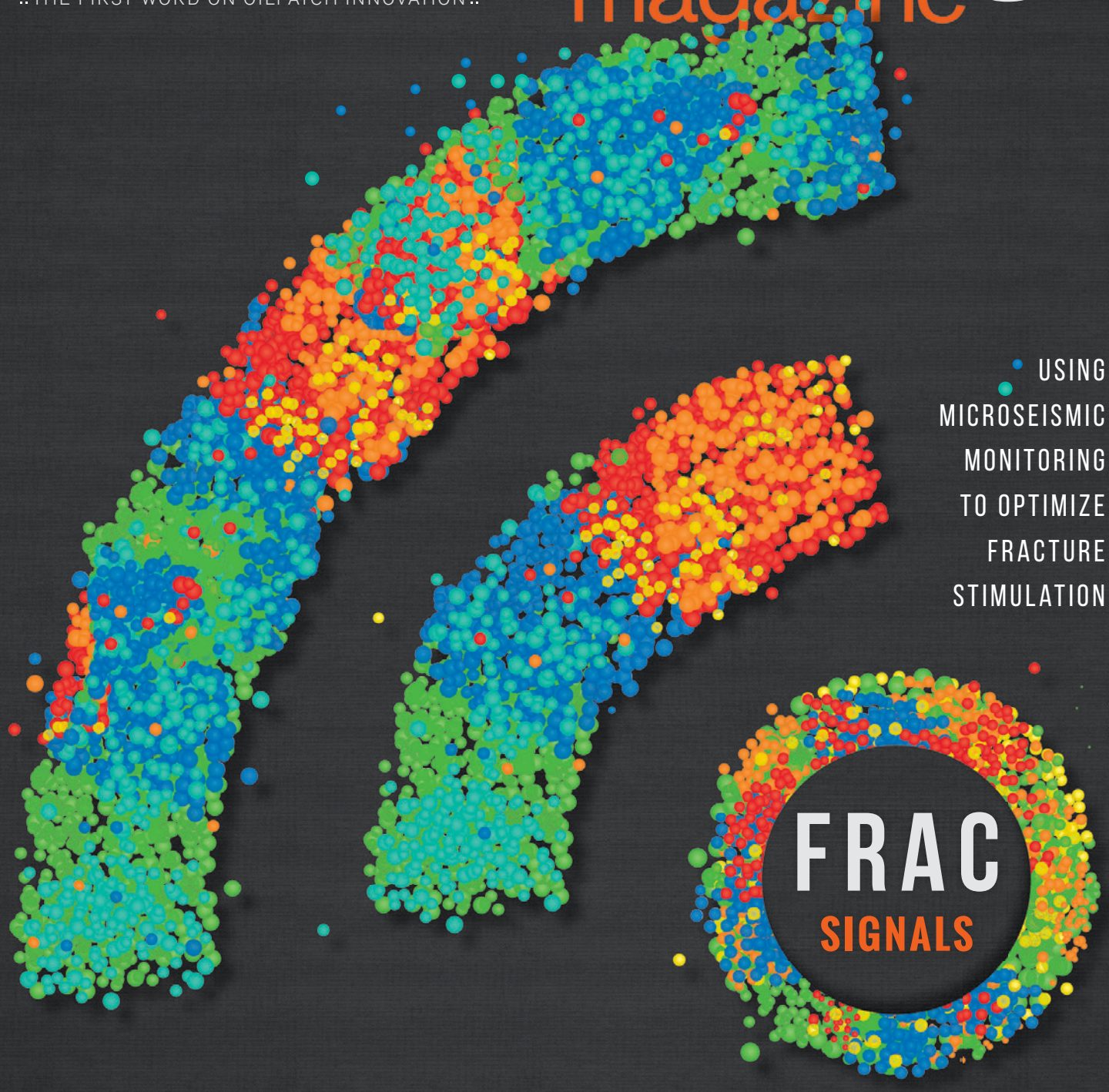
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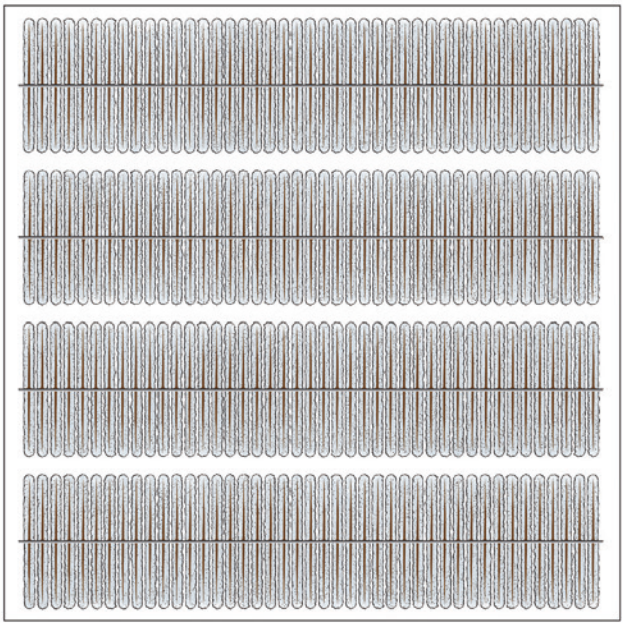
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Industrial Internet offers efficiency gains at all levels of value chain

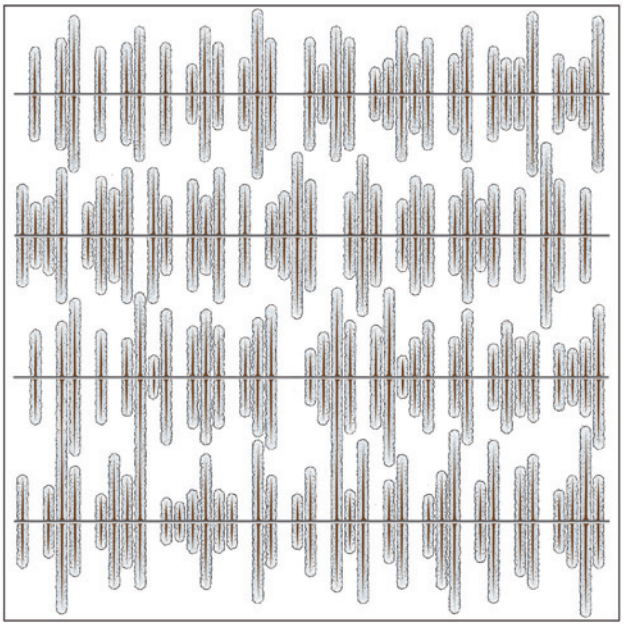
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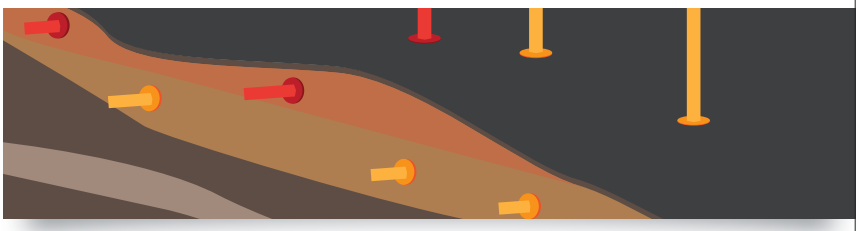
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BUYING LOCAL

It is an often heard complaint of the oil and gas sector that western Canada is shipping jobs out of the province with its oil exports, failing to diversify its economy and missing the innovation boat—remaining the clichéd hewers of wood and drawers of water for the rest of the world.

While there may be some truth to those old arguments, they don't tell the whole story, as has been shown by some determined and plucky companies establishing manufacturing facilities in Alberta—companies that are not at all fazed by the recent downturn in the industry.

In May, Harber Coatings opened an expanded Calgary facility to coat oilfield equipment with its proprietary InnoGUARD flakeless, electroless nickel coating, effectively quadrupling productivity and, through increased efficiency, reducing pricing by 15 per cent, a "huge benefit for companies now dealing with tight budgets," noted Ken Wang, its president and chief executive officer.

Replacement and repair of damaged equipment is the largest maintenance requirement in the oil and gas industry. Harber says its high phosphorous-nickel coating extends the life of critical metal items by over 20 times. The company, which continues to develop innovative technologies with research and development facilities funded by the National Research Council of Canada, also plans to use its expanded Calgary facility as a staff training centre as it opens new locations globally over the next five years.

Also in Calgary, Triple D Bending has invested $7 million in recent years to add its third induction bender and remain on the leading edge of pipe bending technology, as we report in this issue of *New Technology Magazine*. While induction bending machines may not sound like exciting new technology, they are sophisticated and costly units that offer many benefits over traditional elbow welding, and Triple D believes it is the only company in Canada to have three of them.

In Edmonton, Absolute Completion Technologies has just unveiled its $5-million robotic machining cell for the production of downhole well completion components. Previously, the process involved progressing through several manufacturing stages. By integrating these into one stage—the robotic machining cell combines five different machines—the cell performs the work of five people while reducing manufacturing times by up to 50 per cent. The company notes no jobs were lost in the transition—in fact, it created some new technology-focused positions.

In developing the technology, Absolute borrowed from the Ontario auto sector, marrying its automation technology with standard Alberta-grown machining techniques. According to Thane Russell, company vice-president of business development, the downhole flow control products represent "made in Alberta technology" the company is selling to the world—now used in at least 13 different countries.

While none of these innovative companies by themselves will have a large impact on an economy struggling through the oil and gas price bust, as a group they—like the junior exploration and production sector—can add up to a significant part of a growing economy.

As long as they can remain on the forefront of technological innovation, as these and other companies have shown, they can not only compete with cheaper imports, but grow by exporting to other countries. It is telling of the benefits of local manufacturing, with its high level of quality control, that one Triple D customer said it could save 30 per cent to outsource to an overseas competitor, but chose not to because the savings would be more than offset by the loss of quality.

Such innovation also helps to keep jobs local and to bridge companies through the low price cycle, ready to benefit from the inevitable price rebound. "Things change. The only question is when and where the price for oil will stay," sums up Triple D president Maros Tropp. "Our intention is to be prepared for when oil comes back. It's a slow time right now, but we have a plan for how to survive."

■ ***Maurice Smith***

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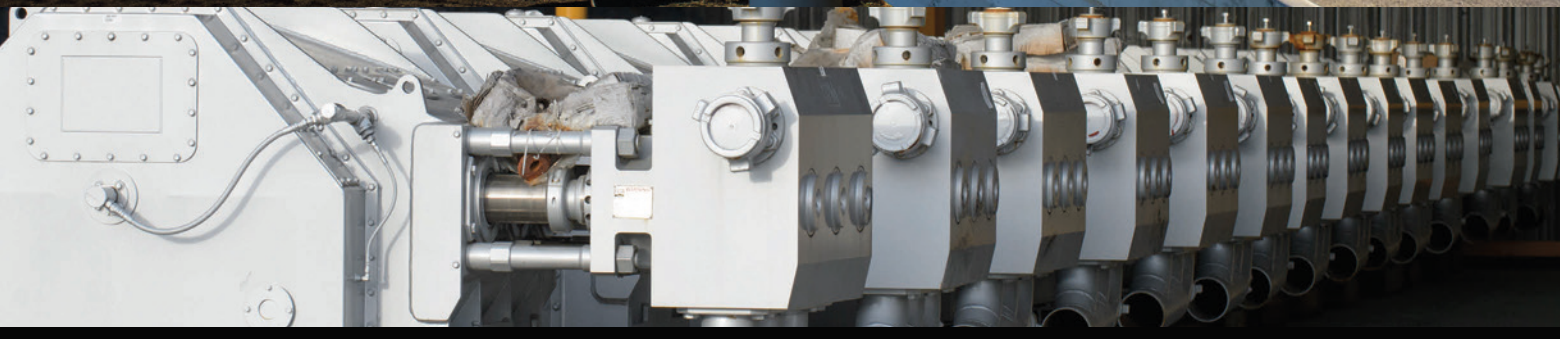
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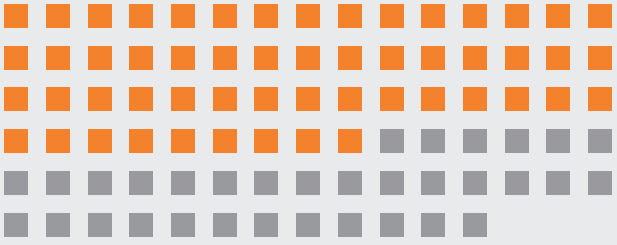
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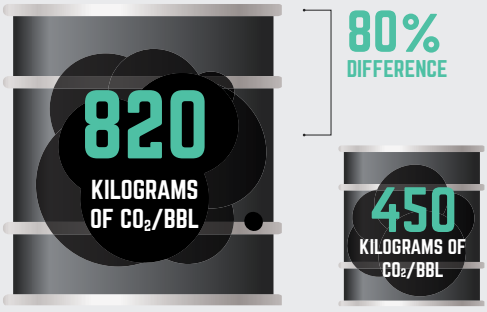
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MILLION TONNES OF CARBON EMISSIONS PER YEAR

Infrastructure projects such as TransCanada Corporation's proposed 1.1-million-bbl/d Energy East Pipeline will limit Canada's ability to meet its climate change goals, says the Pembina Institute. Production required to fill Energy East could generate 32 million tonnes of carbon emissions per year, roughly equal to Ontario's emission reductions from phasing out coal-fired power.

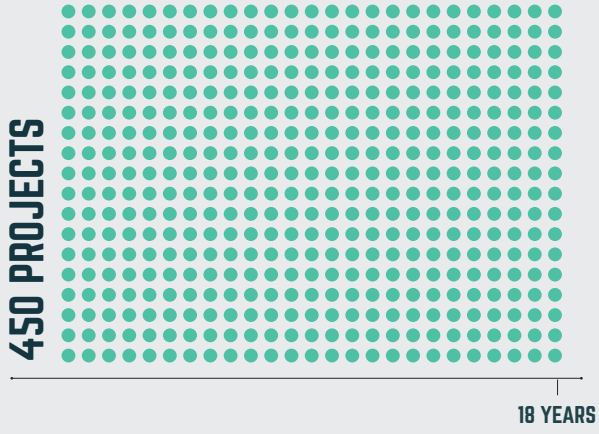
NDP 54/87 SEATS IN MAY ALBERTA ELECTION



Alberta's New Democratic Party captured 54 of 87 seats in the May 5 election, ending 44 years of Progressive Conservative rule. The new government is expected to increase the corporate tax rate from 10 to 12 per cent and undertake a broad review of oil and gas royalty rates.



Analysis of 30 crudes from around the world reveals greenhouse gas emission differences are greater than expected, says a University of Calgary and Stanford University report. The life-cycle Oil-Climate Index found a difference of over 80 per cent, from 450 to 820 kilograms CO_2 equivalent per barrel. Suncor Energy and Syncrude Canada synthetic oilsands crudes ranked number one and number three in emissions intensity, with China Bozhong ranked second.



Petroleum Technology Alliance Canada (PTAC) completed nearly 450 projects over 18 years focused on increasing oil and gas production and reducing costs and environmental impact. An evaluation of projects managed by PTAC estimates that for $119 million invested, cost savings alone have been $90 million to $350 million so far, and value creation continues to grow.



EOG Resources, considered a leader in the shale oil industry, says it plans to begin fracturing hundreds of drilled but not completed wells in the U.S. if oil prices stabilize around $65/bbl. Other companies have similarly pegged a price recovery of $65–$70 for fracking to return to pre–price collapse levels. Oil was fetching just under $60/bbl in early May.

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PHOTO: GENSCAPE

MIDSTREAM

I SPY

High-tech surveillance keeps tabs on storage levels, provides market transparency

Until Louisville, Ky.–based Genscape developed a suite of sophisticated monitoring technologies, there was no reliable way to measure how much crude oil and refined crude was piling up in storage tanks throughout North America—and it is piling up.

As a result of the growing volumes of shale oil and oilsands crude being produced in the U.S. and Canada, while pipeline capacity to carry that crude has lagged, tank storage is at record levels, with expansions planned that will substantially increase that capacity.

The U.S. Energy Information Administration (EIA), which monitors storage levels in the U.S., has determined that "working storage capacity," which excludes contingency space and tank bottoms, is at more than 521 million barrels, with about 60 per cent of that filled (compared to 48 per cent last year).

Meanwhile, as of late March, according to Genscape, storage in western Canada was bursting at the seams, with inventories at Edmonton reaching the highest level measured since Genscape began monitoring the location in 2010. Though at record levels, the Edmonton terminals were only utilizing 64 per cent of storage capacity—short of the record 67 per cent utilization rate—due to the vast amounts of storage tanks brought online since 2012. But Genscape predicted in March that a record utilization rate could also soon be met.

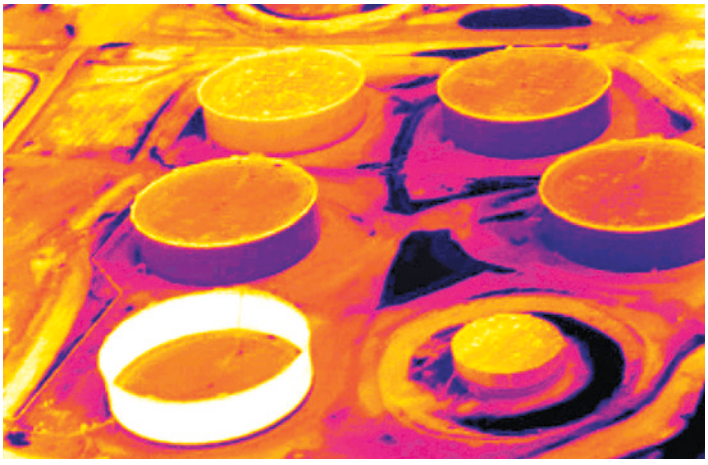
More storage is coming as oilsands production continues to grow, with Enbridge, TransCanada and Gibson Energy having announced plans to add a total of about 2.6 million barrels at Hardisty, Alta. In addition, Teck Resources, Keyera Energy and Kinder Morgan announced in early April they would build as much as 4.8 million barrels of new storage near Edmonton, with the potential to expand that to 6.6 million barrels.

Genscape produces a weekly Canadian Storage Report estimating physical crude oil inventories held in above-ground tanks at Hardisty, Kerrobert, Sask., and Edmonton, as well as cavern storage at Hardisty—based >

∧ EYEING INVENTORY
On external floating roof tanks, the roof floats on the surface of the stored liquid, indicating how full it is. Using proprietary monitoring technologies, Genscape provides weekly estimates of crude storage levels at major hubs around North America. Data from tank farms in western Canada is particularly interesting to traders since it provides a good leading indicator of what to expect at major U.S. storage hub Cushing, Okla., three weeks later.

> STORAGE TRANSPARENCY

Genscape uses infrared cameras, aerial diagnostics and other proprietary measurement techniques to determine actual tank volumes with granularity down to individual tank levels, providing important information to producers and oil traders.



on actual tank volumes with granularity down to the individual tank levels—and in the cavern connected to Brine Lake. Genscape collects data using infrared cameras, aerial diagnostics and other proprietary measurement techniques, which the company says translates into highly accurate estimates of actual oil storage levels.

Infrared cameras are able to peer inside storage tanks, while aerial photos allow analysts to estimate storage levels by using the angle of shadows cast by the tanks' floating roofs to calculate, using proprietary algorithms, actual tank volumes. Additionally, electromagnetic monitors placed beneath power lines running to tank farms can measure power usage, allowing the company to estimate how much oil is being pumped into and out of the tanks.

Genscape uses the same methodology at Cushing, Okla.'s enormous storage hub and other locations and closely tracks its performance against the EIA data in the U.S., which is derived from voluntary reporting or accounting flows. Published before the EIA data, such information is valuable to banks, hedge funds and oil traders. With no official Canadian storage data, Genscape is the only provider of storage data in the key hubs in Canada.

Genscape was founded in 1999 by former power market traders who had developed and patented electromagnetic field monitors capable of providing real-time analysis of the power grid. Those devices are now deployed worldwide by utilities, municipalities and others to observe electricity flowing across transmission lines.

Using Genscape's technology and market intelligence, with its capability of utilizing analytics to help power users make more informed decisions, Genscape can provide hourly price forecasts, which can help users manage their costs as they draw power from the grid.

In 2009, the company began expanding its footprint, utilizing its technologies to monitor the above-ground storage of crude oil and refined products. Since launching its power sector product, it had spent the previous decade investing heavily in research and development and has since been awarded several patents.

Genscape is considered to have pioneered the field of sophisticated surveillance and data-crunching analysis of the markets it now reaches, helping its thousands of users track everything from oil supplies to crop yields.

It now operates the world's largest private network of in-the-field monitors and has also added satellite reconnaissance, artificial intelligence and maritime freight tracking to its data acquisition capabilities. It provides monitoring and market intelligence data to the power, oil and gas, petrochemical, agricultural, maritime freight, financial and market trading sectors, and to government agencies.

Brian Busch, director, oil markets and business development, joined Genscape two years ago after working for various companies for 21 years in energy trading and risk management roles. "I joined the company after becoming familiar with their technology," says the Houston-based executive. "I realized they had technology I would have killed for [when he was a trader]."

The company is owned by London, U.K.–based DMG Information, a London Stock Exchange–listed division of Daily Mail and General Trust. It has 280 employees located in sales and monitoring centres in Louisville; Amsterdam; London; Hamburg, Germany; Singapore; Boston; Boulder, Colo.; suburban Houston and Austin. It has a sales representative in Alberta, where Busch says it has a number of clients.

All customers pay for the company's services on a subscription basis, with rates increasing depending on the amount and frequency of information they receive.

Hillary Stevenson, manager, supply chain network, says its infrared spectrum and other monitoring technologies provide its clients with real-time analysis of the "supply chain" involved in the crude oil market.

"Monitoring above-ground storage is important, but we allow for analysis of the entire supply chain from pipeline to crude-by-rail to demand by refineries," she says. "We can track supplies of diesel, gasoline, petcoke and other refinery products. If there's an issue at a refinery, our intelligence-gathering technology can detect it."

For instance, in May 2013 when the flow of crude through TransCanada's Keystone pipeline from Hardisty to Cushing was interrupted for 21 hours due to a power outage cutting the electricity supply to pumping stations in Alberta—which also stopped planned work at the Hardisty terminal—it was Genscape's proprietary pipeline monitoring technology that detected the pipeline's early-morning shutdown. Genscape alerted its customers of the shutdown more than five hours before TransCanada confirmed the outage on the 590,000-bbl/d system.

Busch says the company's employees range from those like Stevenson, a six-year veteran of the fast-growing firm who has a degree in chemistry and a deep understanding of the company's technology, to those with physics and applied math and business management degrees. "We don't have a specific profile of the people we hire—just that they need to be very smart and capable."

He says the kind of transparency Genscape's technology offers about crude markets "just wasn't there" before it entered the market. "In the past, if you had storage capacity at Cushing, you knew what you had stored, but you didn't know how much your competitors had stored," he says.

Previously, that information was available from the EIA, which still provides it, but that data is based mostly on surveys of companies involved in the crude and refined product storage business and is dated and not always reliable.

PHOTO: GENSCAPE

"We are the only people who measure Cushing [storage] twice a week," he says, adding that it does the same at key refining hubs like the U.S. Gulf Coast, a target market for Canada's bitumen and heavy crude. "If you're a bitumen producer, you want that information."

However, Busch says there are some natural barriers to extending the use of the technology, with access to private property or other areas being the most significant. "I don't think we'll ever get down to the wellhead level, even though that would be a natural extension of the whole supply chain," he says, adding that producers wouldn't necessarily want its monitors at their well locations.

There are also going to be areas of the world, such as countries in the Middle East, Russia or India, where legal issues would prevent Genscape's monitoring technology from being deployed.

"When you go into countries like Russia or India the laws are very different than they are in North America," he says. "Technology-wise, we could get there, but the legal issues would be difficult to deal with. In the U.S. [and Canada] we have a right to publish that data" and to gain access to most sites.

In North America, where the traditions of free trade and free-flowing information are strong, there is the potential to extend its monitoring technologies to cover many of the major players in the energy, power, agriculture and retail sectors, he says.

> **"MONITORING ABOVE-GROUND STORAGE IS IMPORTANT, BUT WE ALLOW FOR ANALYSIS OF THE ENTIRE SUPPLY CHAIN FROM PIPELINE TO CRUDE-BY-RAIL TO DEMAND BY REFINERIES.... IF THERE'S AN ISSUE AT A REFINERY, OUR INTELLIGENCE-GATHERING TECHNOLOGY CAN DETECT IT."**
>
> *— Hillary Stevenson, manager, supply chain network, Genscape*

The company is considering a move into Mexico as well, especially given the energy industry and power sector reforms taking place there and its integration with the U.S. and Canada. For example, most of the natural gas consumed in Mexico passes through cross-border pipelines.

It has a major presence already in Europe, and he says there is also the potential for significant growth there.

Genscape is also playing a growing role in monitoring fuel and bulk goods marine shipments. "We're getting better at tracking the flow of crude and refined products [and other goods] on the water. Eventually that will become a worldwide product," with little in the way of legal barriers, he says.

While its technologies have obvious value for companies involved in transporting and storing various products, he says its role in helping to create "a more transparent marketplace" is also consumer-friendly.

Stevenson says the growth in crude oil and gas production in North America is causing much of the firm's growth in business and revenue of about 20 per cent or more a year. "It's definitely causing demand for more data sets," she says. "We didn't have a crude-by-rail product until the growth in volumes on rail took place, and the same thing applies to the Gulf Coast [storage market]."

■ ***Jim Bentein***

SUPPLY CHAIN

TAG, YOU'RE IT

High-tech company helping firms locate materials, cut costs at major projects

It's no secret that major energy projects suffer budget overruns. The cost for Imperial Oil's Kearl oilsands project increased from $10.9 billion to $12.9 billion. The estimated cost of the North West Redwater upgrader/refinery near Edmonton has grown from $5.7 billion to $8.5 billion.

A host of causes—including high labour demand, difficulties in building in remote locations and insufficient front-end engineering—have been identified, but when the Construction Owners Association of Alberta (COAA) conducted a study that focused on advanced workface planning, they made an interesting discovery.

"The workface is the actual place where work is being executed," says Josh Girvin, senior vice-president, product marketing and strategy, for Atlas RFID Solutions. "The COAA estimated that integrated materials management—getting the materials to where they are needed when they are needed—could increase productivity by 25 per cent."

Atlas RFID is based in Birmingham, Ala., and has offices in Houston and Calgary. It was founded in 2007 to develop materials management solutions in the automotive industry. The company soon realized that there was a need for materials management in the construction sector, and began work on the Jovix system, an automatic identification–based materials management solution. The system is now deployed at more than 200 sites around the globe.

Radio frequency identification (RFID) technology is at the heart of the Jovix system. An RFID tag contains electronically stored information that allows it to be identified and tracked. Some tags are powered by energy from radio waves, while others use batteries to increase their range of detection. An RFID reader transmits an encoded radio signal. When a tag passes within range of an RFID reader, the tag automatically transmits electronic information to the reader, where it can then be recorded on tabulation software.

Because RFID tags can be attached to manufactured goods, cash, clothing, humans and animals, they are employed in a wide spectrum of uses. In 2014, the world RFID market was worth almost US$9 billion, and it is expected to triple in value over the next decade.

In order to service the materials management sector, Atlas RFID designed >

a customized system from a wide variety of hardware sources. "We have active and passive tags, barcodes and GPS tags," says Girvin.

The company also deploys an assortment of readers, including stationary devices that can be mounted at the exit of a construction yard and the entrance to a laydown yard (essentially a fenced area open to the elements where materials and equipment are stored), portable tablets and hand-held readers. "Some clients lease the equipment, but most purchase and reuse it when they move on to a new project," says Girvin.

The Jovix system is unique, however, in that it offers purpose-designed materials management applications. The system takes into account modern manufacturing technologies, so that materials can be followed from the fabrication floor right to final assembly. "Although we supply RFIDs and a full hardware solution, our core value is in our software," says Girvin.

HOW IT WORKS

During the course of a major project, millions of separate pieces of specialty equipment, construction materials, plumbing and electrical supplies must be manufactured and delivered to the site. Tracking and locating each and every item is crucial to the success of the project. Traditionally, materials management has been done by hand, where a technician physically identifies each item, makes a list, then transfers the list to a computer for tallying.

With the Jovix system, items are identified and tracked automatically. When a delivery truck—which can be carrying as many as 100,000 separate pieces of material—leaves a manufacturing site, a reader identifies every item. When it drives into a laydown yard, a gate reader then automatically identifies and catalogues each piece of material.

During periodic materials counts, workers can roam through the yard or warehouse and identify where each item is being stored. "A technician has a tablet instead of a clipboard," says Girvin. "The system collects information and transfers it in real time through an Internet connection to HQ. It eliminates errors and the extra step of re-tabulating the information."

As an added benefit to Canadian projects, the effects of inclement winter weather can be eliminated. "In the oilsands, there might be two metres of snow in a laydown yard," says Girvin. "The system can read right through the snow and locate items during a cycle count."



KEEPING TRACK
Using RFID tags that are able to maintain a beacon signal for up to five years and withstand northern Alberta winters, Atlas RFID's tracking and locating technology identifies and traces items automatically, allowing companies to know where equipment and critical parts are at all times.

Bantrel, the Canadian subsidiary of Bechtel Corporation, is an engineering, procurement and construction (EPC) company. It designs a project, sources materials and manages the delivery of everything to the worksite. It then oversees the subcontractors that build the project.

"We have used the Jovix system numerous times over the past several years on different projects for several of our business lines," says Ed Koch, software product manager for Bechtel Global Corporation. "What we do know is that by deploying a system for modern materials management, we have the opportunity to realize improvements in worker productivity."

In 2012, Bantrel was contracted to help construct a SAGD project in the oilsands. The client wanted to know where critical construction materials were located at all times; it wanted to reduce costs related to missing materials; and it wanted to improve the efficiency and productivity of its construction contractors.

According to Atlas RFID, the Jovix system offers three value components. "The first is indirect labour costs, in which we reduce man-hours used to perform materials management at receiving points and warehouse counts," says Girvin.

The second advantage is direct labour efficiency. "Craft labour, the people who build things, need to be kept as productive as possible," says Girvin. "In the oilsands, it is estimated that someone like a welder spends only 3.7 hours in a ten-hour shift actually working on tools. The number one non-tool activity is waiting for materials and equipment, what we call material readiness issues. A welder needs a machine, welding rods and materials to weld; we remove issues by providing the flow of specific materials."

The third advantage is materials budgeting. "When you can't locate something, you have to decide either to continue to look for it, or to buy new because it's less costly than doing nothing," says Girvin. "Our system provides

PHOTO: ATLAS RFID SOLUTIONS

visibility, so it reduces unnecessary re-procurement."

Bantrel contracted with Atlas RFID to install and operate the Jovix system. Atlas deployed active RFID tags that had been tested to minus 40 degrees Celsius to maintain a beacon signal for up to five years. They also installed GPS-enabled devices with Bluetooth barcode readers and integrated RFID readers in order to locate critical materials when needed.

Over the course of the project, the system was able to reduce the time spent searching for lost materials, lower labour costs and reduce replacement costs. In all, the system saved the client almost $12 million over two years.

THE FUTURE

Currently, Atlas is working with Bechtel and other EPCs to evaluate and expand functionality of the Jovix system. Often, space is at a premium in laydown yards, and delivery trailers must be parked until room can be made. By creating a special software application, the contents and location of tagged trailers can be automatically ascertained. Trailers arriving with just-in-time materials (also known as "hot trailers") can be identified and crews alerted to their imminent arrival.

In addition, many pieces of equipment awaiting installation in the laydown yard require periodic and/or preventative maintenance to maintain functionality. The Jovix system can both locate and diarize maintenance activities.

Finally, software can chronologically record the installation of material bearing RFID tags, allowing the EPC to analyze whether construction is on time.

Bechtel has no hesitation recommending the system. "Jovix is a state-of-the-art software solution that can radically alter the work processes associated with material management in an innovative manner," says Koch. "Any company wanting to apply innovative solutions to their material management capabilities via the use of technology should be looking to implement a system like Jovix. There is no other commercially available software solution like the Jovix product for the EPC industry and that's because Atlas RFID Solutions Inc. is only focused on providing solutions related to capital industrial construction projects."

Clearly, the message is getting through: Atlas RFID is enjoying rapid global expansion of its products. "We are on three continents, and expect to be on five by the end of the year," says Girvin.

■ *Gordon Cope*

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Fast-Track to PRODUCTIVITY IMPROVEMENT

Industrial Internet offers efficiency gains at all levels of value chain



ILLUSTRATION: ©ISTOCK.COM/KROLONE

The oil and gas industry could save billions of dollars by shifting all of its upstream, midstream and downstream operations to the Industrial Internet, say energy and technology executives with two of the world's largest corporations, both of which have embraced the technology.

"I believe there's the potential for a 25–50 per cent reduction in costs on the operational side; that's the opportunity that exists," says Brad Bechtold, the Calgary-based director of oil and gas industry transformation with technology giant Cisco Canada (a division of Cisco Systems).

Bechtold, who spent 25 years as a manager in the energy services sector, 18 of which were with Halliburton, and most of those spent heading the global operations for its GeoGraphix software product line, before joining Cisco three years ago, says he was astounded to see the potential efficiencies that could be brought to the energy industry after joining Cisco, which has been touting its Internet of Things strategy for several years. He also refers to the technology as the machine-to-machine (M2M) approach.

While lower oil and gas prices present a challenge for the entire energy industry, Bechtold, who holds a diploma in business management from SAIT Polytechnic, says the Canadian energy sector faces added pressures.

"The problem for the Canadian industry isn't the price [of the commodity], it's their costs," he says. "It is the most expensive [oil and gas] resource in the world. If they don't resolve that, they don't grow."

Bechtold, who emphasizes that he "is not an IT person," is convinced Industrial Internet technology holds the key to helping the energy sector manage its costs.

While emphasizing that the one per cent productivity improvement General Electric (see related story page 18) and other advocates have touted as likely for firms embracing the Industrial Internet is readily achievable, he says he's convinced there is far more potential than that.

The Cisco executive argues that there are more inefficiencies in the oil and gas industry than in many other sectors, likening it to the days when the utility sector dispatched meter readers to remote sites rather than relying on readings from sensors.

"If you think about it today, we have many workers [doing the equivalent of] reading meters, driving to remote work sites to monitor equipment," he says. "That could all be done with centralized monitoring."

There is also a worker safety issue. "Anytime you send someone to a remote work site you compromise his safety," he says.

That M2M technology approach would also allow operators to take a predictive approach toward equipment failures.

Bechtold says the automobile industry and many other sectors have fully embraced the technology, while the oil and gas industry "is barely in the third inning" of the game.

He says the biggest potential beneficiaries of the technology are oilsands producers, who could reduce their field staff substantially using M2M technology. The Cisco executive believes three people in a control room could do the work of dozens of workers in the field of an oilsands site.

He says oilsands players are now eagerly embracing the potential of the technology, and his office has been very busy of late. That doesn't surprise the oil industry veteran.

"The oilsands is a technology-driven sector," he says. "The reality is it's a more economic resource because we have found ways to make it economic."

And now Industrial Internet technology can make it even more so.

He sees the potential for the M2M approach to solve multiple problems in the oilsands sector, from ensuring steam is more accurately injected into a reservoir to advancing the use of autonomous trucks at oilsands mines.

The technology can also make fracking more efficient by providing more accurate monitoring to limit water use.

Cisco has worked with Royal Dutch Shell, Marathon Oil and others to implement its M2M technology, he says.

The company retained consulting firm Accenture to measure the results of that implementation, and it reported up to a 15 per cent increase in productivity.

Cisco recently produced a case study of the implementation of its M2M technology at the site of the $8-billion North West Redwater Partnership refinery being built northeast of Edmonton. Data, video and voice technology were provided by partner Redline Communications, which specializes in wireless communications. Cisco provided the M2M tracking technology.

All construction workers and equipment at the site have been continuously monitored, leading to what might eventually be millions of dollars in productivity improvements.

Bechtold believes the oilsands sector's biggest potential for improvement is in "time on tools," both in ongoing operations and in plant turnarounds and shutdowns. Industrial Internet technology can help the industry more accurately gauge how much wear and tear there has been on an asset, limiting the time a facility is off-line. >

How Digital Transformation in Oil and Gas Can Fuel Global GDP

Industry-wide adoption of Internet of Everything solutions could boost GDP as much as 0.8%. This means up to

$816 billion in GDP benefits by 2025.

1. Oil and gas firms invest in Internet of Everything

Reduced costs from asset monitoring, workforce efficiencies, improved logistics and more

2. Increased investments boost production and supply

4% increase in supply from Internet of Everything improvements

3. Consumer demand increases

3.7% increase in demand as greater supply causes prices to drop

4. High production/ low prices stimulate global economy

This "positive supply shock" triggers additional impacts such as increased economic activity and high employment so that by 2025, consumer and business spending grows up to **1.5%** adding billions to the global economy.

SOURCES: OXFORD ECONOMICS 2015; CISCO CONSULTING SERVICES, 2015

The mantra of the oil and gas industry for years has been around the approach of continuous improvement, which he thinks is perfectly aligned with the M2M approach. "There is no single problem with a single solution," he says.

Dan Brennan, the California-based director of the Industrial Internet for GE's $20-billion oil and gas division, says he believes the upstream, downstream and midstream sectors can all realize cost savings of 10–15 per cent by shifting to the widespread use of the technology.

Like Bechtold, he thinks it's early days in the implementation of the technology.

While he agrees that large oilsands and offshore oil and gas projects are the most logical places to look for big cost savings, he says GE is finding the greatest interest among small and intermediate-sized oil and gas producers, which have faced the greatest financial stress as a result of lower oil and gas prices.

"We think they'll be the first to move because they don't have their own [M2M] resources," says Brennan, who has an engineering degree and an MBA and has been with GE for 12 years.

He also believes the biggest potential gain in the implementation of the Industrial Internet is in reducing or even eliminating downtime at worksites. "For example, at an average LNG plant, there's 10 days of downtime a year, at a cost of $100 [million] to $150 million," he says.

Similarly, downtime during turnarounds and shutdowns at large industrial sites could be virtually eliminated, leading to billions of dollars in savings.

Because manufacturers of equipment would be involved in the process, thanks to the implementation of the Industrial Internet, they would provide needed parts just in time, he says.

"The Industrial Internet allows for connectivity all along the value chain," he says. "The upstream oil and gas industry spends $800 billion a year. Just a one per cent improvement a year in cost savings could lead to many billions of dollars in cumulative savings."

There are logical efficiencies that could be realized in the midstream sector as well.

For instance, about 60 per cent of oil and gas pipelines in North America were put into operation prior to 1970 and are therefore "unpiggable" (not accessible by devices placed inside pipelines for inspection), requiring a great deal of human monitoring. Brennan believes Industrial Internet technology would virtually eliminate the need for manual inspections.

Refineries are another area where the technology could play a significant role since process optimization and gauging demand and supply play a large role in making refineries operate efficiently.

GE is working with a SAGD operator in the oilsands, where he sees the potential of the technology to make water handling and use more efficient, playing a vital role in reducing costs. "We think we can accelerate the process," he says.

The technology can also lead to more efficient waterflooding and other enhanced oil operation approaches, he says.

The only thing standing in the way of faster and greater implementation of the technology in the energy industry is a "knowledge barrier," he says.

There's a widespread misunderstanding about how the technology works, as well as concerns about cyber security. The latter concern would be non-existent if more in the industry knew about the level of security that is possible with today's cloud technology options, he says.

"The industry needs to see that the marginal value of the technology far exceeds the marginal risks," he says. ■



PHOTO: GE

CONNECTIVITY FOR INDUSTRY

Internet of Things: The social media of industrial applications

Just as the Internet transformed the way people communicate with one another, in a world dominated by emails, social media, smartphones and digital information, the Industrial Internet, which allows machine-to-machine dialogue, will change the way the world works in the future, according to a Chicago-based manager with General Electric's (GE's) software division.

"The way social media has changed the way people interact, machine-to-machine communication will change the way industry works. GE is [at] the forefront of that change," says Kristy Lundgren, marketing leader of the company's Rail Connect 360 program, which is implementing the technology in the railway sector.

That implementation revolves around the company's new industrial software strategy that saw it invest $1 billion in a new lab in San Ramon, Calif., where a software team has built a new Industrial Internet platform, called Predix, similar to an operating system like Android but aimed exclusively at machine-to-machine communication.

Jessica Taylor, Chicago-based head of external communications for GE Transportation, says the company's Industrial Internet strategy is aimed at helping it "move beyond being a heavy hardware manufacturer."

There are about 4,500 GE gas turbines around the world, 22,000 GE wind turbines and 20,000 GE locomotives all outfitted with multiple sensors. Jeff Immelt, GE chairman and chief executive officer, and other executives realized about three years ago the industrial behemoth, with about 300,000 employees worldwide and annual revenue of about $146 billion, needed a strategy to manage all the data coming from its sensors, which dwarfs data sets generated by consumers using the conventional Internet.

That is what led to the creation of the San Ramon centre, which employs 1,000 software engineers, IT experts and others from Silicon Valley.

Lundgren says the intelligence gathering and parsing potential of the Industrial Internet, also called the Internet of Things, is mind-boggling.

"As 50 billion machines become connected, it will change everything," she says. "Just as my thermostat talks to me and I can manipulate it from a distance, the Industrial Internet allows a locomotive to 'talk' to a service dispatcher and say 'I'm sick.'"

In GE's case—and the same can be said for all other manufacturers deploying Internet of Things technology—it is about moving beyond the old way of servicing machines. In GE's case, the company earns $180 billion a year servicing the machines it sells.

In the past, the approach was "it breaks, we fix it," according to Immelt and other executives. The next wave saw the development of service agreements that assured customers a GE-built engine or turbine would achieve a certain level of performance and would have regularly scheduled maintenance based on GE's experience with its equipment.

The third wave, the one made possible by the Internet of Things, strikes an agreement between GE and customers for certain kinds of outcomes: an assurance of ongoing performance.

> "The upstream oil and gas industry spends $800 billion a year. Just a one per cent improvement a year in cost savings could lead to many billions of dollars in cumulative savings."
>
> *— Dan Brennan, director, Industrial Internet, GE Oil & Gas*

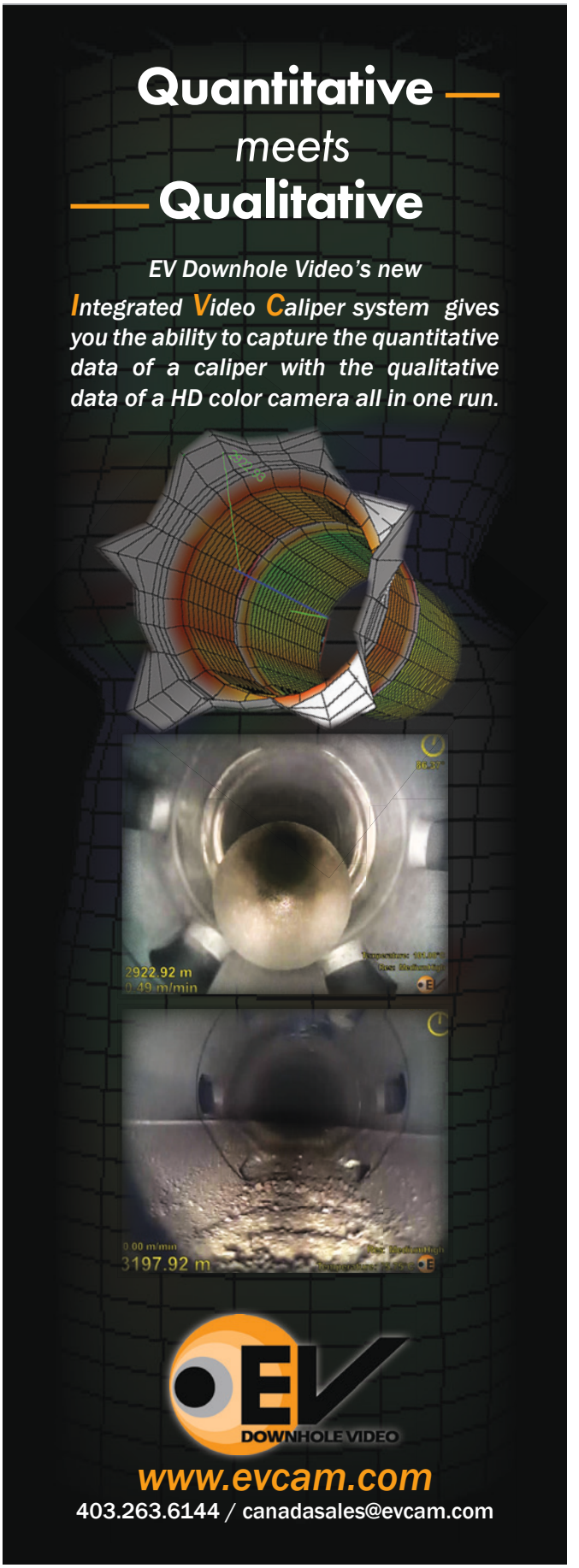


The rail segment was a logical area for GE to utilize its Industrial Internet strategy, says Lundgren, since it is an area where the company has a huge market share. On any given day Class 1 freight haulers in North America move about 24,000 locomotives and almost 500,000 freight cars (there are an additional 800,000 privately owned cars, most reliant on thousands of additional locomotives). GE calculates that even a one per cent gain in efficiency of the system could result in savings of over $2.8 billion a year for the rail companies.

This can be accomplished utilizing a suite of tools made possible by the Industrial Internet. These include Trip Optimizer, a type of cruise control that analyzes data and allows train engineers to maintain the most efficient speeds and reduce fuel burn, and the use of remote diagnostics that transmit the warning signs if there are impending problems, averting breakdowns. A tool called Yard Planner limits the amount of time trains are inactive, and a tool called Movement Planner allows for the tracking of a train's present and future location, which increases its velocity by 15–20 per cent.

"The amount of freight moving on North American railroads is expected to double between now and 2020," says Lundgren. "You can't just lay more track, which is why this technology is so important."

As all the world's machines become more interconnected and "smart" thanks to the advent of the Industrial Internet, GE's executives believe cost savings from the management of big data, thanks to its Industrial Internet technology, could reach the double digits for each industry adopting it. ■



GAS IN, OIL OUT

Encouraging production convinces companies to grow EOR despite low prices

By Pat Roche

Amid the constraints of low crude prices, two tight oil producers continue to build on their success in re-injecting natural gas to enhance oil recovery.

Lightstream Resources plans to add more injection wells to its gasflood in the Bakken of southern Saskatchewan in the fourth quarter of this year, while DeeThree Exploration keeps adding injectors to its gasflood in southern Alberta tight oil.

DeeThree reported in early April on the success of horizontal well 11-20-003-16W4—the first well specifically designed to optimize the enhanced oil recovery (EOR) scheme that re-injects gas produced from the company's own oil wells.

With oil output topping 10,000 bbls/d, DeeThree boasts exploration success no one else has yet been able to emulate by exploiting light tight oil resources in a southern Alberta formation officially known as the Exshaw, but probably better known as the Alberta Bakken. A low-permeability formation with a large in-place light-oil volume, the Exshaw is Alberta's lithological equivalent of the Bakken in southern Saskatchewan, Montana and North Dakota.

The 2,000-metre horizontal lateral of the 11-20-003-16W4 well was drilled into the Alberta Bakken within DeeThree's core EOR area, near where the company has been re-injecting produced Bakken gas with a high CO_2 content since July 2013. At the end of a five-day production test, the well continued to flow 30-degree API gravity oil at a rate of about 1,000 bbls/d with 500 mcf of natural gas at a flowing wellhead pressure of 300 pounds per square inch.

ALBERTA BAKKEN SUCCESS

"The significant rate—and, more specifically, the low gas-to-oil ratio of the production—further demonstrates the efficiency and effectiveness of DeeThree's gas re-injection EOR scheme," the company said in an April 1 press release. (*New Technology Magazine* was unable to get an interview with DeeThree for this article despite several requests.)

DeeThree said it will continue its EOR-tailored drilling and production program to maximize returns from the pool. As part of its program to reduce capital costs, well 11-20-003-16 W4M was drilled with monobore technology and completed with cemented sliding sleeve technology.

The company began gas re-injection on its Alberta Bakken properties in July 2013, about a year after the main oil pool was discovered. The EOR project began with the conversion of one of the company's best producing oil wells into a gas injector pilot. Soon after, production declines were reduced in offsetting oil wells.

DeeThree expanded the EOR project last September by adding two more gas injection wells and installing permanent and scalable gas injection facilities. The company reported a significant reduction in production declines over a 14-square-mile area. Current gas injection into the project area is roughly three mmcf/d, or about 70 per cent of the associated gas produced from the Alberta Bakken property.

The company received approval from the Alberta Energy Regulator to begin injecting into a fourth well in April. A fifth injection well application was awaiting regulatory approval at the time of the press release. In late March, DeeThree said it expected that by mid-2015 all the gas being produced from its Alberta Bakken properties would be re-injected to enhance oil recovery. To supplement injection volumes for future voidage replacement, the company said it has taken steps to develop its low-cost, 100-per-cent-owned, non-associated gas from the Bow Island and Sunburst zones overlying its Alberta Bakken properties.

In releasing its 2014 year-end results, DeeThree said capital efficiencies could be improved by moving to a gas re-injection scheme rather than continuing with down-spacing alone, due to a combination of pressure maintenance and the CO_2 component of the re-injected gas. The company said its Bakken oil pool produces gas with high CO_2 content, and CO_2 provides better miscibility than methane.

DeeThree is sufficiently impressed with the results of its EOR scheme that it has committed to full-scale implementation, but it offered no details. The company said it will continue to advance development of the oil pool at a measured pace, matching drilling activity and subsequent production increases with its ability to replace voidage through the EOR project.

In April, DeeThree announced it would reorganize to create two independent, publicly traded companies—a growth-focused light-oil company centred around its Belly River development in the Pembina-Brazeau area of Alberta named Boulder Energy and a dividend-and-growth-focused oil company centred around its Alberta Bakken EOR project called Granite Oil.

SASKATCHEWAN BAKKEN PIONEER

Lightstream and its predecessor companies spearheaded development of the Saskatchewan Bakken from negligible volumes to a major part of the province's economy.

Like DeeThree, Lightstream is re-injecting its own natural gas that is produced with its oil. It currently has four wells injecting natural gas into the southern Saskatchewan Bakken at Creelman.

Two of the wells are what Lightstream calls heel-to-toe injectors—horizontal injection wells drilled along the lease line perpendicular to the producing wells—so named because they're flooding the toes of some offsetting horizontal producers and flooding the heels of others.

One heel-to-toe horizontal injector has been on stream since February 2012; the other has only been on stream since March 15.

Also at Creelman, Lightstream has two parallel injectors that have been on production for more than a year. The parallel gas injection wells are drilled between and are parallel to the offsetting oil producers. The parallel injectors are less efficient, however, because each floods only about two offsetting producers.

In contrast, with just one heel-to-toe injector along the lease line, Lightstream can gasflood two square miles, or eight producing wells. So not only are fewer injectors flooding more producers, but fewer wells have to be taken out of production to be converted to gas injectors. And since gas moves through the rock more easily than water does, fewer injection wells are needed in a gasflood than in a waterflood.

Because of the much lower ratio of injectors to producers, the capital cost of the heel-to-toe injectors is significantly lower, and the more efficient use of capital means better economic returns, says Rene LaPrade, Lightstream's senior vice-president and chief operating officer.

INCREASED RECOVERY EXPECTED

From its modelling, Lightstream believes gasflooding will increase ultimate oil recoveries on its Saskatchewan Bakken properties to beyond 25 per cent from 15 per cent on primary production.

As this article went to press, the company was still planning to bring two more horizontal heel-to-toe injectors on stream at Creelman in the fourth quarter, which will increase the total heel-to-toe injectors at that property to four.

Also in the fourth quarter, Lightstream plans to start a flood in the Midale area, just south of Creelman, by converting a producer to a heel-to-toe injector. Lightstream has two other tight oil properties, the Cardium of west and central Alberta and the Swan Hills in north-central Alberta. No gasflooding has been scheduled for either property.

At Swan Hills, Lightstream expects to eventually use waterflooding rather than gasflooding. LaPrade said Arcan Resources has shown that waterflooding works there. Also, there's lots of water available in the area, but very little gas. Says LaPrade, "This is not a high GOR [gas-to-oil ratio] area—you'd have to buy gas and move it around."

In the Cardium Formation, Lightstream is currently doing a waterflood pilot at West Pembina. "And the reason is it's near an existing waterflood," says LaPrade.

However, he says the company is eyeing another area of the Cardium for possible gasflooding. "Where we're looking at evaluating the use of natural gas injection is in our Brazeau area, where we have some very high GOR oil wells.... But to date, nothing has been set in stone for Brazeau."

The collapse of world oil prices in late 2014 has delayed planning for a potential Cardium gasflooding pilot as well as waterflooding at Swan Hills.

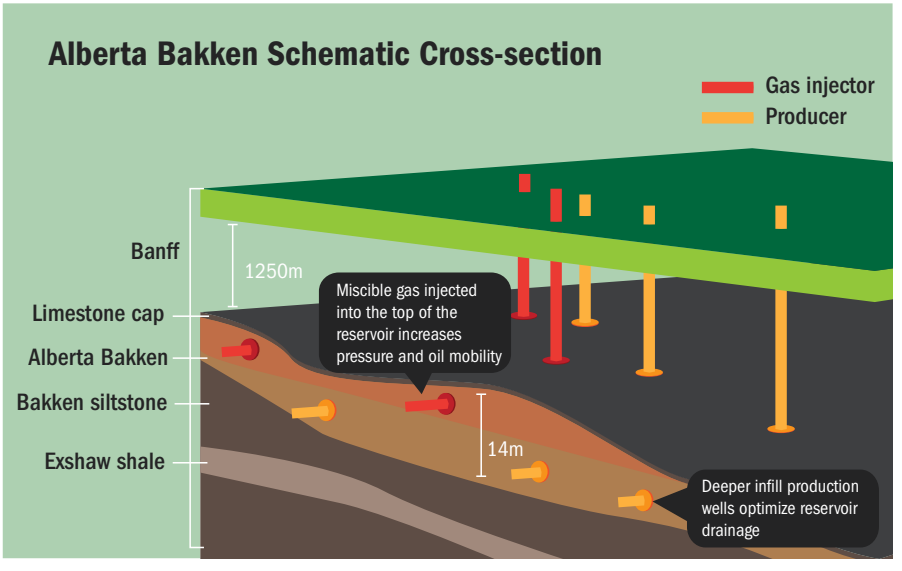
FAST PRODUCTION RESPONSE

But low oil prices haven't prevented Lightstream and DeeThree from expanding their existing gasfloods. A hint as to why the two producers continue to allocate capital to these EOR schemes can be found in production graphs (see page 22). DeeThree's chart shows the natural decline in the oil production rate in its core EOR area flattened after gas injection began. Lightstream's chart shows oil production not only stopped declining, but actually rose six months after gas injection began at Creelman.

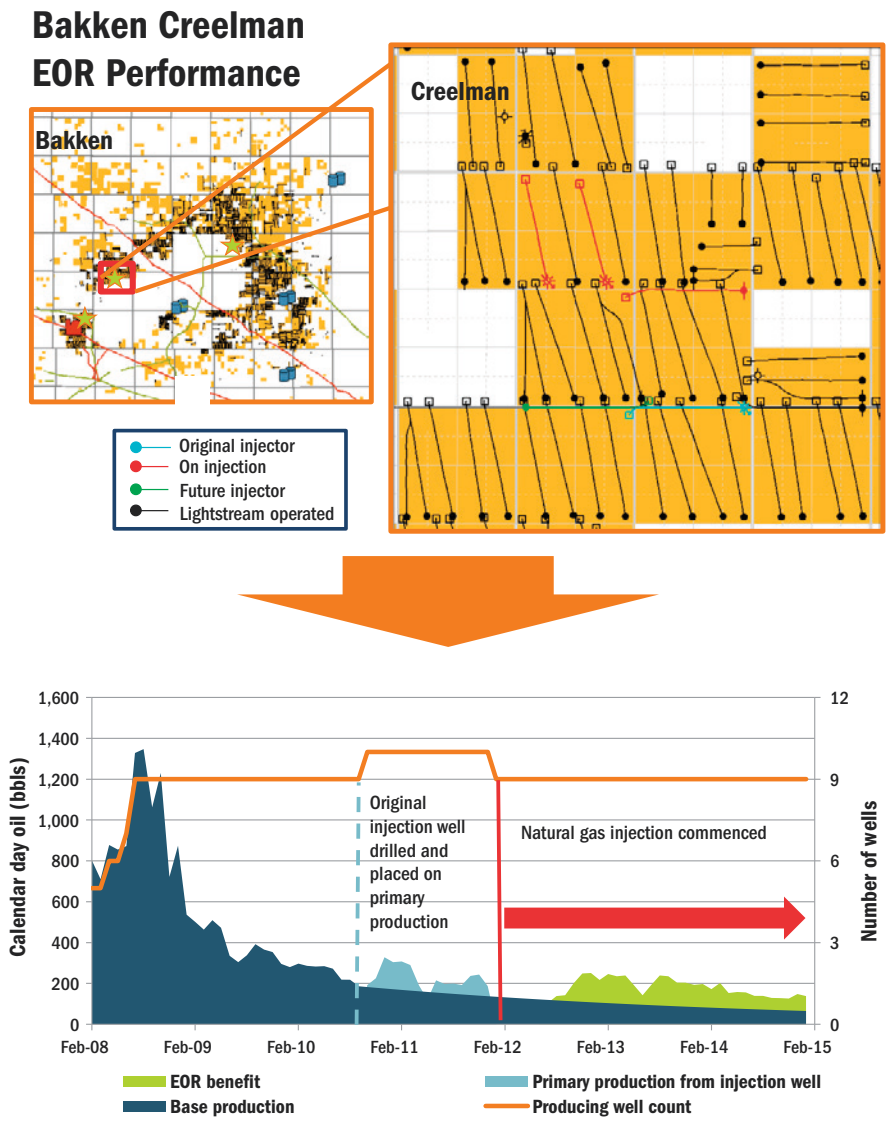
Lightstream's graph shows how much oil output increased above the established decline curve in the eight producing wells that are benefiting from a single heel-to-toe injector.

"What's interesting is that in most floods, most EOR schemes, you don't see a real production bump, you just see a change in the inflection of the decline," LaPrade points out. "That's an exciting result because we're actually seeing incremental production associated with the actual flood itself. Normally what you see is a change in or flattening of the decline with these types of floods. But we've seen, within six months, benefit and response at our producing wells as a result of natural gas injection."

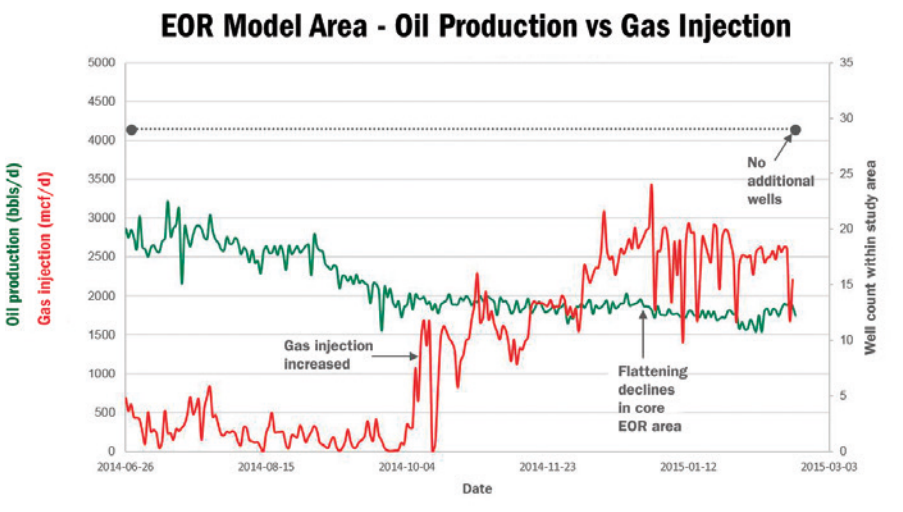
LaPrade suggests gasfloods experience a quicker production response than waterfloods because gas can move more easily through the reservoir. >



SOURCE: GRANITE OIL



SOURCE: LIGHTSTREAM RESOURCES



SOURCE: DEETHREE

And there are other reasons why Lightstream prefers natural gas or methane flooding over CO_2-based EOR. For one thing, methane is readily available from the company's own oil production. High-purity, economically priced CO_2, on the other hand, often isn't widely or readily available.

Another advantage of injecting natural gas rather than CO_2 is that the former is easily handled; there are no corrosion problems. Notes LaPrade, "The capital deployment that's required for a CO_2 flood is astronomical because of the type of tubulars, wellheads and pipelines that have to be utilized to handle CO_2 because of its acidic and corrosive nature."

Also, while natural gas isn't as miscible as CO_2, which has a greater affinity for the oil, it is still partially miscible. Another benefit in this era of low gas prices is that once a methane-based EOR project is finished, the gas can be produced and sold when prices are higher.

FRAGMENTED RIGHTS A HURDLE

However, gas flooding won't work everywhere. LaPrade estimates Lightstream can gasflood about half its Bakken acreage. In areas with a high water cut, for example, the concern is that the gas will be lost into thief zones. Still, Lightstream boasts 282 square miles of undeveloped land in the Saskatchewan Bakken with an inventory of about 1,050 net drilling locations, so there's lots of room to expand its gasflooding.

But the major hurdle isn't geological.

Companies can't do commercial-scale EOR on a well-by-well basis; it has to be pool-wide. Unless an operator owns 100 per cent of the oil and gas rights and the royalty rights, it needs the cooperation of the other rights holders to get the unitization agreements needed for EOR projects to proceed.

Lightstream is finalizing the creation of a 12.5-section unit at Creelman. Others would presumably follow as the company expands gasflooding over more of its tight oil assets.

"Probably our biggest wall in getting these things on isn't necessarily finding the right sections or number of sections to put it in. Because I think once you have an injection scheme in place, you can expand it pretty rapidly," says LaPrade. "The problem [is] where you've got complications in who owns the mineral rights. If you've got a mineral holder and you've got Crown and you've got freehold, there's a difficulty in trying to formulate units."

No operator would attempt an EOR project without a high working interest, but even 100 per cent working interest may not be enough.

"When I talk about freehold minerals and Crown minerals, we're talking more on the royalty side than the working interest side," LaPrade explains. "We could have 100 per cent of a section and somebody could have a 20 per cent freehold mineral lease where they

get 20 per cent of the revenue.... When you're unitizing this, it affects them, so you have to get them onside. So it's not just working interest owners that you have to get onside; you have to get your freehold owners also onside—which takes time. In some cases it's a phone call and it's easy. In other cases you're trying to chase somebody who lives somewhere in North Dakota.... So it's not even the fact that you're not wanting to do it, it's sometimes the fact that they don't want to do it, it's sometimes the fact you can't find them."

And when you do find them, they may balk at the prospect of foregoing income today for more revenue in the long term as EOR increases ultimate oil recovery.

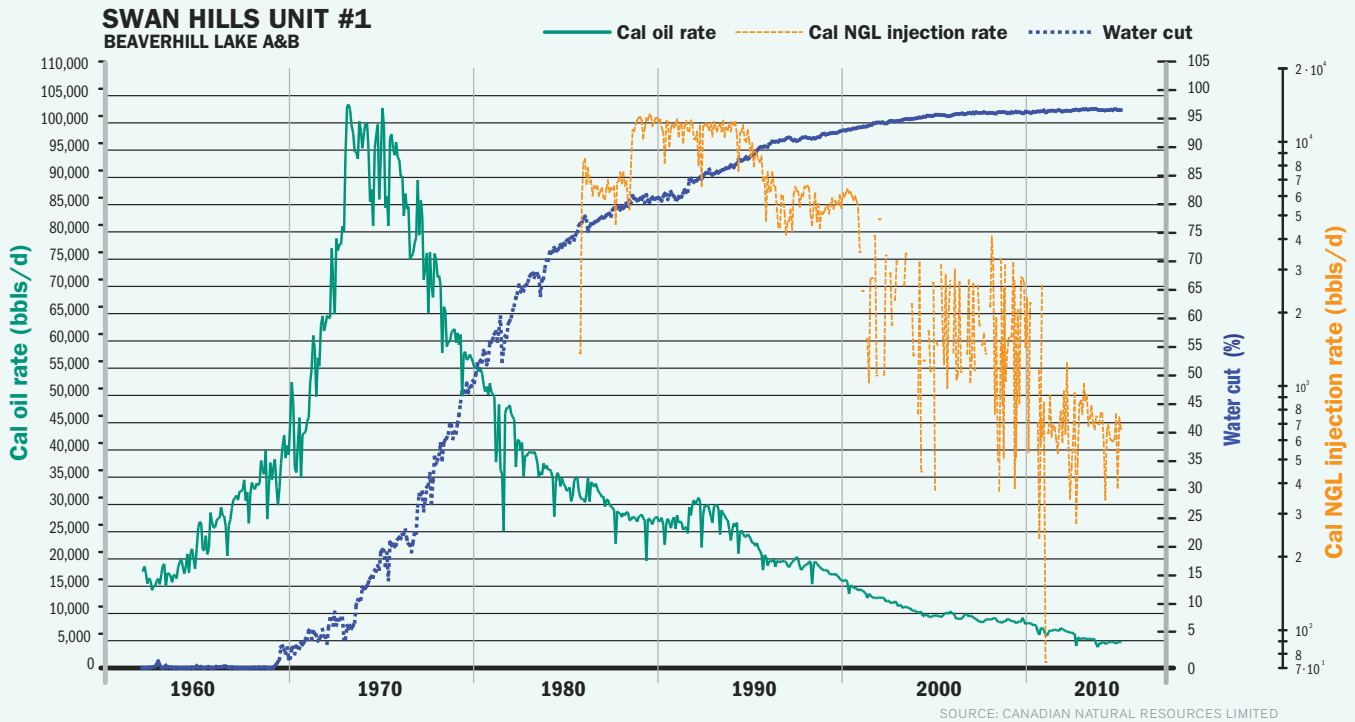
"Units are by no means an easy thing to put together. Every oil-and-gas guy should do it once just to understand how frustrating they are," LaPrade jokes. "Because people want immediate cash flow. And these are long term. They have good economic returns but they're long-term propositions."

However, there's no suggestion Lightstream won't be able to complete the required unitizations. So despite the collapse in oil prices, the company is continuing to invest in its gasfloods.

Says LaPrade, "We see this as a value-add to the Bakken.... We could have taken these new injectors off for 2015, but we felt it's important enough for us to continue to develop this unit and the associated recoveries." ■

STILL PUMPING

Swan Hills hydrocarbon miscible flood marks 30 years of production



SOURCE: CANADIAN NATURAL RESOURCES LIMITED

Although rare, hydrocarbon-based enhanced oil recovery (EOR) projects are nothing new in Alberta.

Most EOR schemes in western Canada are waterfloods. In recent years, with increased discussion of climate change mitigation, CO_2-based EOR has been the subject of much talk but little action.

Less is heard about projects where hydrocarbons, such as natural gas or natural gas liquids (NGLs), are injected into oil reservoirs to increase ultimate recoveries.

One such project celebrates its 30th anniversary this year: the miscible hydrocarbon injection scheme at Swan Hills Unit No. 1 in north-central Alberta.

Since the project began injecting NGL in 1985, the miscible flood has changed hands several times as companies and assets were sold. It was acquired by Anderson Exploration in 2000 and Devon Energy Corporation in 2001.

Canadian Natural Resources Limited, which bought Devon's Canadian conventional light oil and natural gas assets, became operator in April 2014 and holds a roughly 32-per-cent working interest in the unit. Some other major working interest holders include Sabre Energy Partnership (25 per cent), Pengrowth Energy (24 per cent) and Penn West Petroleum (13 per cent).

Solvent is injected into the carbonate Beaverhill Lake zone. According to Canadian Natural data, the average composition is roughly 71 per cent ethane, 17 per cent methane, six per cent propane, and small amounts of other hydrocarbons. NGLs produced with the oil are recovered and re-injected into the reservoir.

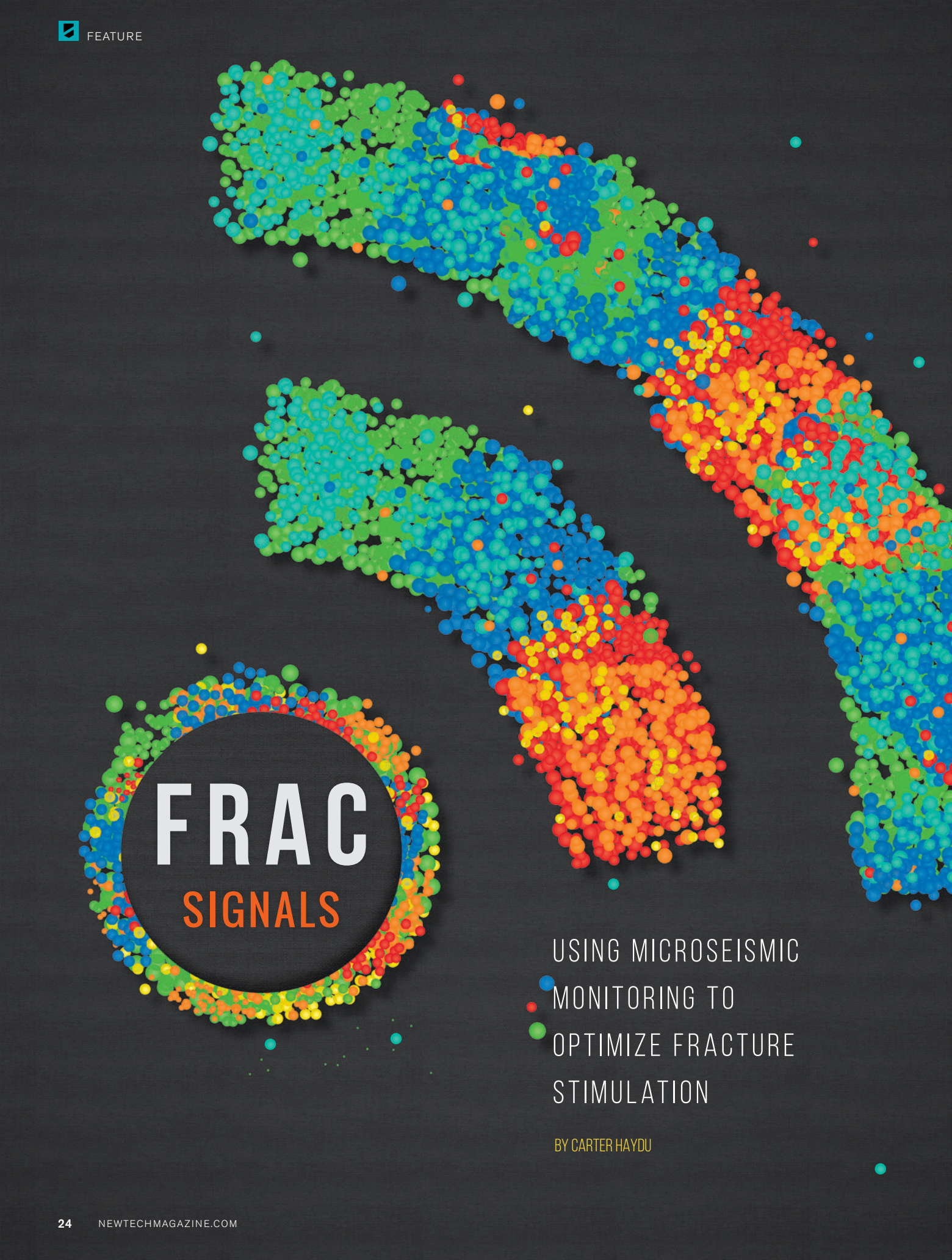
Discovered in 1957, the light oil pool was first produced in 1962 and unitized in 1963 by Home Oil. It has been under waterflood since 1965.

Canadian Natural says the miscible flood is expected to recover an extra seven per cent per well pattern of the 1.4 billion barrels of original oil in place in the Swan Hills Unit No. 1. That's in addition to a primary recovery factor of 15 per cent and a secondary (waterflooding) recovery factor of 26 per cent.

To date, cumulative oil production is more than 620 million barrels. All of the pool is currently under waterflood and 61 per cent is hydrocarbon miscible flooded.

How much more oil will be recovered by miscible hydrocarbon flooding will depend on how many patterns are developed, Canadian Natural says. Currently, there are 17 undeveloped patterns.

Asked how much longer the 30-year-old hydrocarbon miscible flood will continue, Canadian Natural said in an email that NGL injection will continue as long as the economics justify it. ■



FRAC SIGNALS

USING MICROSEISMIC MONITORING TO OPTIMIZE FRACTURE STIMULATION

BY CARTER HAYDU

As the unconventional sector grapples with its first major industry downturn since the hydraulic fracturing revolution opened up many new North American oil and gas reserves, a key to traversing these tough economic times will include lowering costs and improving production through implementation of better fracture monitoring.

"I think the companies that are innovative technology developers, suppliers and service providers—like us—will emerge from this and will help the industry to get back on its feet again, producing at a lower cost," says Jorge Machnizh, chief executive officer of Sigma Cubed (SIGMA^3).

"We will see jobs coming back into the industry, more complex types of drilling will take place. I see this period as an opportunity for the industry."

As the emphasis on monitoring becomes more pronounced, for its part, the Microseismic Industry Consortium and its partners are studying the links between hydraulic fracturing and geomechanics, as well as induced seismicity.

"This is now where a lot of companies are focusing their attention—to see what is actually going on during a hydraulic fracturing treatment," says Mirko van der Baan, a professor in exploration seismology at the University of Alberta.

"We don't yet understand the long-term efficiency, and that means people are trying to better find out how to make the treatments more effective long term, and as well how, from the monitoring, [to] actually predict what will be the production decline curves. This is something for which a lot of work is being done, as well, in the consortium."

A partnership between the Universities of Alberta and Calgary, the consortium includes academia and industry advancing knowledge and practical applications of microseismic methods to monitor hydraulic fracturing operations.

According to David Eaton, professor of geophysics and former head of the Department of Geoscience at the University of Calgary, there is a scientific disconnect when it comes to truly understanding the geomechanical links between microseismic monitoring recording and what interests reservoir engineers, including fracture size and distribution, as well as proppant placement within the fracture system.

"Bridging that gap by understanding the small-scale processes taking place will significantly advance our ability to make full use of the microseismic data recorded," he says, noting microseismic events are tiny earthquakes in the subsurface that represent brittle failure in the rock layer.

With pros and cons to either option, the two primary fracture-monitoring methods include placing low-frequency microphones called geophones down a wellbore, or else placing those sensors at the surface using much larger arrays, says van der Baan.

"When people do it inside the boreholes, they must have boreholes available and are therefore essentially restricted by where those boreholes are. It is quite expensive to drill, and so people don't want to drill more than they have to for observation wells.

"The advantage is you are closer to the source, because many of these reservoirs are at a two-kilometre depth. If the borehole is nearby, then it makes it much easier to pick up very, very weak signals."

He adds, "If you are at the surface, the advantage is it's much cheaper to put thousands of [sensors on] the surface, rather than drilling a borehole specifically. The flexibility is that you can use much, much more equipment, but you are farther away from the source, and so you need this much equipment to pick up the microseismic events."

Then there are hybrid methods using shallow borehole acquisition that attempt to trade off the advantages of both the borehole and surface approach. Complimenting microseismic monitoring technologies are tiltmeters and satellite remote sensing for microdeformation and surface deformation studies. Eaton says, "There is a lot of scope for scientific and technological enhancements by integrating those different methods."

> "WE WILL SEE JOBS COMING BACK INTO THE INDUSTRY, MORE COMPLEX TYPES OF DRILLING WILL TAKE PLACE. I SEE THIS PERIOD AS AN OPPORTUNITY FOR THE INDUSTRY."
>
> ***— Jorge Machnizh, chief executive officer, SIGMA^3***

In some cases, companies perform microseismic monitoring in real time, meaning analysis occurs during the fracture treatment itself and provides immediate microseismic feedback to the hydraulic fracturing operations. In other cases, Eaton adds, microseismic data is processed following the fracture work. "Any information that comes from that can be incorporated into the design of the next treatment."

A SPARTAN APPROACH

Nanometrics is opting for a sparse network long-term monitoring strategy to provide insight on the natural seismicity of an area, thus illuminating many natural faults, enabling companies to assess or quantify the existing subterranean stress field and therefore run better frac completions.

"If you have a good understanding of the broader geology, stress field and seismicity, then you are better placed to operate in an area," says Neil Spriggs, co–chief executive officer of global operations for the Kanata, Ont.–based company, which has an Oil & Gas Division in Calgary.

Traditional surface microseismic involves 5,000–7,000 geophones measuring actual frac completion during the brief two-to three-week treatment process, he notes, while Nanometrics typically uses 10–15 stations and continuously monitors the subject environment long term.

"What that allows us to do is capture a lot of the seismic activity over a period of time, which provides a lot of insight into the environment in which we are working. A sparse network is lower cost, requires fewer stations and is less intrusive on the environment."

According to Spriggs, typical surface-frac monitoring requires a lot of equipment densely instrumenting an area, which can be >

disruptive and may require line cutting. His company requires less-obtrusive technology because it is only trying to answer a few key questions about the fracturing network.

"We provide our customers with a broader understanding of the environment in which they are operating, and we look for potentially larger events associated with natural seismicity and frac completions. With just a few of those events, we could drill down into the data and then tell a customer whether [he or she] found an existing fault and if the fracturing completion is moving out of zone."

Nanometrics installs continuously monitoring, permanent networks, which provides immediate, real-time feedback on seismicity and the environment in which operators are producing. Using a smaller subset of data over a longer period of time, the network can answer broader questions such as whether a company is fracturing in expected volumes, or whether proppant and fractures could move out of zone along a pre-existing fault.

"On the list of 20 questions [companies] want answered, you have to bring a big, dense network in order to answer all 20," Spriggs says. "However, if you only need answers to the top five or six questions, then we can do that with a sparse network. The beauty is we can then do that on many, many more completions."

Nanometrics takes many noise measurements in an area and models the whole environment, ascertaining key locations at which to place stations to meet objectives. Since the company is not placing its array randomly, it can design that array for the specific environment, yielding significant gains in signal-to-noise ratios.

The stations themselves use high-end, more sensitive seismometers as opposed to geophones. By placing such sensitive stations in quieter locations and at shallow depths, Spriggs says, Nanometrics achieves significant signal-to-nose ratio gains before monitoring even begins.

"We can use fewer [stations] because we use higher-quality instrumentation and a different approach to sampling the data. To answer the very detailed questions, we wouldn't need thousands of geophones. Rather, we would use hundreds of seismometers. There is an advantage there."

He adds, "There is real value in giving customers real-time and immediate feedback on what is going on, but I think what we are looking to do and what we are investing in is the signal processing in order to basically define smaller and smaller events from sparse networks. We are investing in mining a sparse network for the richest catalogue we can get."

BETTER MODELLING, GREATER UNDERSTANDING

Have fractures stayed in the reservoir or have they grown outside of it? Is the company wasting fracture completion costs breaking nonproductive rock that does not contain hydrocarbons? These are questions ITASCA Microseismic and Geomechanical Evaluation (IMaGE) strives to answer with its geomechanical models predicting where microseismic activity will occur.

"Our elevator pitch is we extract more information about the microseismic data being recorded so the clients can see more value from that data they are starting to collect," says Shawn Maxwell, president and chief technology officer of the company, which has principal offices in Calgary, Houston and the U.K.

"The idea is to take these field observations of the snaps and cracks in the reservoir from the fracturing and try [to] take them to the next level—meaning instead of just taking an image that contains individual locations of microseismic events developed during the image…you take these dots and you try conventionally to interpret them in the further fracture patterns that exist."

According to Maxwell, there is a lot of value for operators simply in understanding the degree to which fracturing results impact geological variability and how much of the reservoir is actually contacted. "If you are looking at where to drill the next well to drain your reservoir, you have to know how far out the first fractures have grown so you can decide how far away to drill to get uniform reservoir drainage."

There is much guesswork in the engineering design of hydraulic fractures, Maxwell says, and IMaGE's combination of microseismic monitoring and geomechanical simulations enables companies to determine fluid injection rates with test designs allowing different fracture stages on a horizontal well to be varied at each stage.

"You can look at the results and use the microseismic to decide which one is most effective.… If you adjust the rate, then you can find the optimal of where the fractures are contained to the reservoir."

IMaGE performs most of its work on existing data collected from wells already fractured, simply because predicatively modelling reservoirs for real-time operations is problematic given the depth of geological variation and the big difference that even a small change in the model can make, although Maxwell expects to see improvements in this area as well.

"Ultimately, we want to run it so the project is being done to make the real-time decisions," he says, adding induced seismicity is another key area for his company.

"We have been involved in a few projects where there are basic questions and we are trying to assess the seismic risk. Rather than do it in real time, what we are doing there is running a number of models beforehand, and then we use those for pattern recognition based on the microseismic response to try [to] identify what the conditions might be that are riskier from an operational point of view as compared to others."

According to Maxwell, his clients increasingly want to revisit microseismic data collected on existing wells that either never produced at expected rates or declined rapidly early on, thus facilitating recompletions—a cost-effective practice for companies looking to turn a profit during an industry downturn.

"There have been examples where you could come in and refracture a well, boost production significantly and pay for the costs of the second fracture after a relatively short time period. Microseismic becomes an important diagnostic tool to understand how the



> SPARSE NETWORKS
A Nanometrics field engineer works with a broadband seismometer. By installing continuously monitoring, permanent networks, Nanometrics can provide immediate, real-time feedback on seismicity and the environment in which operators are producing.

PHOTO: NANOMETRICS

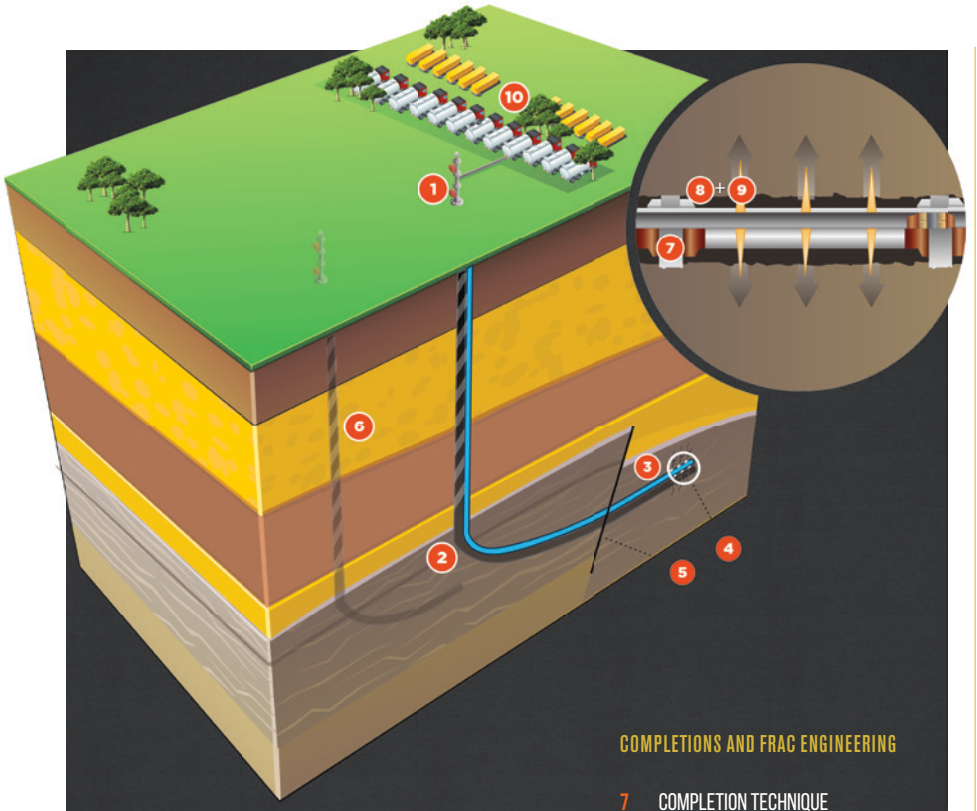


IMAGE: SIGMA CUBED

fracture system was there originally and how is has been redeveloped a second time."

Working with existing standard microseismic technology, IMaGE is extending industry standards by using computer modelling that provides context and ultimately predictive models. Maxwell says, "Very much at its heart has been a lot of microseismic being collected, and we are seeing a lot of interest in going back to the existing data and trying to realize more value by gaining a better understanding of what it is telling us."

THE UPSIDE OF A DOWNTURN

Difficult as the current energy sector downturn is for companies and workers in the oil and gas industry, for Houston, Texas–based SIGMA^3, it also provides an opportunity to accelerate technology investments as low commodity prices drive demand for greater levels of efficiency.

"The only way to address the next level of productivity is through technology and innovation, and commercializing those technologies to the market," says Machnizh. "We are really excited to be well positioned to take advantage of that."

For example, the company's CRYSTAL software includes broadband spectral inversion capabilities for resolution enhancement and specialized tools for natural fracture modelling. These enhancements allow users to better resolve structure, stress anisotropy, stratigraphy, texture, rock physics, total organic content, fracture density, porosity and permeability. Ultimately, this improves reservoir understanding and helps target the sweet spot to frac.

"When we perform a microseismic project, the processed data is delivered in the fully interactive CRYSTAL tool, which enables full analysis and interpretation," Machnizh says, adding that companies can perform integrated analysis that includes the geological, geophysical and engineering information.

"Previously, as much as 40 per cent of frac stages were ineffective, at a huge cost. With fully integrated geo-engineering workflows leveraging microseismic, shale capacity and engineering, oil companies can achieve efficiency and better production, and remain competitive.

"The low commodity price is a new environment companies must deal with, and so adopting some of these concepts becomes really critical for survival."

According to Machnizh, the company's 3-D Shale Capacity model for brittleness, permeability, total organic content and natural fractures enables better plans to locate frac stages within specific surface wellbore locations. This can serve as input into simulations, enabling a predictive model as to how the fracture geometry will behave and the potential production of the well.

"Our clients are predicting production with accuracy as high as 90 per cent. The Shale Capacity model, along with integrated geo-mechanical modelling and proper frac-engineering workflows, delivers increased levels of production. That becomes really important, because at a low-commodity price you can start deciding where to direct your efforts."

Once hydraulic fracturing begins, SIGMA^3 engineers ensure maximum returns on a company's investment, using an integrated microseismic approach, to enable more accurate event location, as well as enhanced-signal processing and detection algorithms. According to Machnizh, high-confidence microseismic validates the models.

"That is the uniqueness of our workflow, and because this is our sole focus, it enables us to have a high pace of development and innovation in our company," he says. "We have developed a foundation with various different types of analytical tools in order to bring in a workflow that addresses the very specific inefficiencies that exist in the marketplace."

At SIGMA^3, the preferred method of microseismic data acquisition is borehole monitoring, although the company has a unique way of acquiring the data, Machnizh says. "It all starts with the planning and modelling of what exactly we are trying to achieve and the data we are trying to record. We have a high-density recording system that acquires high-density data with the widest possible geometry.

"So, it starts with the data collection and planning, the customer's technical and business objectives, as well as what are the answers they are trying to achieve."

With technology acquiring high-fidelity data, he adds, SIGMA^3 transmits the information to its Real-Time Centres and experts, who in turn collaborate with the customers to make decisions on frac geometries, where they go and, in some cases, allowing real-time decisions in order to optimize the frac.

Machnizh says, "We are collaborating now with some innovators to bring in some new microseismic technology that leverages the richness of the data we have been able to collect, really taking it to be able to match the fracture propagation as it occurs.

"That is really interesting…and I think in the next six to 12 months we will be commercializing some of these technologies. This is an opportunity." ■

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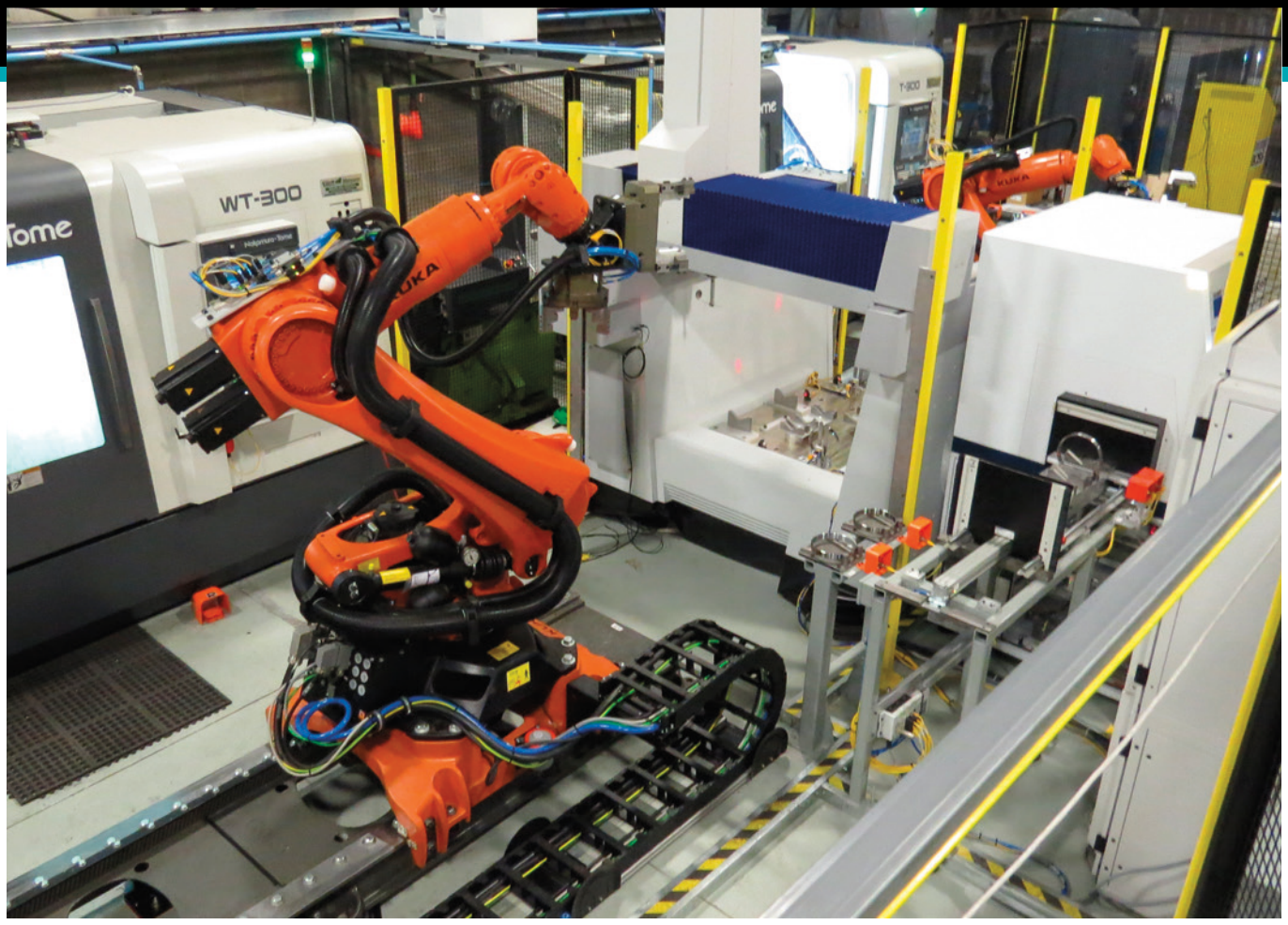


PHOTO: ABSOLUTE COMPLETION TECHNOLOGIES

MANUFACTURING

IMPROVING PERFORMANCE BEGINS AT HOME

High-tech domestic firms investing in Alberta's future

When the price of oil is about half what it was a year ago and producers are cutting capital expenditure programs to keep afloat, it might seem like folly for Alberta manufacturers to invest in their facilities now, especially when the oil and gas industry might be able to import for less.

Yet that's exactly what two high-technology manufacturers are doing, and their clients are benefiting by getting greater efficiency, reduced costs and higher quality.

Absolute Completion Technologies recently unveiled a new robotic machining cell: an automated production cell for the manufacture of downhole well completion tools for the oil and gas industry.

"We're developing innovative solutions to make wells produce better, and we believe that if we were to not have manufacturing as part of our mandate we would miss out on a lot of opportunities to improve the products further—improve their performance and innovate further—so we see manufacturing as a critical part of that circle of design, test, engineer, construct and refine," Thane Russell, Absolute's vice-president of business development, tells *New Technology Magazine*.

"You have to do all those things to be competitive, and if we weren't able to take advantage of all of these technologies we'd be building these things some other place or we'd be outsourcing them, and we'd miss out on all that, so we really think it's critical that we're able to build our products close to home where we're designing them."

With more than 6,000 square feet of production space, the robotic machining cell contains two three-metre-tall robots that build the patented PremiumPort downhole adjustable injection and inflow control technology with a unique valve and port system. >

^ AUTOMATION AND CONTROL
Absolute's robotic machining cell will cut manufacturing times for the company's downhole well completion tools up to 50 per cent. With the opening of the Edmonton manufacturing facility, Absolute is maintaining control over its production of high-quality products while expanding and growing its staff.



> **LOCAL MANUFACTURING**
Triple D Bending's spray booth.



v LOCAL MANUFACTURING
Absolute's PremiumPort downhole tool manufactured by its new robotic machining cell. Despite the slump in oil and gas prices, many companies continue to expand their manufacturing capabilities in western Canada.

"We call it a cell because there are multiple components," says Russell.

He says the first fully integrated robotic machining cell in Alberta can reduce manufacturing times up to 50 per cent and, even though the production unit can do the work of five people, not a single employee was replaced by the investment.

Formed in 2002, the company's corporate office and engineering and design team are located Calgary, while its manufacturing centre is in Edmonton. A second manufacturing facility is located in Indonesia.

"We've found that Edmonton is a better manufacturing centre than Calgary," says Russell. "I think Calgary is coming along, and it does depend on what you're making, too. What I'm saying wouldn't apply to people building other things, perhaps, but for us, we have a highly machining-centred business where we're cutting steel, and we have to have access to pipe and metals and a skill set around machining and fabricating. We just find that that skill set and that mix of inputs is more readily available in Edmonton," says Russell.

Meanwhile, for 30 years Triple D Bending, comprised of four buildings on more than 10 acres, has been bending pipe in Calgary's industrial area, and its clients appreciate that they can buy quality products in Alberta.

Pravin Patil, project buyer for Vista Projects, which does a lot of engineering for oilsands projects, is one such customer.

He says Vista could save about 30 per cent on purchases if his company were to buy from China, but it would just not be worth the savings because of the quality that would be lost.

According to Patil, when pipes are bent, unwanted changes can occur, such as wall thinning, wall thickening and wrinkling, resulting in compromised integrity. Triple D Bending's method results in consistent thickness throughout.

It pays to buy locally, he says.

Triple D Bending is a full-service manufacturing facility that provides induction bending, cold bending, coating and blasting services to the oil and gas, mining, manufacturing and fabrication, structural, architectural and agricultural industries.

"To my knowledge, we are the only company in Canada with three induction bending machines. We're talking about sophisticated, expensive technology," says Maros Tropp, company president.

According to Tropp, pipe bending greatly reduces the amount of welds needed in a project and results in lower installation and operating costs, increased efficiency and improved flow versus traditional elbow welding.

Induction heating is a combination of electricity and magnetism. A copper ring creates a heat zone that heats the pipe to the required temperature to bend it.

"Because you are cooling and heating material, you are able to control metallurgical and mechanical parameters for the material you are bending, also geometrical parameters. You have better control over ovality, wall thinning and wall thickening and such.

"For some types of bends, for some specific wall thicknesses, diameters and radiuses, it's difficult to use any other technology than induction bending, which is gaining popularity. You can buy fittings and stuff like that, [but] that can be expensive and time consuming," says Tropp, adding that for some projects, induction bending can eliminate welds.

Triple D Bending can bend pipes measuring anywhere between one-quarter to 36 inches in diameter.

Facilities include a coating division and paint booth where Triple D Bending can control the environment's humidity and temperature and supply full air filtration.

The company has invested $7 million in its facilities in the past four years, and while the industry is in a slump now, Triple D Bending is preparing for the future, says Tropp.

"Things change. The only question is when and where the price for oil will stay," he says. "We would like to be ready for this because to buy an induction bending machine is probably a two-and-a-half-year process. Our intention is to be prepared for when oil comes back.

"It's a slow time right now, but we have a plan for how to survive. We still have jobs coming, projects, and we are dealing with companies that don't really depend on oil prices. Also we [are getting business] from projects that require maintenance, especially oilsands projects. Maintenance still needs to be done—it doesn't matter if the oil price is high or low. We still have jobs to do and projects to finish."

Lynda Harrison

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PHOTOS: (TOP) TRIPLE D BENDING; (BOTTOM) ABSOLUTE COMPLETION TECHNOLOGIES

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