisions on how to best extract oil and gas, such as activating underground valves electronically to better manage the oil flow. In its first field to have Smart Fields technology, Champion West in the South China Sea, Shell says the technology allowed it to produce oil from scattered sub-sea reservoirs that for 30 years had been considered too costly to develop.

Costs are continuing to decline and capabilities are rapidly increasing. Producers are now migrating Digital Oilfield technologies for onshore applications:

- BP announced an agreement in mid-2015 to license GE's Intelligent Platforms Software to connect all its oil wells to the Internet in order to optimize production globally. BP, which has 6,000 producing wells worldwide, plans to capture, store, contextualize and visualize data in real time in order to drive efficiency and performance. It estimates its Digital Oilfield technology will increase its global production by 100,000 bbls/d by 2017 and support the addition of one billion barrels of reserves.

- Shell is bringing the use of Smart Fields to the oilsands, where producers can leverage them to optimize their field contingent versus remote operations in the major centres.

The returns on early use cases over the last 10 years have generally been very positive for early adopters. Wider use of Digital Oilfield technologies will lead to further improvements in productivity and cost structure.

PHOTO: ©ISTOCK.COM/HUYANGSHU

PHOTO: ©ISTOCK.COM/CARD76

Digital Oilfield potential: **the coming digital revolution**

There is little doubt that the digital revolution will have a large impact on several industries in the coming decades. While industry forecasts differ as to its impact, the consensus is that it will be transformative and will add trillions of dollars worth of value to the world economy.

For example, it is forecast the number of connected devices will grow from 10 billion in 2013 to anywhere from 19 billion to 40 billion by 2019, creating cost savings and productivity gains across several industries. It is estimated the total global impact of Internet of Things (IoT) technologies will generate anywhere from $2.7 trillion to $14.4 trillion in value by 2025.

In a report in January, the World Economic Forum stated the Internet revolution that redefined business-to-consumer industries is set to dramatically alter industries such as energy, manufacturing and transportation as the "Internet of Things revolution" takes hold over the next decade, bringing both unprecedented opportunities and new risks for businesses.

"Our research concludes that the Industrial Internet is indeed transformative. It will change the basis of competition, redraw industry boundaries and create a new wave of disruptive companies, just as the current Internet has given rise to Amazon, Google and Netflix. However, the vast majority of organizations are still struggling to understand the implications of the Industrial Internet on their businesses and industries. For these organizations, the risks of moving too slowly are real."

The Digital Oilfield could also usher in a second shale revolution more impactful than the first, suggests the Manhattan Institute. Continued technological progress, "particularly in big-data analytics, has the U.S. shale industry poised for another, longer boom, a 'Shale 2.0,'" states Mark Mills in the paper *Shale 2.0: Technology and the Coming Big-Data Revolution in America's Shale Oil Fields*. "Shale 2.0 promises to ultimately yield breakeven costs of $5–$20 per barrel—in the same range as Saudi Arabia's vaunted low-cost fields."

The data-driven Shale 2.0 will start when the industry embraces big-data analytics, it states, pointing to growth rates in the shale sector already more similar to that of Silicon Valley tech firms than conventional energy sector expansion.

"Shale's spectacular rise is also generating massive quantities of data: the $600 billion in U.S. shale infrastructure investments and the nearly 2,000 million well-feet drilled have produced hundreds of petabytes of relevant data. This vast, diverse shale data domain—comparable in scale with the global digital health-care data domain—remains largely untapped and is ripe to be mined by emerging big-data analytics."

Digital Oilfield survey and outlook report

JuneWarren-Nickle's Energy Group (JWN), in partnership with GE and Accenture, conducted a detailed study of Digital Oilfield technological use cases and perspectives

JWN wanted to know what industry leaders, from the technical professional to the executive, thought about the Digital Oilfield: what technologies they consider most ready for adoption and which are not even on their radar, which are best positioned to drive production increases and revenue growth, which could best improve environmental and health and safety outcomes, and how committed are they to moving forward with Digital Oilfield technologies.

In order to generate an overall oil and gas industry perspective, we surveyed across the production and supply spectrum, from those at the top of the organization to those closest to the technology, from small independents to large multinational oil and gas companies. In particular, we sought input from the following industry verticals: exploration and production (E&P), oilsands producers (OSP), service and supply (S&S), midstream and downstream (M&D), and others (institutional investors, consulting firms and government agencies).

In addition to the survey of 160 industry professionals, JWN conducted 25 one-on-one executive interviews throughout the summer of 2015 to gather quantitative and qualitative data for Digital Oilfield technology adoption trend analysis. We believe the combined results presented here represent an accurate representation of Canada's oil and gas industry leaders' perceptions of the coming Digital Oilfield transition.

Survey questions

1. PERCEIVED ROI

Please provide your perception of the return on investment (ROI) of this use case (and associated technologies) relative to other uses of capital investment.

This use case compared to other options for capital use:

1. Much weaker ROI
2. Somewhat weaker ROI
3. Comparable ROI to other uses of capital
4. Somewhat stronger ROI
5. Much stronger ROI

2. TECHNOLOGICAL MATURITY

Please provide your understanding of the maturity of this use case and readiness for in-field deployment.

This use case:

1. Will not be ready for at least 18 months
2. Will be ready for testing in the next 18 months
3. Is ready for testing today
4. Is ready for deployment
5. Is highly proven in the market

3. ORGANIZATIONAL READINESS

Please provide an assessment of your current organization's readiness to adopt this use case and the associated people, process and technology changes.

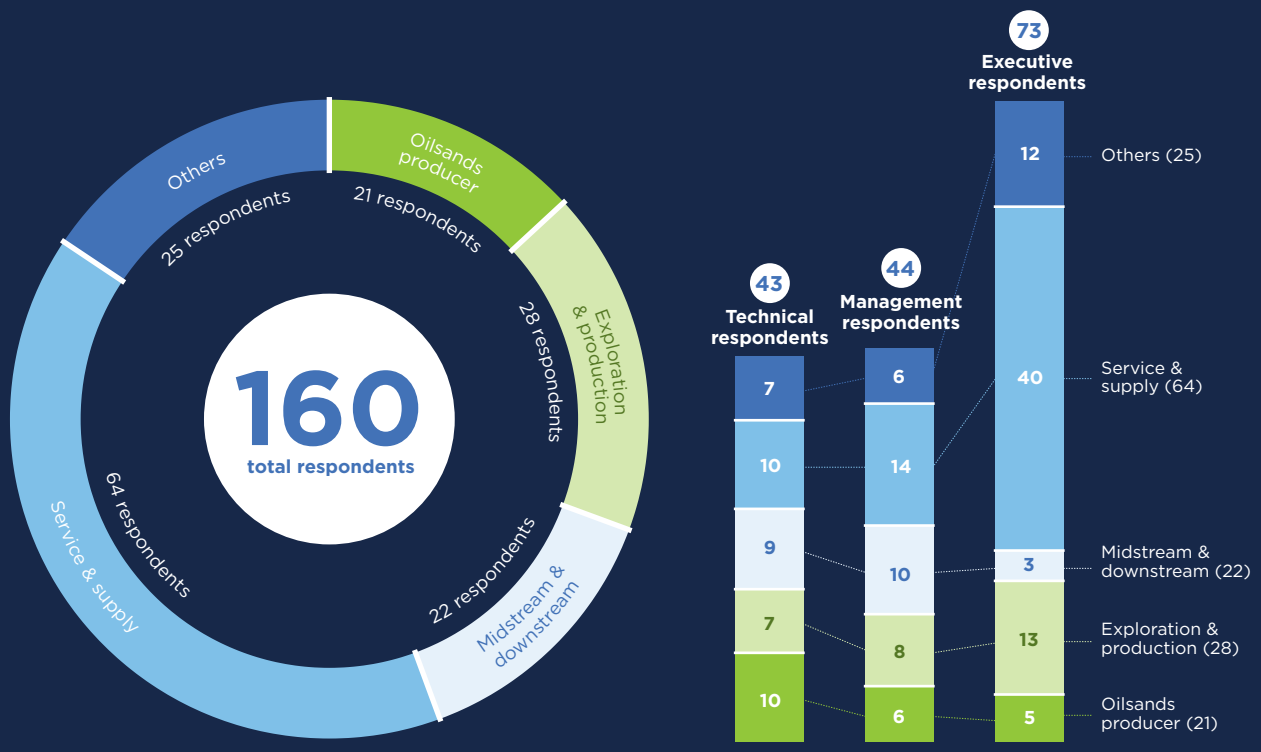
My current organization:

1. Will not be ready for at least 18 months
2. Will likely be ready in the next six to 18 months
3. Will likely be ready in the next six months
4. Has most of the capabilities today
5. Is fully capable and is ready to adopt this use case

Survey respondent profile

The survey reached a broad and representative cross section of the Canadian energy industry

SURVEY RESPONDENT DEMOGRAPHICS



- **Executive interviews:** 25 interviews conducted
- **Survey:** 160 industry professionals surveyed
- **Survey respondents were categorized into three seniority groups:**
  - **Executive:** C-suite executives, senior executives, vice-presidents
  - **Management:** directors, managers, senior technical advisers, senior engineers/geologists/geophysicists
  - **Technical professionals:** frontline managers/supervisors, engineers/geologists/geophysicists, technicians

Market perception:
is the Digital Oilfield ready?

The Digital Oilfield survey focused on understanding oil and gas industry perceptions about 10 Digital Oilfield use cases across three adoption dimensions:

PERCEIVED ROI

Respondents were asked how Digital Oilfield use case technologies compared against other uses of capital.

TECHNOLOGICAL MATURITY

Respondents were surveyed on their perception of Digital Oilfield use case technologies and where their company stood in their testing and deployment phases of these technologies.

ORGANIZATIONAL READINESS

Respondents were surveyed on their assessment of how ready and capable their organizations are to adopt Digital Oilfield use case technologies.

The technology—**Digital Oilfield use cases**

There are several different use cases for Digital Oilfield technologies that address a wide spectrum of applications available today or nearing commercial application. This study concentrates on the following 10 use cases that are currently being developed, tested and deployed.

Collecting and analyzing sensor data related to flow, temperature, vibration and integrity to improve operational safety and performance-related decisions.

- **BENEFITS:** The seamless flow of information to the field via technologies like digital mobile telephony and satellite allows for real-time analysis and response.
- **EXAMPLE:** The two-way flow of operations-critical data allows companies to remotely monitor and control equipment such as compressors and flow meters, detect and diagnose problems, and optimize operations.

2 REMOTE ASSET OPERATIONS

Developing systems to operate plants and facilities from a remote location. Reduce the on-site complement of staff, and allow for remote control of operations at a central location.

- **BENEFITS:** Real-time operations centres provide a range of upstream activities to be monitored and controlled remotely.
- **EXAMPLE:** Machine-to-machine interface and real-time connectivity at remote oilsands facilities allows routine operations and trouble-shooting to be overseen by experts centralized at head office.

Utilizing predictive data analytics and condition-based maintenance approaches to improve asset availability and reliability.

- **BENEFITS:** Reduce or prevent operations interruptions and plant shutdowns due to critical component failure, minimize operations disruptions by allowing maintenance and repair to be completed on off peak cycles or turnarounds, and save cost by completing maintenance based on usage patterns and equipment health rather than set schedules.
- **EXAMPLE:** Predictive maintenance of electric submersible pumps allows operators to monitor the health of the equipment and change-out pumps based on usage rather than set time intervals, thereby avoiding unnecessary maintenance, downtime and damage to the reservoir.

3 PREDICTIVE MAINTENANCE

4 PRODUCTION ASSET OPTIMIZATION

Utilizing specialized sensors to monitor equipment and data analytics to identify improvements in complex operations and improve operational performance.

- **BENEFITS:** Automate routine processes, monitor and diagnose production issues and enable proactive asset management to optimize inputs and enhance recovery.
- **EXAMPLE:** Utilize big-data analytic approaches to analyze combinations of solvent type and water/solvent ratios to determine optimal recovery strategies.

Employing remotely controlled devices that use imaging (video, IR, X-ray) and other sensors to complete inspection and detection tasks more efficiently and safely than conventional field operations.

- **BENEFITS:** Improve the monitoring and performance of assets, and ensure any upsets (e.g., leaks, spills) are minimized through preventative measures and reduced response times.
- **EXAMPLE:** Pipeline monitoring using self-navigating drones enables rapid identification and resolution of pipeline-damage incidents and spills.

5 REMOTE ASSET INSPECTION

6 AUTOMATED PRODUCTION ASSET OPTIMIZATION

Robotic or other automated equipment performing operating, assembly and maintenance tasks in continuous and safety-critical operating environments.

- **BENEFITS:** Machine intelligence allows equipment to sense conditions in their local environment, recognize and solve basic problems and operate independently of human direction.
- **EXAMPLE:** Utilizing reservoir and production engineering workflows to automatically optimize steam and non-condensable gas injection to improve SAGD performance.

Obtaining real-time data—through the use of wireless networks, sensors and video analytics—from on-board sensors to improve asset identification, tracking, utilization and logistics operations.

- **BENEFITS:** Optimize labour productivity, reduce travel requirements, improve supply chain and procurement functions, minimize input material and energy costs, and manage assets more efficiently.
- **EXAMPLE:** Management of vehicle fleets to choose best routes and bypass obstructions, monitor and "coach" drivers to promote safer driving practices, and enable condition-based vehicle maintenance programs.

7 FLEET MANAGEMENT

8 FIELD PRODUCTIVITY

Maximizing worker efficiency by providing wireless mobility that enables on-demand access to field data, engineering drawings and inventory tracking, and communication with centralized operations experts.

- **BENEFITS:** Enable field staff to be fully connected to the head office and able to track and control assets remotely.
- **EXAMPLE:** Using intelligent routing to coordinate field personnel and equipment movements based on factors such as skill sets, distance and inventory availability.

9 BIOMETRIC MONITORING

Using wearable devices capable of continuously monitoring employee location, movements and other indicators in real time, to provide feedback to workers and detect dangerous situations such as gas leaks and accidents.

- **BENEFITS:** Increase worker safety and productivity by tracking worker location and basic vital signs, enabling advanced warning of hazards like gas leaks, decreasing emergency response times.
- **EXAMPLE:** Smart devices and emerging wearable technology provides field workers with instant access to information about equipment and facilities, optimizing inspection and maintenance activities.

10 IN-FIELD MANUFACTURING

Operating portable manufacturing equipment to reduce downtime from critical part failure by producing specialized components/parts on site and on demand.

- **BENEFITS:** Reduces downtime created by delays in moving parts and equipment, allows companies to reduce inventory needs for spare parts.
- **EXAMPLE:** Enterprise 3-D printing technology enables the manufacture of replacement parts in remote locations like offshore drilling rigs, eliminating costly delays in locating and transporting an existing piece of equipment

Survey results—**main findings**

Perceptions about ROI, technological maturity and organizational readiness

USES CASES RANKED BY EACH INDIVIDUAL ADOPTION DIMENSION

		Overall	Perceived ROI	Technological maturity	Organizational readiness
1	Fleet Management	3.85	3.44	4.22	3.87
2	Field Productivity	3.76	3.56	3.93	3.79
3	Production Asset Optimization	3.63	3.75	3.66	3.49
4	Predictive Maintenance	3.59	3.69	3.63	3.45
5	Biometric Monitoring	3.59	3.31	3.84	3.61
6	Remote Asset Monitoring	3.37	3.39	3.67	3.06
7	Remote Asset Inspection	3.31	3.45	3.33	3.14
8	Remote Asset Operations	3.20	3.38	3.30	2.91
9	In-Field Manufacturing	2.75	3.20	2.42	2.65
10	Automated Production Asset Optimization	2.75	3.39	2.45	2.40

THE CASE FOR INVESTMENT IN THE DIGITAL OILFIELD

Survey respondents voiced a high level of confidence that investment in the spectrum of Digital Oilfield technologies compared favourably to other capital investment opportunities. Perceived return on investment in the 10 use cases scored from a low of 3.20 (in-field manufacturing) to a high of 3.75 (production asset optimization), where 3 represents comparable ROI, and 4 and 5 represent somewhat and much stronger perceived ROI, respectively. **This demonstrates that all of the applications for those use cases are viewed as providing equal or greater than anticipated return on investment compared to other uses of capital.**

PROGRESS ALONG THE DEVELOPMENT CURVE

Of the 10 Digital Oilfield use cases, all but two (automated production asset optimization and in-field manufacturing) were deemed ready for testing, deployment or already proven in the market today. Furthest along the development and deployment curve is fleet management (4.22), the only use case ranked in the range of ready for deployment (score above 4). Following close behind, field productivity (3.93) and biometric monitoring (3.84) were the highest of those ranked ready for testing today.

READY TO DEPLOY?

Importantly, while respondents were generally optimistic about the technological maturity of Digital Oilfield use cases, that did not always translate into a feeling their own organizations were ready to adopt them, suggesting institutional barriers (rather than technology readiness) are standing in the way of deployment. Averaged over the industry as a whole, none of the use cases ranked in the category of fully capable and ready to adopt. Seven use cases fell in the category of the respondent's organizations having most of the capabilities to deploy them today, with fleet management (3.87), field productivity (3.79) and biometric monitoring (3.61) leading the pack.

On the other hand, respondents ranked the same top three use cases for both technological maturity and organizational readiness, indicating industry believes it is most prepared to adopt those technologies that are closest to being, or already are, market ready.

Sector-by-sector breakdown: **who likes what?**

Survey results were analyzed among the individual industry verticals

As might be expected, the survey found that the most highly ranked Digital Oilfield technology varied by industry vertical. This reflects the particular technology needs experienced by each sector. The variance is most pronounced by those sectors that characteristically are dominated by field assets, the E&P and S&S verticals, which rank technologies like fleet management and field productivity highest (among the top three in both cases), and those with primarily fixed assets, such as the OSP and M&D verticals, which favoured use cases like production asset optimization and predictive maintenance (top four in both verticals).

However, there was also a discernable degree of consensus among all industry verticals for several of the use cases. Fleet management, for example, ranked third or higher in all verticals except M&D (fifth), while predictive maintenance and product asset optimization both ranked sixth or higher across the board. Overall, 85 per cent of the top-priority technologies listed by one sector can also be found as a top priority in another sector, showing that while each industry vertical may differ operationally, the business case benefits offered by the application of one technology is widely applicable across the value chain

COMPARISON OF OVERALL RANKED USE CASES BY ENERGY VERTICAL

		Oilsands producer (OSP)	Exploration and production (E&P)	Midstream & downstream (M&D)	Service & supply (S&S)	Others
1	Fleet Management	3.55	3.94	3.71	3.88	3.75
2	Field Productivity	3.46	3.63	3.70	3.88	3.58
3	Production Asset Optimization	3.61	3.47	3.90	3.56	3.76
4	Predictive Maintenance	3.56	3.28	3.76	3.70	3.81
5	Biometric Monitoring	3.19	3.66	3.80	3.64	3.33
6	Remote Asset Monitoring	3.27	2.83	3.83	3.59	3.60
7	Remote Asset Inspection	3.30	3.16	3.64	3.29	3.28
8	Remote Asset Operations	2.98	2.95	3.37	3.31	2.83
9	In-Field Manufacturing	2.76	2.32	2.65	3.06	2.33
10	Automated Production Asset Optimization	2.87	2.26	2.48	3.00	2.56

Technology perceptions: **the hierarchical divide**

Oil and gas industry seniority groups see use cases differently

USES CASES RANKED BY ORGANIZATIONAL SENIORITIES

		Overall	Executive group	Management group	Technical group
1	Fleet Management	3.85	3.88	3.97	3.62
2	Field Productivity	3.76	3.87	3.67	3.66
3	Production Asset Optimization	3.63	3.62	3.74	3.53
4	Predictive Maintenance	3.59	3.63	3.61	3.48
5	Biometric Monitoring	3.59	3.45	3.76	3.67
6	Remote Asset Monitoring	3.37	3.37	3.30	3.45
7	Remote Asset Inspection	3.31	3.22	3.52	3.23
8	Remote Asset Operations	3.20	3.22	3.36	2.94
9	In-Field Manufacturing	2.75	2.84	2.97	2.34
10	Automated Production Asset Optimization	2.75	2.83	2.75	2.54

When divided by seniority groups, survey respondents were found to have different priorities in their ranking of Digital Oilfield technologies. Only fleet management, the use case seen to be the most mature Digital Oilfield technology, was selected by all three groups as a top three priority.

The most senior group, the executive suite, also favoured field productivity and predictive maintenance (top three priorities), technologies that ranked in the top five for the other groups surveyed, management and technical professionals. Where the three seniority groups differed most obviously was on biometric monitoring, which was a top priority for technical professionals and second ranked for management, but fell to just a mid-level priority for executives.

This is likely a reflection of the fact technical professionals tend to fall within a demographic group that is younger and more comfortable with a variety of personal monitoring technologies—call it the "Fitbit factor" for the rapid uptake in wearable fitness devices like the Fitbit among that demographic. It's not a big stretch for this group to see those types of technologies deployed in an industrial context, as they may already be using similar technologies in their personal lives and now expect them in the workplace.

The technical group is also more likely to be involved in fieldwork and therefore more likely to benefit from the use of biometric monitoring. Their top ranking of biometric monitoring suggests this group would be most accepting of the technology's widespread use.

Digital Oilfield awareness: **a potential barrier**

Respondents often felt they did not know enough about the topic to provide an informed assessment.

Survey participants often indicated they had insufficient knowledge about and experience with Digital Oilfield technologies to provide insight on use case scenarios, itself an indication that lack of awareness could be a barrier to the technologies' adoption. If they are not yet on the radar of senior decision makers, they are less likely to be given serious consideration in investment decisions.

On average, survey participants opted out of 46 per cent of survey questions about Digital Oilfield use cases due to insufficient knowledge or experience. This aligns with the perception among some industry professionals—who will routinely turn to technology to solve exploration, production and completions challenges—that Digital Oilfield technologies belong primarily in the realm of other departments, such as IT or instrumentation and controls, and are unlikely to offer a core solution to their problem. This is often the root of the problem solving in silos approach, which leaves potential technology solutions on the periphery of their awareness and leads to missed opportunities.

Conversely, those respondents who did indicate some knowledge or experience with Digital Oilfield–related technologies said they felt ready to start adopting some of the applications. They saw significant potential from a perceived ROI as well as a positive impact on their business needs.

USE CASE ADOPTION KNOWLEDGE OF SURVEY RESPONDENTS

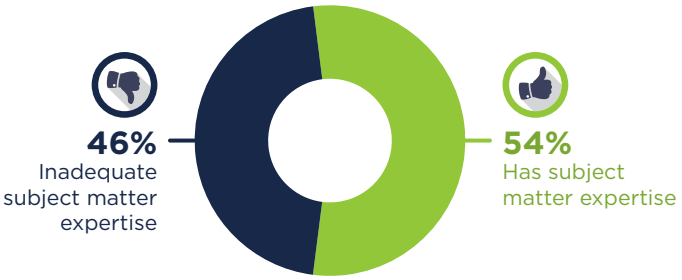


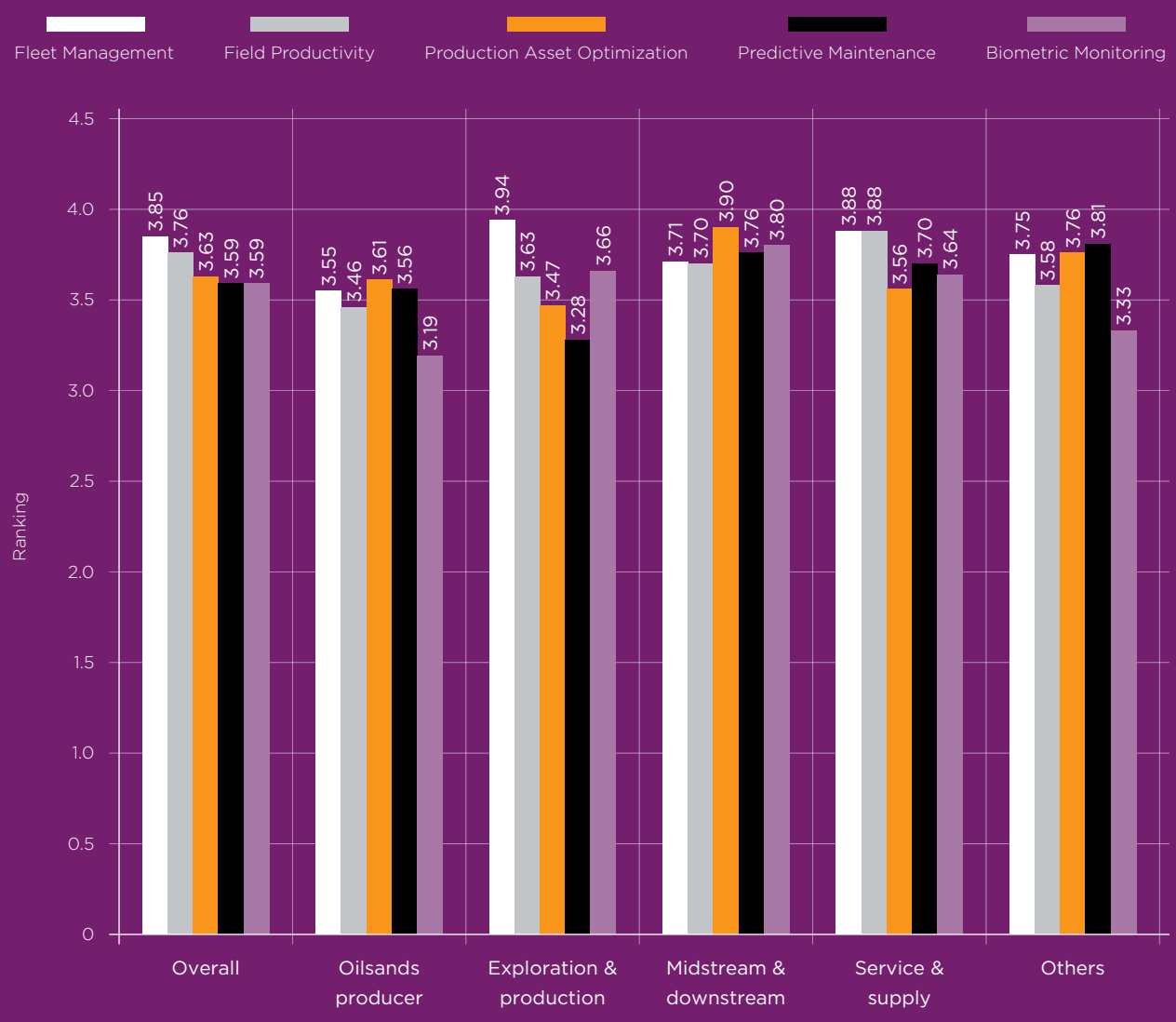
IMAGE: ©ISTOCK.COM/IROCHKA_T

Survey results: **a deeper dive**

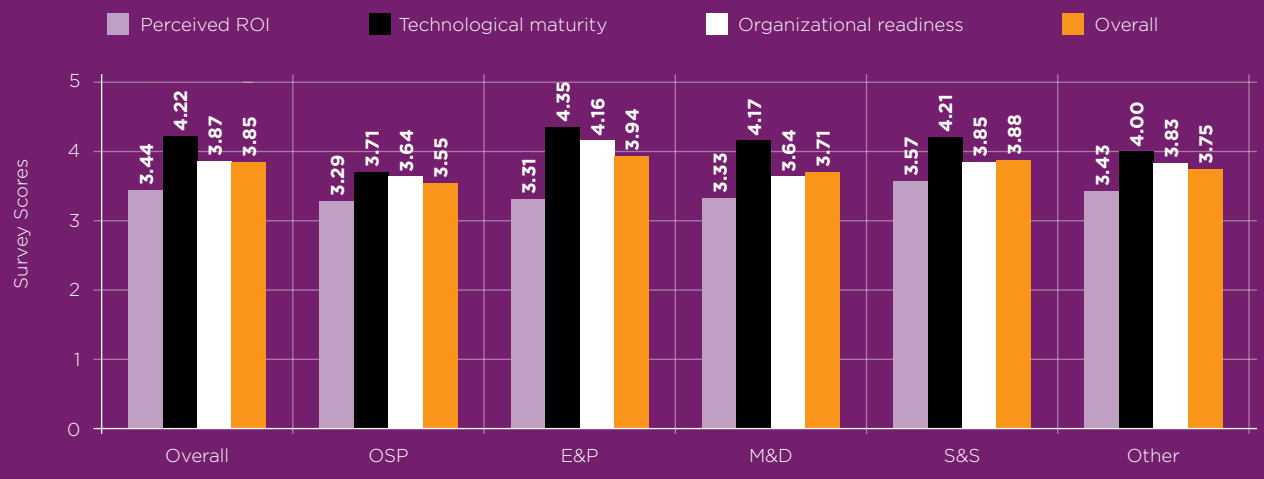
Analysis of the top five use cases by individual adoption dimension

The top five priority use cases identified by survey respondents were fleet management, field productivity, production asset optimization, predictive maintenance and biometric monitoring. The following is a deeper case-by-case analysis of their responses and the industry's perceptions of the use cases and their potential benefits.

TOP 5 OVERALL RANKED USE CASES BY OIL AND GAS INDUSTRY VERTICALS



OVERALL INDUSTRY ADOPTION FOR THE FLEET MANAGEMENT USE CASE



USE CASE ASSESSMENT: fleet management

Ranked first overall in terms of industry use case priority, fleet management was judged to be both the most mature technology and the technology most adoption-ready by survey participants, demonstrating its widespread deployment potential in the short term.

The industry verticals E&P and S&S ranked fleet management as a top priority. This aligns with those sectors' core business functions to manage widespread and mobile field assets. However, fleet management ranked lower on the scale for perceived ROI, in the fifth or sixth spot across industry verticals, an indication industry professionals rank its associated health and safety benefits more highly than its ability to significantly impact the bottom line.

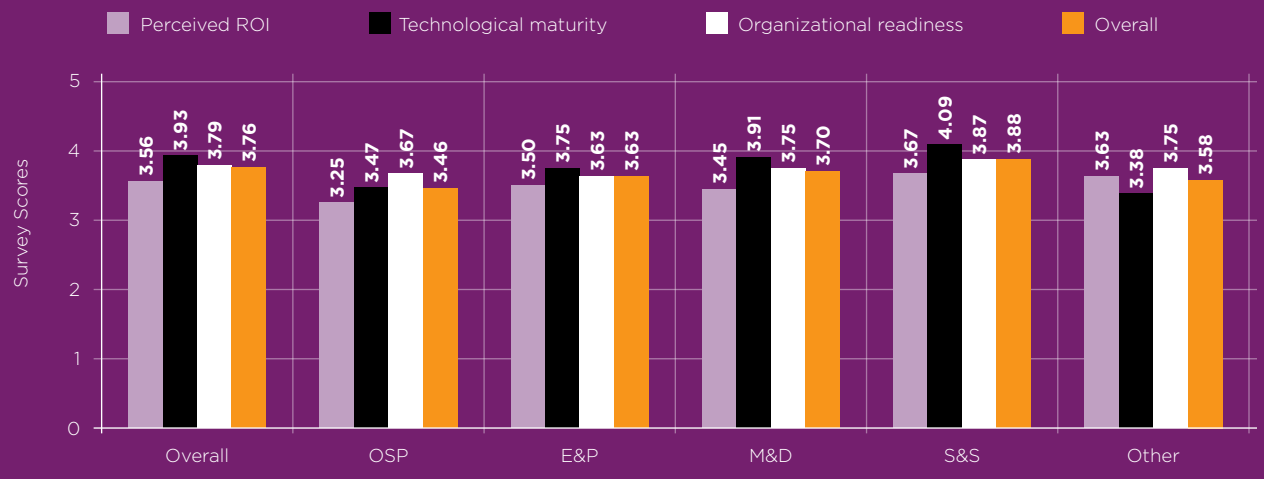
Indeed, interviewees indicated that their main interest in this use case lies in its ability to use data analytics to offer real-time recommendations that drive efficiencies and improve operator behaviour (e.g., safer driving practices).

Though not an entirely new technology offering, fleet management has dramatically improved with advances in software applications, on-board electronics like accelerometers, data delivery and analytics. Its primary benefits are field optimizing resource deployment, solving logistics inefficiencies through journey management, and creating safer driving habits using alerts and applications that "coach" drivers in real time.

Optimizing the movement of trucks and equipment to the right locations improves capacity utilization of mobile assets. Like airlines that seek to optimize utilization of aircraft—which are only making money when they are in the air—oilfield supply companies must optimize fleet movements to improve the bottom line. **Examples include the movement of equipment and materials for drilling operations, workovers and hydraulic fracturing (a single fracking operation typically involves several hundred truck movements to and from a well), and optimizing the movement of large trucks and excavation equipment in oilsands mining applications.**

In addition to driver alerts, lone-worker monitoring, accident detection and vehicle diagnostic monitoring, fleet management systems now offer "gamification" of driver safety—in which drivers can be scored against their peers and tracked on a leaderboard. This could be particularly attractive to many younger "gamer" employees, offering a potential recruitment selling point.According to a case study conducted by a fleet management provider, an oil services company experienced a 300 per cent increase in safe-driving behaviour, a 97 per cent reduction in speeding violations, an 89 per cent reduction in aggressive driving and a 57 per cent increase in seatbelt use within six months of installing the company's fleet management system, saving the oil services company $18 million in one year alone.

OVERALL INDUSTRY ADOPTION FOR THE FIELD PRODUCTIVITY USE CASE



USE CASE ASSESSMENT: field productivity

Industry wide, survey respondents were positive about the field productivity use case, offering consistently high rankings across the three adoption dimensions. Field productivity ranked second for both technological maturity and organizational readiness and third for perceived ROI.

The verticals S&S and E&P ranked field productivity highest (first and third place), likely due to their businesses' predominance of field-related facilities and activities. They indicated that the key benefit of this use case was the application's ability to connect workers in the field with information (from process information to procedures) and experts or resources that are more distant or centrally located (e.g., head office or dispatch centre). In interviews, industry executives from these sectors said success of their operations' centralization strategies was based on how well and how easily field staff could access information and centrally located expertise.

"There is a great amount of knowledge that already exists within each organization, but many of these organizations are not effectively mining this knowledge and leveraging their experts. Improving the connectivity of employees is one of the quickest ways of starting the innovation process."

— Daphne Cheel, executive director, Government of Alberta

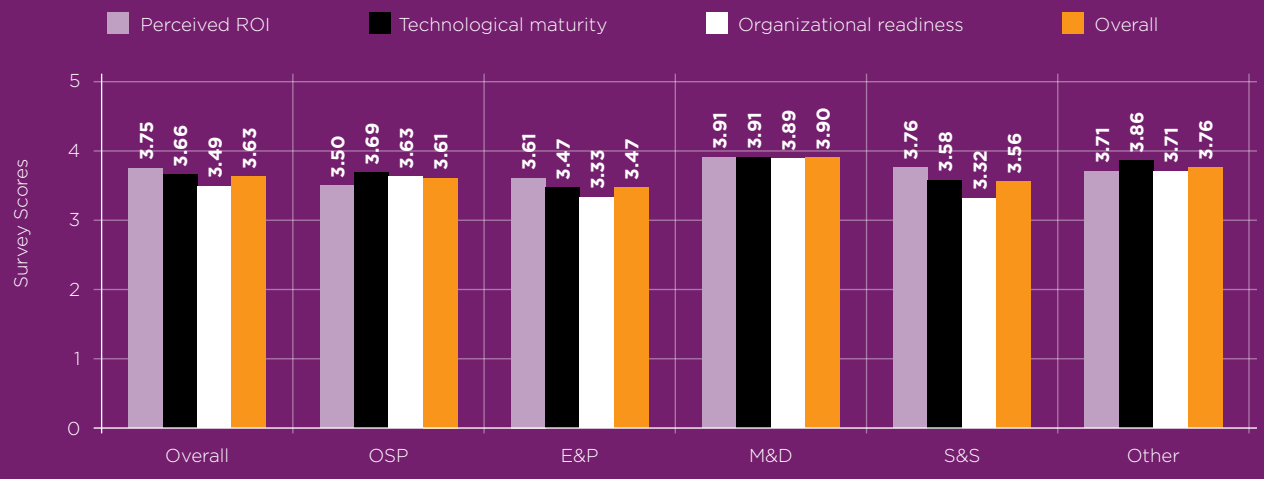
There is also a connection between field productivity and fleet management in that they often work in tandem, particularly in use cases that involve the optimal movement of work crews with the mobile assets they drive and operate. **For example, they enable the optimized deployment of trucks with the right equipment and parts, along with the right crew with the right skill sets, to complete a job in the safest and most cost effective way.**

Technologies such as smart mobile devices are enabling information transfer to the field. Ruggedized and intrinsically safe tablets and laptops are used in the field for functions like accessing field data, processing field tickets and communicating with experts at head office (network connectivity permitting), creating efficiencies in processes like paperless invoicing and improved inventory tracking, and paying safety dividends in reduced field work demands.

Field productivity is also beginning to see the benefit of another consumer-driven technology innovation transferred to the oilpatch—industrial applications of augmented reality, which offers the ability to superimpose virtual information on the screen of a mobile device and to interact with 3-D models of real-world equipment and machinery.

Augmented reality holds tremendous potential to assist field workers in numerous ways, from field equipment maintenance and repair to providing access to updateable and interactive checklists and documentation in real time.

OVERALL INDUSTRY ADOPTION FOR THE PRODUCTION ASSET OPTIMIZATION USE CASE



USE CASE ASSESSMENT: production asset optimization

Survey respondents also looked favourably upon production asset optimization, ranking it third overall with 60 per cent of the industry verticals choosing it as their first or second overall priority. While the use case ranked first for perceived ROI, it fell to fourth for technological maturity and fifth for organization readiness, indicating industry professionals feel it has high potential but is not quite ready for deployment and their organizations are not yet ready for implementation.

"Monitoring more sensors and collecting more data cannot be the end game. Leveraging analytics capabilities to unlock insights from which key management decisions can be made, that would be otherwise missed, is what makes digital oil and gas technologies just as important as other process and equipment innovations."

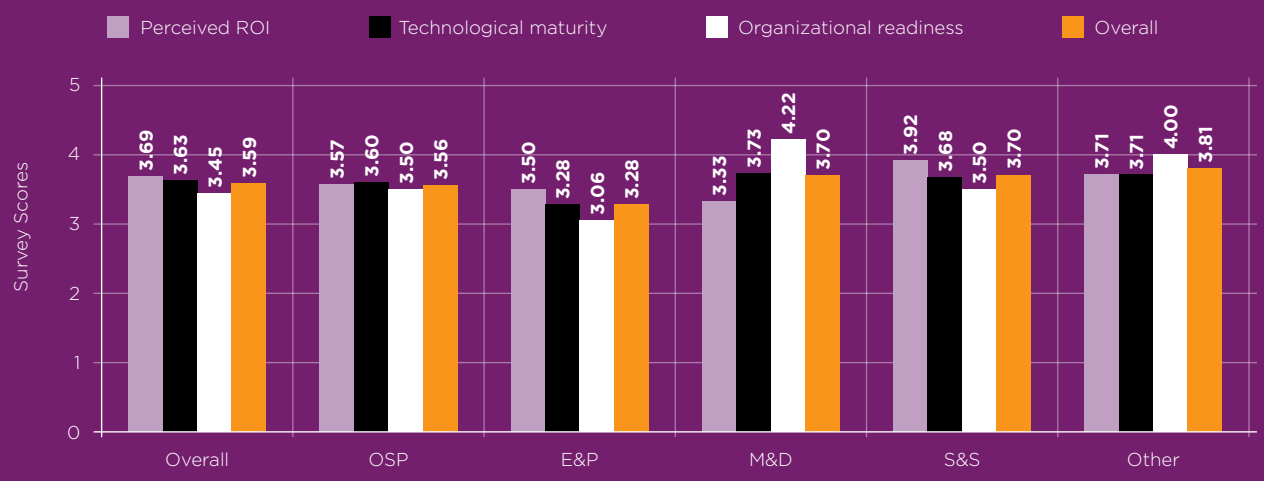
— Barry Lappin, former president, Canadian Heavy Oil Association

Organizations with large fixed assets (SAGD projects, mining and upgrading facilities, pipelines and refineries) were most interested in this use case. For example, they cited their interest in being able to take large amounts of sensor data to analyze for process-improvement insights. For many midstream companies, the opportunities often lie with optimizing the performance, throughput and revenue-generating capacity of their large-capital assets.

These organizations have high fixed costs and often focus innovation on ways to maximize production from existing assets. Management teams interviewed indicated these insights could be translated into increases in production through multiple incremental small-scale capital projects (i.e., debottlenecking projects).

A primary measure of efficiency in SAGD oilsands production is the steam/oil ratio—a measure of the amount of steam required to produce a barrel of bitumen. More steam means higher costs and greenhouse gas emissions per barrel produced. One way to minimize steam use is to co-inject solvents or non-condensable gas with the steam to reduce the amount of steam needed to liquefy the bitumen. But choosing the optimal reservoir management strategy presents enormous challenges, as the possible permutations are massive. **Production asset optimization is used to enable companies to model billions of combinations to find the optimal recipe, thereby reducing cost and environmental impact. The technology can also assist in optimizing aspects like thief zone management, artificial lift and smart completions techniques to minimize the steam-oil ratio and maximize production.**

OVERALL INDUSTRY ADOPTION FOR THE PREDICTIVE MAINTENANCE USE CASE



USE CASE ASSESSMENT: predictive maintenance

Predictive maintenance ranks as a fourth-highest overall industry priority, with 60 per cent of respondents placing it in their top-three priorities. With a second place perceived ROI, the industry believes these applications could provide some of highest payoffs compared to current alternatives.

Predictive maintenance was also seen favourably as a Digital Oilfield technology by oilsands producers, which have significant large fixed production assets that are in continuous operations (e.g., SAGD sites, and mining and upgrading facilities). Interviewed oilsands executives and management indicated this has become a major focal point in their cost-reduction strategies since it maximizes operational output by reducing or eliminating the impact of operation delays and shutdowns.

Midstream and downstream leaders said they viewed these applications as more established and modular in nature, and therefore easier to adopt into their existing systems and infrastructure than other options.

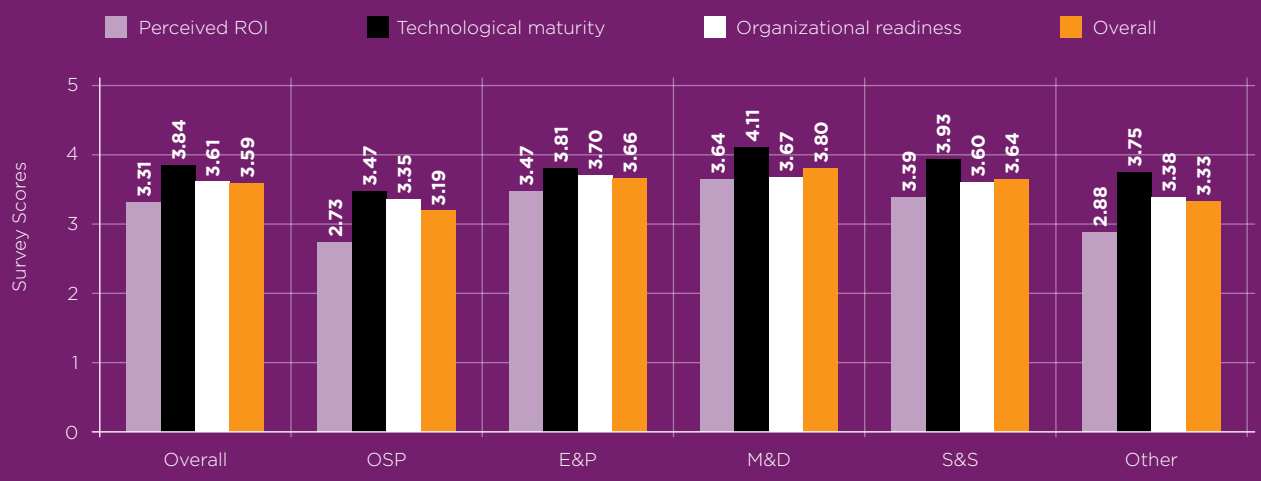
Predictive maintenance is made possible by the proliferation of low-cost connected sensors able to collect vast amounts of data on operating machinery, from electric submersible pumps to mining hauling trucks to compressors. That can then be scrutinized using predictive data analytics to uncover clues and patterns that make it possible to predict when problems like upsets and breakdowns will occur.

Condition-based maintenance offers a twofold benefit. **First, it allows companies to pull maintenance activity forward before an unscheduled failure. Second, it allows operators to selectively delay or defer expensive maintenance activity with the confidence that environmental health and safety aspects, and production, will not be impacted. The savings are potentially large, since unexpected equipment failures can have a significant impact on safety, environmental performance, production and costs.**

"Any knowledgeable person in the O&G sector knows that when they see a pump gauge pass the red line, the pump is going to burn out. What big-data analytics does is look at a wider range of available data to find patterns that are not as obvious to extend the life of that pump but also optimize the way it operates to get the most production out of it."

— Darren Massey, program leader, Customer Innovation Centre, GE Canada Global Growth and Operations

OVERALL INDUSTRY ADOPTION FOR THE BIOMETRIC MONITORING USE CASE



USE CASE ASSESSMENT: biometric monitoring

The biometric monitoring use case was tied with predictive maintenance as the fourth overall industry priority. All five industry verticals had positive outlooks on the maturity of the technology and their organizations' readiness to adopt it (third place rankings for both). However, while seen as very promising and close to widespread deployment, its ROI was seen as lagging, at ninth overall, which could dampen enthusiasm to drive adoption.

Biometric monitoring is yet another example of a consumer-driven technology, in the form of wearable fitness devices and Internet-connected accessories like smart watches, seeping into the workplace—which could explain its relatively high ranking. As such, the technology is likely to be more readily accepted and could even pose an advantage in recruiting new employees.

Though potentially intrusive, wearable devices able to continuously monitor worker location, movements, and in some cases health information, as well as providing emergency response alarms and gas-detection capabilities, bring obvious health and safety benefits to the workplace. They can also reduce costs by improving worker management.

Recent pilot deployment in the mining industry has demonstrated significant gains by optimizing the deployment of people during large turnaround events where the on-site staffing can expand to over 20 times the normal operating contingent. Biometrics in conjunction with field productivity has already demonstrated some early wins.

In interviews, industry officials dismissed any "Big Brother" concerns and indicated a priority was to identify workflow patterns that would help them remove bottlenecks that were beyond field staff control (e.g., observing staff having to routinely wait for parts and material arrivals).

The category could also be extended to include smart wearable devices that provide much greater opportunity for productivity gains such as increasingly sophisticated smart watches and heads-up displays, or smart glasses. While one iteration of smart glasses, Google Glass—which featured an optical head-mounted display able to display information in a smartphone-like format—was discontinued as a prototype (though it remains as a development project), other developers are continuing to develop and test smart glasses for industrial applications, including in the oil and gas and oilsands mining sectors.

Made possible with the advent of smaller microprocessors, better battery power and mobile Internet connectivity, smart glasses and heads-up devices offer such potential advantages as ready accessibility of data, voice-activated hands-free use and augmented reality capabilities. In 2014, consultancy Accenture said wearable technology could have a significant impact on many aspects of the oil and gas sector. "Although smart glasses are an emerging technology," it noted, "by 2017, they may help save the field service industry US$1 billion every year."

Predictive maintenance case study: **forecasting failure**

Electrical submersible pumps (ESPs) are a critical component in securing up to 60 per cent of the world's oil production. But they are a fickle one with unpredictable rates of failure. And when they fail, production stops, costly intervention is needed and producers lose money—it is estimated a single pump failure can cost $100,000–$300,000 per day in lost production.

Apache saw this problem as an opportunity—one with a Digital Oilfield solution. If it could predict failures before they occurred, it could not only prevent them—and the costly shutdowns they cause—but optimize maintenance schedules to coincide pump replacements with scheduled downtimes.

But predicting failure when dozens of different variables are in play is an extremely complex problem to solve. Not only do pumps come in different configurations, but no two pumps will experience the same conditions throughout their lifespan. Conditions encountered in a wellbore are extremely variable, with factors like temperature and pressure, oil viscosity and levels of gas and solids concentrations varying over time and from well to well. Apache determined there were about 40 actionable variables, those over which it had some control, and about 25 non-actionable variables over which it had no control.

Working with GE and Ayata Predictive Analytics, a pioneer in analytics applications and machine learning, it went predictive-data mining, starting with the data available through a joint industry project, ESP-RIFTS (Reliability Information and Failure Tracking System). ESP-RIFTS has collected data from about 106,000 ESP installations from the worldwide operations of several multinational oil companies.

It analyzed the big data set for patterns and systematic relationships between variables in order to ferret out those combinations of factors most likely to lead to failure. Relationships and patterns that emerge are validated by applying them to new subsets of data.

Ayata's first application in its Prescriptive Analytics process predicts ESP failures by taking into account data about pumps, production, completion and subsurface characteristics. It then prescribes actions to reduce pump failures and mitigate production losses. It then predicts and prescribes the right pump for the right well to maximize production. The third application of the software helps the producer evaluate fields for their potential production capacity by taking into account ESP performance, before acquiring these fields, Ayata says.

Preventative maintenance helped Apache avoid significant losses of production. According to the company, a one per cent improvement in global ESP performance industry-wide would provide over a half-million additional barrels of oil per day.

Perceived barriers to **Digital Oilfield adoption**

Industry unanimously recognizes the benefits of Digital Oilfield technologies but also recognizes there are barriers to adoption

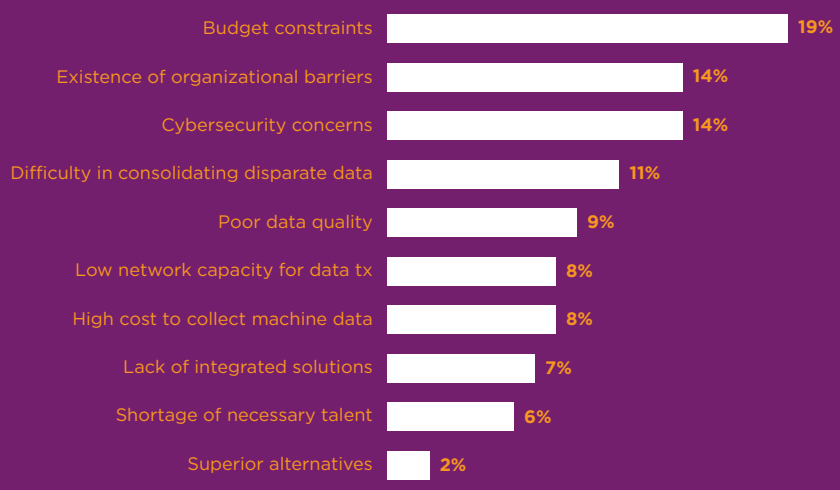
Despite the clear benefits seen by the oil and gas industry for the development and deployment of Digital Oilfield technologies, and the belief most are at or near technological maturity, widespread industry adoption has not taken place. Why not?

The reason most cited by those surveyed for this report, at almost one in five, is budget constraints. The existence of organizational obstacles and concerns about cybersecurity tied as the next most challenging barriers to adoption, each cited by 14 per cent of respondents (see graph).

Even though the industry has indicated the use cases presented here all have perceived ROI equal to or greater than other options for capital deployment, budget constraints are bound to present a barrier when many companies are fighting to stay afloat in the trough of the boom and bust cycle characteristic of the petroleum industry. But the ability to invest in potentially cost-cutting technology cuts both ways—those that do invest are likely to be the most competitive and best positioned to outlast the downturn.

In interviews with executives, it was also suggested the shortage of investment in leading-edge technologies stemmed from the industry's "fast follower" mentality in which organizations tend to prefer to let others assume the risk of pilot projects to prove out the technology before investing in them themselves.

IDENTIFIED BARRIERS TO ADOPTION



Organizational barriers—which could be related to people, processes or infrastructure—are in part attributed to Digital Oilfield applications requiring cross-functional integration to maximize benefit. Traditionally, many organizations have functional groups that operate in silos when evaluating and implementing technological solutions.

Cybersecurity concerns were found to align with the lower overall ranking of those technology applications requiring large data transfers of sensitive information, such as remote asset operations, in which real-time control requires adoption of cloud applications. Industry interviewees indicated they are widely distrusted because of the perceived data risk exposure they may present. For example, recent security breaches at Sony and Ashley Madison were specifically cited.

"It's amazing the number of sensors we now have downhole and all the data we can capture—so much so that the issue now becomes how to analyze it in a meaningful and timely way. Fantastic cloud solutions are available, but our members are met with resistance from their customers, who worry about who else may get the data."

— Steven Berg, vice-president, operations, CAODC

Conclusions and recommendations

INNOVATION IMPERATIVE

In response to the sustained decline in oil and gas prices, companies across the industry must innovate to improve financial and operating performance. The Digital Oilfield presents a tremendous opportunity to transform operations and drive significant improvements in performance and cost structure.

Notably, this survey shows that the industry on average perceives that all of the presented Digital Oilfield technology groupings have the ability to deliver equal to or higher returns compared to other options for investment. The industry also perceives that eight of the 10 use cases presented have reached a level of maturity at which they are ready for testing today. And industry professionals recognize that their organizations are either ready to tackle many of these opportunities today or will be within the next six months.

"As organizations consider their long term strategic plans the most important question they need to ask themselves is, 'How do we want to look at the beginning of the next downturn?'"

— Robert Phillips, chairman of the board, Precision Drilling

CRITICAL BARRIERS TO OVERCOME

One of the most critical barriers to moving forward is awareness and knowledge. This survey demonstrates that a large portion of the industry has a limited grasp of Digital Oilfield–related technologies and their potential benefits, resulting in missed investment opportunities due to lack of awareness.

Technology adoption starts with getting connected, then getting insights, then getting optimized. If it becomes stalled at the connection phase, it won't move up the value path to enterprise optimization.

The *MIT Sloan Management Review* global study of digital businesses found the oil and gas industry's digital maturity to be among the lowest of the industries it examined. "Less digitally mature organizations tend to focus on individual technologies and have strategies that are decidedly operational in focus," the study states.

Those industry professionals most involved in Digital Oilfield opportunities say there remain challenging barriers to overcome, including:

- Securing investment and resources at this challenging time.
- Overcoming organizational silos—in order to thrive, Digital Oilfield adoption requires some level of collaboration across operations, IT, instrumentation and controls, maintenance and other departments that has not occurred historically.
- Understanding and managing the technologies to collaborate, share and utilize data.

Recommended next steps:

1 Deepen awareness

Developing a better understanding of Digital Oilfield use cases, technologies, benefits and adoption considerations is a critical next step for industry leaders regardless of organizational level or organizational department. Most analysts agree that we are facing a prolonged period of low energy prices. It is critical for leaders to explore innovative approaches to improve cost structure and productivity.

"The 'next big thing' will happen in our lifetime, but as important as it is to develop the enabling technologies so too will creating robust business cases that demonstrate the qualitative and quantitative benefits to multiple users and stakeholders as a means of increasing adoption."

— John O'Rourke, chief executive officer, SIGIT Automation Inc.

2 Executive leadership

One of the barriers standing in the way of Digital Oilfield adoption is the fact that the opportunity requires an unprecedented level of collaboration and change across organizational silos. Many of the biggest opportunities cross several areas including operations, maintenance, IT, and instrumentation and controls. Other opportunities require collaboration across companies. Executive sponsorship is essential.

In other industries, companies have named a Chief Digital Officer to prioritize opportunities, bring focus and deliver tangible results. Digitalization is more than a business strategy—it represents a new way of doing business, and a CDO can coordinate and manage the organization-wide changes necessary to bring that about.

"We need to get dedicated people to work on organizational technology strategies and not just people who dabble in the field when they have time or focus on what only helps them. Defining innovation roles within industry is paramount to drive adoption. The movement will continue to struggle until internal champions emerge."

— Eddy Isaacs, chief executive officer, Alberta Innovates - Energy & Environment Solutions

3 Leadership at all levels

Leaders in all parts of an organization have an opportunity to explore Digital Oilfield technologies. Often those closest to the use case and application can identify and deliver the benefits. Companies can help accelerate this activity by creating an environment that encourages innovation and collaboration.

"If an organization wants to maximize the benefit it can expect to realize by adopting new cutting edge digital oilfield technologies there has to be commitment to implement and sharing of the risk across all organizational levels."

— Gail Powley, former president, Canadian Heavy Oil Association

4 Explore collaboration with partners

There is an opportunity to increase collaboration between producers and suppliers. Producers can be more open about their technology needs and more willing to share data. Vendors can often help build the business cases for the Digital Oilfield at a time when capital investment is in short supply. Producers and suppliers can explore joint pilots and proof-of-concept solutions to advance implementation. Difficult times can also call for creative financing solutions: service and supply majors Schlumberger and Halliburton, for example, recently indicated they are open to "frac now, pay later" arrangements whereby they will perform refractures for essentially a stake in the well's production.

"What BlackRock [funding] gives us is an ability to lever beyond that, look at additional ways of doing business with our customers, different business models, push beyond where we have been today or where we might be going in the future."

— Dave Lesar, chief executive officer, Halliburton

5 Ramp up the conversation

Increased dialogue and open interaction will help accelerate learning. Whether you consider the oilsands producer, E&P, midstream or S&S, there is an opportunity for groups within an industry vertical to share the outcomes from their pilots, benchmark performance and compare practices. The industry as a whole would benefit from quickly understanding successes and failures. Ideally, this approach can accelerate the identification and adoption of best practices. In many use cases involving safety and the environment, the performance of one company can impact the perception of the entire industry. It benefits everyone when the best solutions are identified and adopted.

"We have only scratched the surface as to how we are finding applications for technologies related to areas such as asset optimization. To further push the boundaries of innovation and adoption will be a function of educating enterprises that they can expect more from the industry and should expect more."

— Curtis Serna, president, Storm Telematics

IMAGE ©ISTOCK.COM/TEEKID