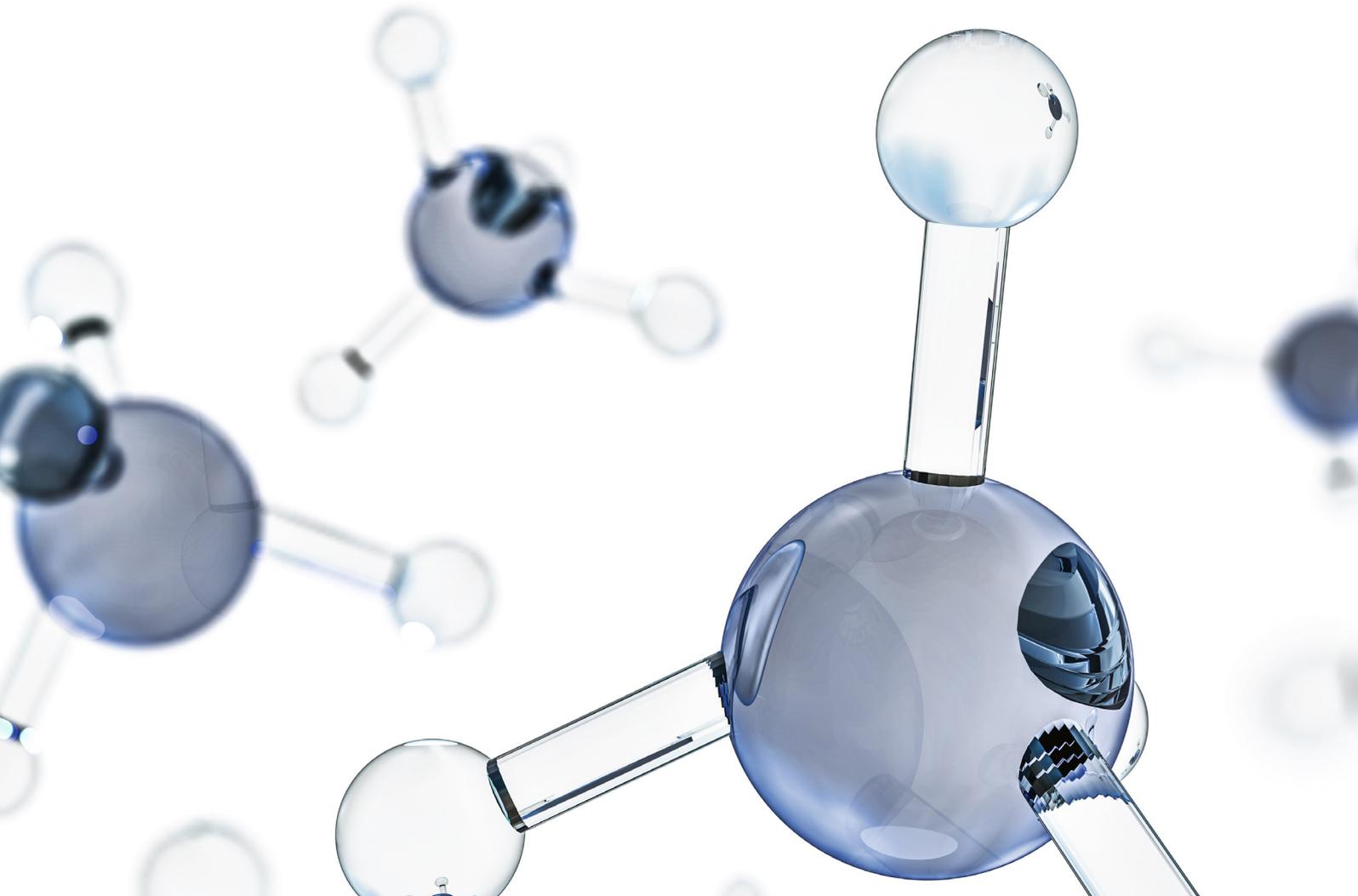


FUELING A DIGITAL METHANE FUTURE

The role of digital technologies in minimizing
global oil and gas methane emissions



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PREFACE

Natural gas is a major source of energy today. The International Energy Agency predicts continued wide scale use of natural gas in multiple sectors around the world. Amid growing concerns about air quality and climate change, the industry is increasingly looking at the potential of natural gas to meet the energy challenges of a low-carbon economy.

But methane – the primary component of natural gas – is a leading contributor to global warming. When it leaks into the atmosphere, it creates a powerful greenhouse gas effect. It is estimated that, on average, 2.3 percent of methane produced is lost to the atmosphere before it reaches consumers. Because methane can leak from various points in the supply chain, some operations waste much more.

Wasteful methane emissions pose a serious challenge that, if not addressed, will diminish the role of natural gas in the future energy system. Each ton of methane emissions emitted from oil and gas operations increases the climate impact of the fuels and makes a 2-degree future more difficult to achieve. That is because the greenhouse gas potential of methane is 86x more than that of CO₂ over a 20-year timeframe. Beyond the environmental impact, the economic loss associated with methane emissions is significant. Every year, methane worth an estimated US\$30 billion is released into the environment. Methane emissions pose a significant challenge to the oil and gas industry. Mitigating methane risk presents a huge opportunity.

The industry is beginning to take notice. For instance, members of the Oil and Gas Climate Initiative (OGCI) recently committed to reducing their methane emissions to 0.25 percent of total production by 2025. These companies are already taking action, including but not limited to equipping field staff with hand-held sensors, replacing pneumatic devices, and rolling out broader leak detection and repair (LDAR) solutions that use drones and vehicle mounted sensors. Across the industry as a whole, however, a limited number of companies currently consider the reduction of methane emissions a priority issue.

Digital technologies have the potential to change that. Digital transformations, which have been key drivers of change and optimization across many industries, are now taking hold in the oil and gas industry. By broadening the scope of their digital transformation to incorporate technologies that capture high quality, high frequency methane emissions data, companies can accelerate, scale and optimize methane reduction programs. With digital tools, companies can not only meet emission reduction targets with more efficiency, but also leverage the data to demonstrate their success to key stakeholders.

The Environmental Defense Fund, a leading voice in methane mitigation, has developed this report in collaboration with Accenture Strategy to show how digital solutions can enable and advance the oil and gas industry's journey to a low methane emissions future. We would like to thank the dozens of leaders in the oil and gas industry, technology, academia and science for taking the time to share their valuable insights and recommendations.

We hope this paper will drive meaningful discussions and help accelerate the shift toward a digital future for methane management.



A stylized, handwritten signature of Mark Brownstein in white ink.

Mark Brownstein
Senior Vice President
Energy, Environmental
Defense Fund



A handwritten signature of Muqsit Ashraf in white ink.

Muqsit Ashraf
Senior Managing Director,
Accenture Strategy,
Energy



A handwritten signature of Vivek Chidambaram in white ink.

Vivek Chidambaram
Managing Director,
Accenture Strategy,
Energy

EXECUTIVE SUMMARY

Oil and gas production comes with associated emissions of methane, a potent greenhouse gas. Methane emissions in the atmosphere account for about 25 percent of global warming today.¹ Beyond the environmental impact, the economic loss is significant. Every year, an estimated \$30 billion of methane is released into the atmosphere.

Methane emissions occur throughout the value chain, from production to distribution. However, more than half of emissions occur upstream during production. Given the scale and complexity of oil and gas infrastructure, finding and fixing methane leaks can be resource-intensive. While conventional solutions exist to address this challenge, digital technologies have the potential to expand the scope and accelerate the scale of methane emissions reduction.

Digital will be key to the industry's transformation efforts in light of ongoing supply and demand disruptions

The oil and gas industry is no stranger to technology. Yet, despite facing a confluence of disruptive supply and demand-side forces, the industry has lagged others such as consumer products and industrials in scaling digital technologies. Digital solutions are critical to the industry's transformation and holds sizeable value potential. According to World Economic Forum research conducted in collaboration with Accenture, it is estimated that US\$1.6 trillion of economic, environmental and societal

value can be unlocked through digital transformation. Going forward, accelerated and holistic adoption of digital solutions will change the way the industry operates and makes decisions.

...and so with methane emissions, digital can play a pivotal role in expanding scale and scope of impact

Digital enables oil and gas companies to run advanced diagnostics that enable better prescriptions and faster decisions. In the area of methane emissions, these abilities can underpin a system that can detect – either ahead of time or just in time – a potential or actual leak event, present remedies, and enable rapid action. The industry is in the early stages of this shift.

As they move forward, companies are encountering the same challenges with scaling digital (and conventional) methane management technologies as they are with adopting a system-wide approach to digital across the value chain. This presents an opportunity for industry players to integrate emissions management into their broader digital transformation. It is particularly important that they do so now, while they are deploying or scaling their broader

digital initiatives—not after their digital agendas are set. For instance, while the industry uses operational data, advanced analytics and artificial intelligence to build their predictive maintenance capabilities, proxy parameters already captured can be used to identify methane leaks.

A multi-stakeholder, ecosystem-based approach can accelerate this journey and maximize potential impact

Realizing the shift toward a digital methane future requires an enabling ecosystem – one that can only be shaped through the collaborative efforts of diverse stakeholders. Such an industry ecosystem can play a key role in identifying, piloting and adopting innovative business models. For example, methane management-as-a-service could help promote shared ownership of investments and rewards, thereby fostering action from smaller operators. Similarly, stakeholders such as investors and regulators can help build a shared commitment toward the digital methane agenda, thereby galvanizing accelerated action at scale.

The industry is waking up to the challenge that methane emissions pose. It must now translate commitments, such as those made through the Oil and Gas Climate Initiative (OGCI) and Methane Guiding Principles, into actions. An infrastructure comprising conventional and digital elements makes that possible.

This paper explores how the journey to the digital methane future can be shaped and accelerated and will address pertinent questions such as: How can digital play a role in preventing methane emissions? Can digital help make the opportunities available today financially viable for businesses? What are the potential opportunities to expand the scope of existing digital solutions to cover methane reduction?





THE BIG PICTURE

Natural gas is considered one of the lower emitting fossil fuels in the global energy mix. However, when directly emitted into the atmosphere, methane poses a grave challenge, accounting for about 25 percent of global warming today.²

Natural gas is considered one of the cleanest fossil fuel-based source of energy and is poised to be a fuel of the future.³ It is estimated that CO₂ emissions (per unit of energy produced) from natural gas are approximately 40 percent lower than those from coal and about 20 percent lower than those from oil.

However, over a few decades, methane can warm the planet 86 times more than CO₂.⁵ The environmental consequences of methane emissions are a concern for stakeholders. However, there are financial and health implications as well.



Environment: It is estimated that 2.3 percent of gas produced is lost to the atmosphere,⁶ with some operations wasting much more. Each ton of methane emissions emitted from oil and gas operations increases the climate impact of the fuels and makes a 2-degree future more difficult to achieve.



Health and safety: At small concentrations, methane alone has no known impact on human health. However, other harmful materials can be released along with these emissions. In a 2015 study conducted by Sage Environmental for California Air Resources Board (CARB), most of the leaked methane samples were found to contain carcinogens and development toxins.⁷

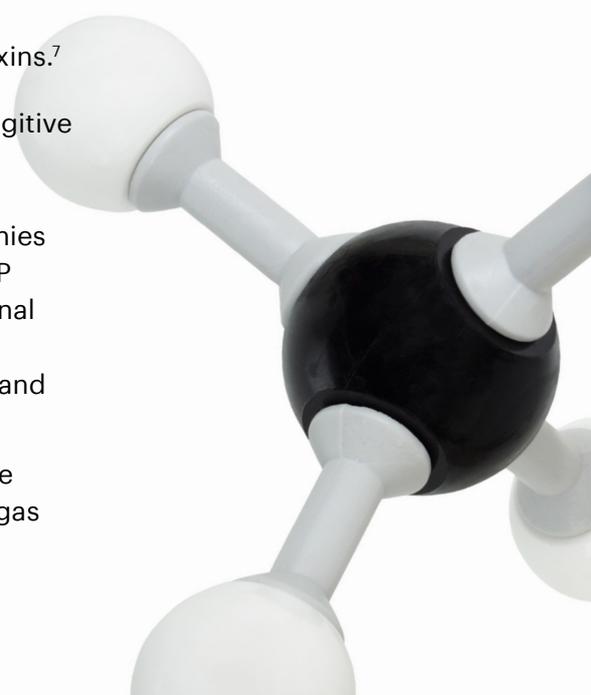


Financial: Many companies are unaware of their fugitive methane emissions and, therefore, the associated financial impact. According to research, reducing emissions could save upstream oil and gas companies US\$34 billion globally.⁸ This is greater than the GDP of more than 90 countries.⁹ Furthermore, institutional investors have expressed concern about methane emissions weakening the credibility of natural gas and contributing to costly license to operate risks.

Given the broad implications of methane leaks, it is imperative to develop a holistic view of the challenge across the oil and gas value chain.

“THE METHANE REDUCTION AGENDA IS IMPORTANT TO THE OIL AND GAS INDUSTRY AS IT IS A PREREQUISITE TO REMAIN RELEVANT IN THE ENERGY TRANSITION. FOR NATURAL GAS TO BE A SOCIALLY TRUSTED, INTEGRAL COMPONENT OF THE OVERALL ENERGY MIX, METHODS TO CONSTRAIN METHANE EMISSIONS MUST BE DEVELOPED AND DEPLOYED.”

- DREW POMERANTZ, PRINCIPAL RESEARCH SCIENTIST AND PROGRAM MANAGER, SCHLUMBERGER

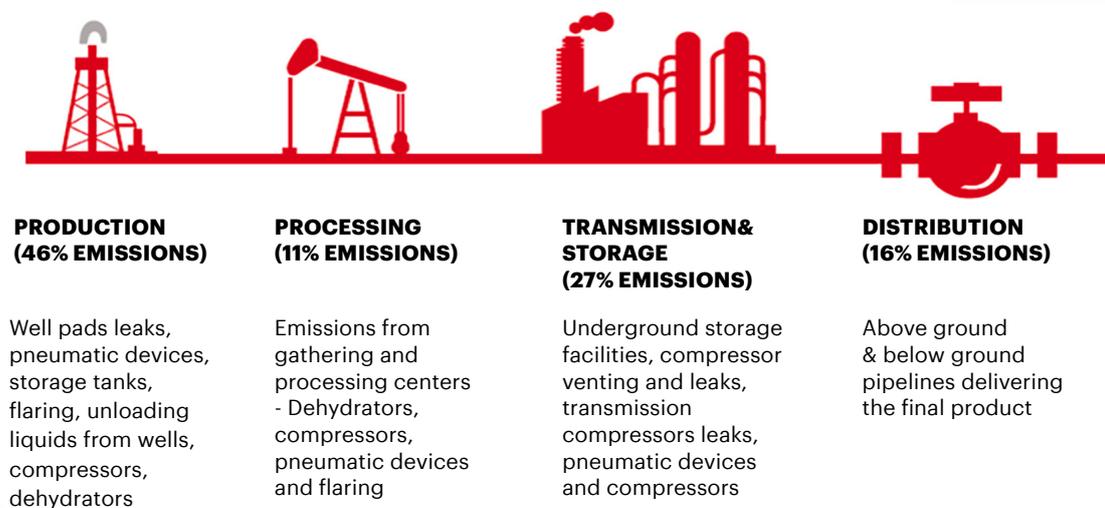


METHANE EMISSIONS IN THE OIL AND GAS INDUSTRY

A significant share of methane emissions across the oil and gas value chain occurs upstream, with production accounting for almost half the emissions.

Methane emissions can occur across the four primary segments of the oil and gas value chain: production, processing, transmission and storage, and distribution (see Figure 1).

Figure 1: Methane leakage across the oil and gas value chain¹⁰



Source: ICF, *Methane Emissions from the Oil and Gas Industry: "Making Sense of the Noise," 2015*

These emissions are classified as either planned or fugitive. Planned methane emissions in upstream oil and gas typically occur through two processes: (i) Venting (due to a lack of infrastructure to accommodate gas), and (ii) Pneumatic devices (controlled by gas to regulate pressure). Fugitive emissions are commonly caused by leaks in components across the value chain, or by venting devices emitting beyond design specifications.

A STUDY CONDUCTED BY ICF REVEALED THAT, WITHIN THE UPSTREAM SEGMENT, VENTING AND PNEUMATIC DEVICES REPRESENT A METHANE REDUCTION POTENTIAL OF 22 PERCENT AND 30 PERCENT, RESPECTIVELY. FUGITIVE EMISSIONS FROM VARIOUS SOURCES, MOST NOTABLY COMPRESSORS, ACCOUNT FOR THE REMAINING 48 PERCENT."

Discussions with industry experts confirmed that the "80-20 rule" applies. That is, approximately 80 percent of methane emissions across the oil and gas value chain are caused by 20 percent of the identified leaks .

The industry is deploying a variety of solutions to minimize methane leaks. However, in some cases the labor-intensive, siloed nature of these solutions inhibits a viable business case for adoption at scale.

Companies rising to the methane emissions challenge are deploying a variety of isolated equipment repairs, replacements and leak detection solutions. However, large-scale, global adoption has yet to materialize. This may be, in part, because some companies have not yet fully realized the environmental, reputational and economic benefits of reducing methane emissions. The direct and indirect costs associated with current detection and retrofit solutions may contribute to the lackluster global adoption.

"OPERATORS MISS COST-EFFECTIVE METHANE MITIGATION INVESTMENTS BECAUSE DRILLING NEW WELLS IS EVEN MORE PROFITABLE IN THE SHORT TERM."

- DR. DAVID LYON, SCIENTIST, EDF

The availability of digital technologies is not a barrier to the adoption of methane emission solutions. New technologies are already disrupting virtually every facet of the oil and gas industry. In exploring the general trends in oilfield digitalization, it is apparent that many digital solutions available today can be applied to mitigate methane emissions, drive value and deliver scalable, integrated impact.



DIGITALIZATION IN THE OIL AND GAS INDUSTRY – AN OVERVIEW

The oil and gas sector has been lagging other industries in scaling digital technologies on a broad basis, despite the potential economic, environmental and societal value it holds.

The oil and gas industry has made notable headway in its digital transformation. Today, due in part to the shifting and complex industry landscape, there appears to be greater acceptance and appetite to accelerate and advance digital programs across the value chain. The industry's move to digital makes sense. World Economic Forum research conducted in collaboration with Accenture has identified opportunities that have the potential to create approximately US\$1.6 trillion worth of digital-driven value for the oil and gas industry – all while reducing CO₂ emissions by approximately 1.3 billion tons, saving about 800 million gallons of water, and avoiding oil spills equivalent to approximately 230,000 barrels.¹² Another Accenture Strategy study indicates that digital transformation can enable a 10-25 percent improvement in EBITDA (Earnings Before Interest Tax Depreciation and Amortization) and a 10-15 percent reduction in capex in upstream operations.¹³

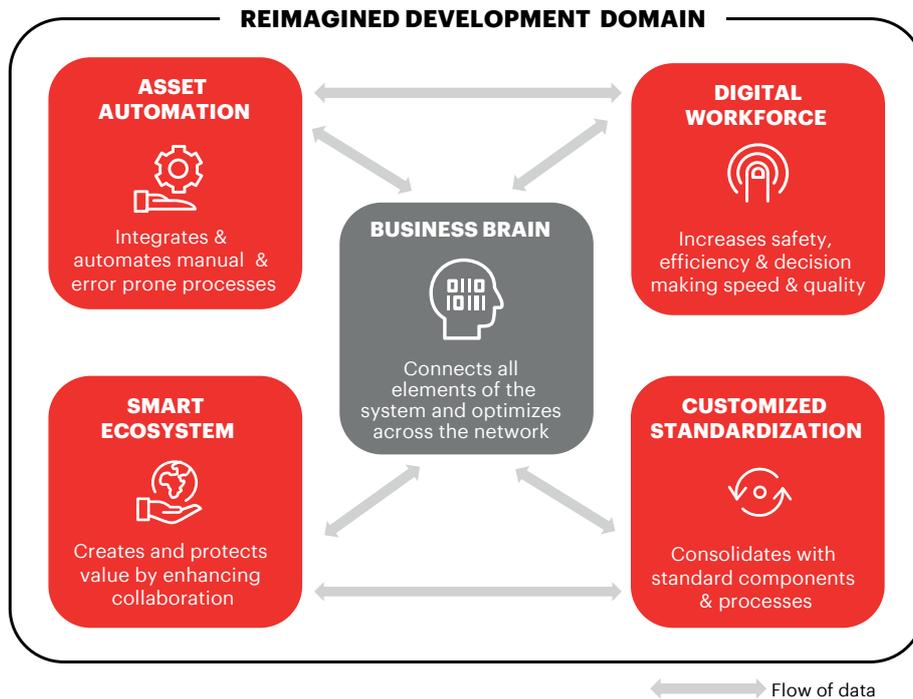
In a 2016 survey of upstream operators commissioned by Accenture and Microsoft, 80 percent of respondents said they planned to invest either the same amount or more in digital technologies over the next 3-5 years. At the time, their

digital investments were focused on mobility and the Internet of Things (IoT). Analytics and IoT were poised to lead the next wave of investment.¹⁴

Further, the Accenture 2018 Disruptability Index indicates that 70 percent of the energy sector is susceptible to future disruption, the highest of the 20 industries analyzed.¹⁵ As the cost of sensors fall, and as the Industrial Internet of Things (IIoT) and data analytics gain traction, the industry has an immediate opportunity to disrupt, or revolutionize, itself. Figure 2 illustrates five areas in which digital disruption can create value.



Figure 2: Areas in which digital can help create value in the oil and gas industry¹⁶



Source: Accenture Strategy, "Digital agility: From high hopes to higher value" and "Re-imagining the future of upstream production," 2018.



Asset automation: Specialized sensors capture real-time information from physical assets and centralize this data through cloud-based analytics engines. This approach eliminates the need for human intervention, reduces downtime and maintenance costs, and triggers an improvement in health, safety and environmental (HSE) performance.



Digital workforce: Data from wearables and smart connected products is leveraged for enhanced decision-making. Additionally, digitally augmented workers can carry out risky operational tasks more precisely and safely.



Smart ecosystem: The application of integrated digital platforms greatly enhances collaboration among ecosystem participants such as vendors and customers, thereby helping to fast-track innovation, reduce costs and provide operational transparency.



Customized standardization: Standardized platforms and processes ensure consistency and predictability. The piecemeal implementation for marginal efficiencies needs to give way to more simplified structures which allow for customized services and end-to-end asset-specific value creation.



Business brain: A digitally enabled, connected "business brain" positions oil and gas companies for long-term growth and drives portfolio effectiveness and operational efficiency.

This brings us to the role of digital in preventing methane emissions, improving the financial viability of mitigation opportunities available today and expanding the scope of existing digital solutions to cover methane reduction.

UNLOCKING TRAPPED VALUE THROUGH DIGITAL METHANE

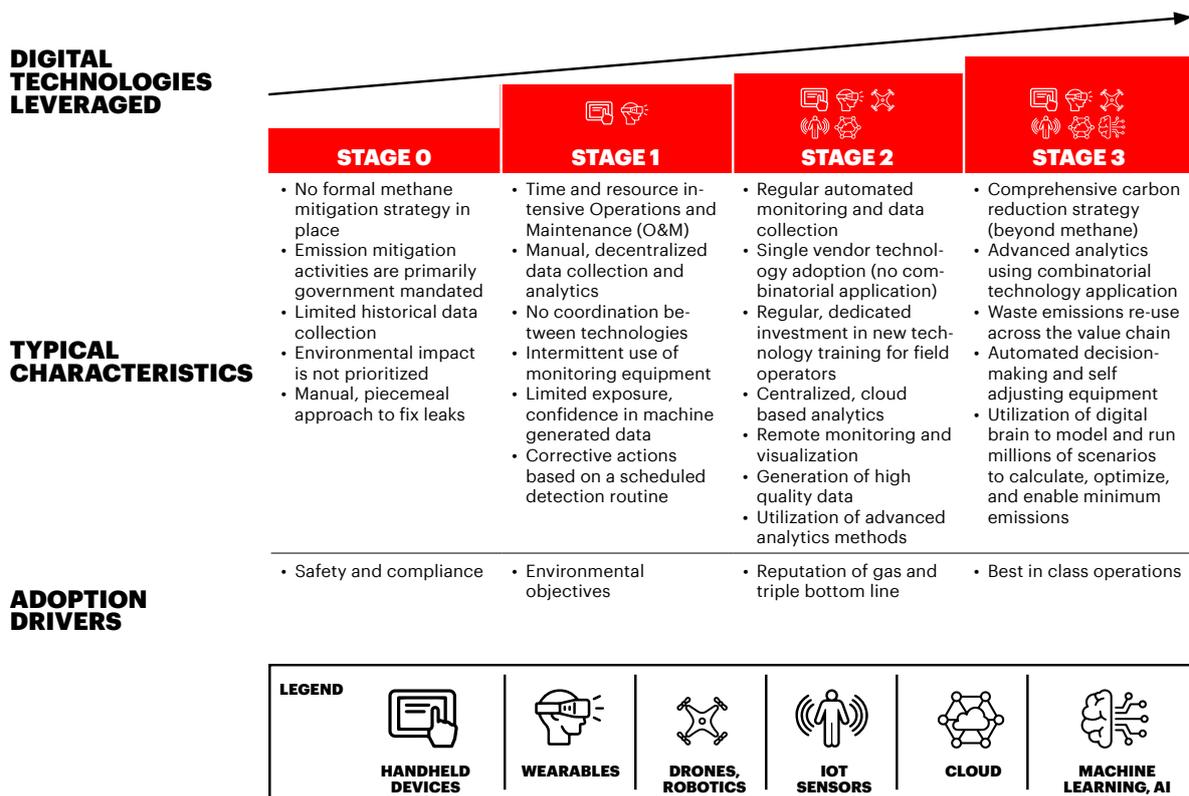
Early industry efforts to reduce methane emissions are largely centered on the deployment of manually controlled sensor instruments. Leveraging digital capabilities can help the industry achieve emissions reductions more quickly and effectively.

The use of digital technologies to drive a step change in methane emissions management is relatively immature. Methane management maturity advances over four stages (see Figure 3). Most industry participants are still in stages 0 or 1 – that is, either not having a methane mitigation strategy in place or still largely reliant on manual actions.

“UPSTREAM CURRENTLY USES DIGITAL AND TECHNOLOGY VERY EFFECTIVELY, BUT NOT WITH METHANE REDUCTION IN MIND.”

- ANDREW CUNNINGHAM, MANAGER, BUSINESS DEVELOPMENT, SENSIT TECHNOLOGIES

Figure 3: The digital methane maturity continuum¹⁷



Stage 0 is characterized by industry players whose emissions priorities are driven predominantly by regulatory mandates, health and safety issues, and impacts to the broader reputation of gas, which may directly impact the bottom line. Methane-curbing technology adoption of organizations in stage 0 is limited, with operators focused on minimizing costs and operating near or at the regulatory limit.

Stage 1 organizations leverage hand-held, sensor-enabled instruments to detect emissions. These include optical and laser-based sensors, deployed on an individual basis to allow screening and quantification of emission sources for further field intervention. Stage 1 organizations also commonly deploy mobile input devices, such as tablets, to optimize local data collection and establish a historical baseline. This data, which is interpreted manually, is typically used for local reporting purposes.

“SENDING PEOPLE IS THE MOST EXPENSIVE PART OF THE OPERATIONS. BUT IF YOU HAVE AN AUTOMATED SYSTEM, THEN YOU DON'T HAVE TO SEND PEOPLE. METHANE IS VERY INEXPENSIVE, BUT PEOPLE ARE NOT. WE INSTALLED CONTINUOUS MONITORING CAMERAS ON A PIPELINE AND REDUCED THE WORKFORCE FROM 160 TO 15.”

- ROBERT KESTER, CEO, REBELLION PHOTONICS

Organizations at **Stage 2** maturity leverage remote monitoring technologies, including embedded IoT sensors, drones, robotics, and cloud-based analytics platforms. These technologies enable remote monitoring and visualization of emissions, as well as the centralization of site data across the organization's portfolio. They also utilize continuous methane detection, enabling the organization to leverage more advanced analytical methods that derive richer insights to inform and prioritize methane mitigation actions. At this level of maturity, most operators opt for single-vendor solutions, shying away from a

combinatorial application of disparate technologies. Operators in Stage 2 also invest more heavily in training on new sensor technologies to build competence and confidence among workers transitioning from field-based to remote diagnostics. Repairs at this stage continue to be implemented manually through

“A LOT OF SITES ARE REMOTE, WHICH REPRESENTS A CHALLENGE TO EFFECTIVELY MONITOR AND REPAIR METHANE EMISSIONS. DIGITAL HAS TO BE THE WAY TO GET AROUND THIS PROBLEM.”

- GLEN PARKES, SENSOR/DIGITAL SOLUTIONS LEAD, BAKE HUGHES- GE

scheduled maintenance regimes.

Stage 3, the most advanced stage in the digital methane management journey, entails an even more integrated, systems-based approach to asset management. This approach makes use of advanced capabilities such as big data analytics, machine learning and advanced sensors/IoT to enable operators to predict and prevent leaks before they occur.

A business brain – leveraging big data derived from IoT and connected devices – can run millions of scenarios based on historical data to generate new insights. Automated decision-making embedded in monitoring systems enables equipment to self-adjust (and even self-heal) in order to minimize leakage risks with no manual intervention enabling significant direct cost savings. An integrated systems-based approach, while higher in capex, has the potential to drive substantial improvements in overall system productivity beyond emissions reductions alone. Systems-level data and combinatorial technology applications create the opportunity for operators to pursue a bolder, zero emissions agenda that harnesses advanced solutions across the value chain. To date, no organization has fully entered this stage of digital methane management maturity.

The digital maturity continuum refers to an evolutionary journey, but it does not necessarily mean that each operator needs to navigate through every stage to achieve the highest level of maturity. Operators have a chance to jump the chasm by aligning their internal capabilities,

understanding the investment required, and estimating the full impact potential. Figure 4 highlights key implementation considerations that might impact digital investment decisions for operators at different stages of the maturity continuum.

Figure 4: Considerations and impact potential along the methane management maturity spectrum¹⁸

	STAGE 0	STAGE 1	STAGE 2	STAGE 3
ALIGNMENT WITH CURRENT INTERNAL CAPABILITIES	HIGH HSE maturity in energy sector is traditionally high, driven by stringent safety regulations	HIGH Leaders in industry already conduct leak detection surveys using hand-held instruments and collect emissions data	MID Limited technology exposure across field personnel due to low penetration of digital solutions and analytics, especially for small operators	LOW Limited digital capabilities with few experts on combinatorial applications
CAPITAL REQUIREMENTS	LOW Limited or no need for infrastructure augmentation	MID Upfront investments in detection equipment is declining but resource intensiveness of current methods may result in higher operating costs	HIGH High technology acquisition, capability development and human resources costs	HIGH High upfront technology and capability development costs coupled with potential operating costs reductions
IMPACT POTENTIAL	LOW Limited impact due to piecemeal/ad hoc approach	LOW Impact constrained by higher labor involvement and associated costs	MID High ability to identify, quantify and triage methane emissions by sources	HIGH Predictive capabilities coupled with reduced human intervention catalyzing journey towards zero emissions

ACCELERATING THE SHIFT TO DIGITAL

While most companies are still in the first stages of the digital methane management evolution, they are not a homogenous group. Some operators question the opportunity costs altogether, given other possible investment allocation opportunities. Others are demonstrating their commitment through tangible actions and public methane reduction targets. A third set of organizations is deploying isolated initiatives driven more by compliance and reputational risk considerations.

Among those taking incremental steps to reduce methane emissions, many are using hand-held technologies. Industry experts have suggested that organizations at this stage of digital maturity often face a “Catch-22” dilemma: the price of existing solutions is inhibiting the widespread adoption of additional tools. But widespread adoption is needed to bring down costs and achieve economies of scale.

This apparent paradox need not stop their move to digital methane management. There are, in fact, several things organizations can do to accelerate their shift to digital.

“INDUSTRY COMMITMENT IS THERE, BUT THE VISION IS POORLY ARTICULATED. SOME COMPANIES’ GOAL IS TO GET DOWN TO ZERO, AND SOME COMPANIES’ GOAL IS TO NOT BE THE WORST.”

- LEADING METHANE RESEARCHER

MANAGING METHANE EMISSIONS BEGINS WITH A COMPELLING CASE FOR ACTION

A business case for methane emissions management can be built not just on short- and long-term financial value, but on environmental and societal benefits, as well.

In determining whether to move forward with a digitally enabled methane management program, companies must consider the infrastructure investments required, as well as costs associated with developing new capabilities. These costs may keep some companies from taking action. They may believe the investment could be better allocated towards more lucrative investment opportunities.

While companies will each have their own unique strategic goals and priorities, the industry as a whole has a compelling business case for minimizing methane emissions. As mentioned previously, it is estimated that methane emissions cost the oil and gas industry about US\$30 billion a year.¹⁹ Moreover, 40–50 percent of the estimated 76 million metric tons of methane leaked from the industry annually can be minimized at no net cost.²⁰ For some organizations, recouping the value of lost methane will be sufficient to catalyze

action. Accurately calculating current emissions, and their affiliated cost, is a critical first step in developing the business case.

The industry as a whole may also benefit from collective action on methane mitigation as it seeks to position gas as a crucial fuel source in the low-carbon energy shift. Potential carbon-pricing or cap and trade regulations in the future will influence the future cost of fuels across the wider energy supply curve and, in particular, the competitiveness of natural gas for power generation. The industry's ability to effectively manage and mitigate its methane emissions will influence the magnitude of the role natural gas can play in the future energy mix.

Finally, few oil and companies are seen as emissions reduction leaders. Managing methane provides an opportunity for companies to allay growing stakeholder skepticism and concern. The degradation of trust across stakeholder groups including investors, customers, civil society, and employees is a growing concern for oil and gas companies. And for good reason. Accenture Strategy research has found that a large integrated or national oil company stands to lose about US\$9 billion due to a breach in trust.²¹

The degradation in trust presents itself in myriad ways. Investors are now asking oil and gas companies to not only improve their returns, but also set emissions reduction targets. Consumers are increasingly demanding access to affordable and clean energy. Partners

want to work toward shared objectives that go beyond just cost reduction. And employees want to work for a company that has a purpose they believe in and allows them to be at the leading edge of technology innovation. Currently, fewer than 10 percent of recent college graduates say they want to work for an energy company.²² Managing methane emissions, while one piece of the trust equation, can be a visible demonstration of the industry's commitment to close the trust gap among all these critical constituents.

MANAGING METHANE EMISSIONS NEEDS TO BE AT THE TOP OF THE (DIGITAL) OPERATIONAL EXCELLENCE AGENDA.

Achieving full scalability of methane mitigation solutions continues to be a challenge. But it likely won't be for long. Oil and gas companies can take advantage of their digital agendas, which are designed to accelerate and optimize their operations to take actions on methane management.

The oil and gas industry tends to have a much longer adoption cycle for new technologies and systems influenced by stringent safety standards. What it needs are pioneers that can lead the way by demonstrating the value that can be gained from aligning methane reduction strategies with programs designed to drive operational excellence.

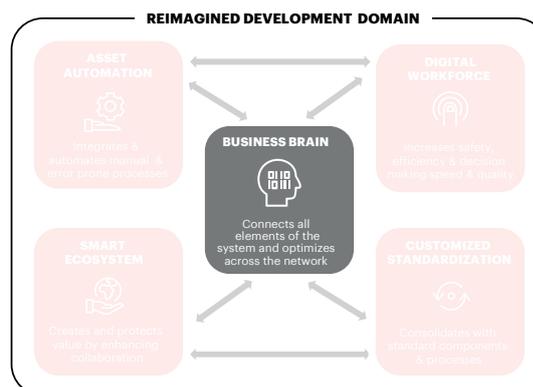
These pioneers can identify synergies between methane management and digital transformation strategies, thus establishing a best-in-class model for others in industry to adopt. With respect to the five potential areas of digital value illustrated in Figure 2, this section explores three ways organizations can incorporate methane management in their existing digital architecture.

“MAKING THE METHANE PROBLEM SYNONYMOUS WITH THE OPERATIONS PROBLEM IS THE WAY FORWARD, SO EXCESS FUGITIVE METHANE EMISSIONS ARE SEEN AS A BYPRODUCT OF ‘BAD’ OR INEFFICIENT OPERATIONS. MANY IN THE INDUSTRY VIEW METHANE EMISSIONS AS ANOTHER POTENTIAL REGULATORY REPORTING REQUIREMENT, THE SAME WAY AS REGULATORS DO. IT NEEDS TO BE CLEAR THAT REDUCING FUGITIVE METHANE IS ABOUT IMPROVING OPERATIONS, PRODUCTIVITY AND ULTIMATELY PROFITABILITY. ONCE THIS IS ACCEPTED, THE INDUSTRY WILL BE MUCH MORE WILLING TO REPORT ON THOSE PARAMETERS.”

DAVID MOUNT, PARTNER, G2VP

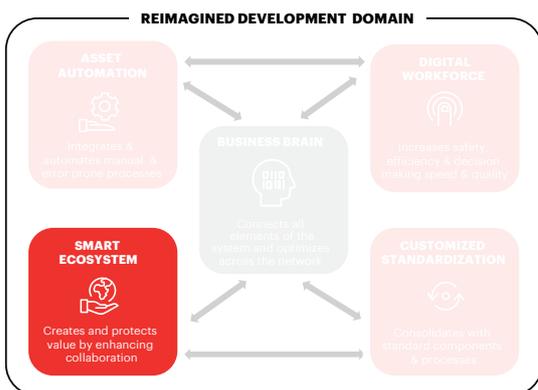
Predictive asset management – Many operators have already switched from time-based to condition-based asset management, which is predictive in nature. In a condition-based approach, maintenance is performed based on the requirement of the equipment instead of a calendar schedule. Condition-based asset management allows operators to avoid sporadic runs for repair, improve uptime of critical equipment, and reduce costs—in some cases by 50–60 percent.²³

To enable a condition-based approach, organizations can utilize the business brain element of the overall digital framework. This brain enables the seamless digital merger of different sets of data collected through different technologies in different ways and at varying times and/or spatial scales. With this data, algorithms can be applied to predict the next equipment failure and/or a consequent methane leak. Alerts can be issued to maintenance and methane-monitoring staff to warn them of pending equipment issues. Depending on the nature of the problem or the potential size of the leak, corrective action could be triaged and scheduled, thereby reducing costly, ad hoc field repair runs. To take advantage of this predictive capability, the organization’s digital architecture would need to be modified to include methane emissions as a key input into the processing engine.



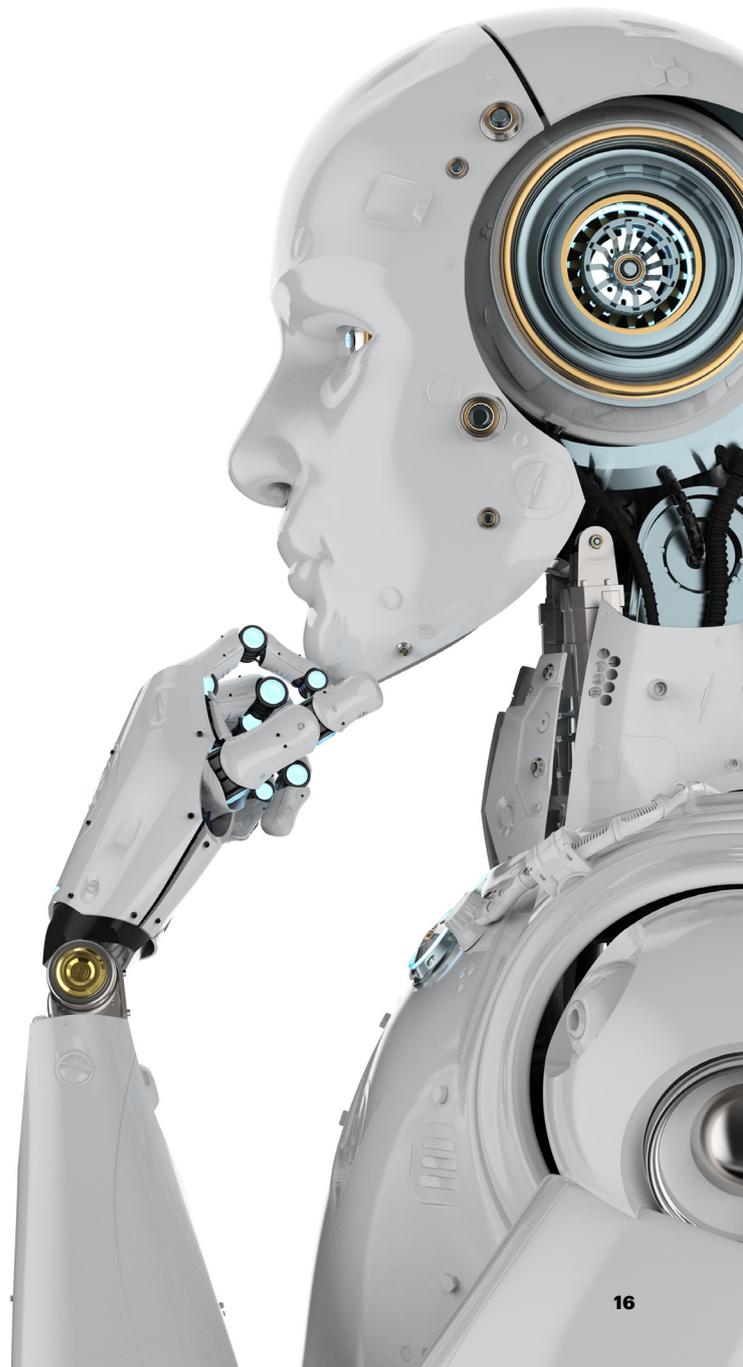
Ecosystem convergence – When optimizing business performance, operational excellence teams typically collaborate with the supply chain function and use digital tools to identify weaknesses in the system, including issues with parts or materials that are sourced from suppliers. A “smart ecosystem” based approach can help identify components such as seals and valves that are causing the highest methane emissions. The collaboration enabled by this approach not only helps organizations identify suppliers offering inferior components or components with high failure rates over time, but allows manufacturers to distinguish themselves in the crowded infrastructure marketplace with superior, lower-emitting products.

Importantly, successful ecosystem management extends beyond the oil and gas sector. Greater collaboration between innovative startups and big technology companies help make digital methane management a vital component of operational efficiency. Standardization and open digital architectures, delivered through an ecosystem model, will make it possible for operators to “plug in” methane management solutions and integrate them with their broader digital strategies.



CLARK VALVE RAISES US\$5.5 MILLION IN FUNDING ROUND LED BY OGC I CLIMATE INVESTMENTS

MIAMI-BASED CLARK VALVE MANUFACTURES COST-EFFECTIVE VALVES AND CLAIMS TO BE THE WORD’S ONLY CONTROL VALVE MANUFACTURER TO HAVE MET STRINGENT CERTIFICATION REQUIREMENTS FOR LOW FUGITIVE EMISSION PERFORMANCE. LEGACY VALVE DESIGNS ARE THE CAUSE OF SIGNIFICANT AMOUNTS OF METHANE EMITTED INTO THE ATMOSPHERE BY INDUSTRIAL FACILITIES. THE COMPANY SAYS THE NEW FUNDING WILL ENABLE THE COMPANY TO ROLL OUT ITS PROPRIETARY SOLUTION FOR REDUCING FUGITIVE EMISSIONS AND PROVIDE A RETROFIT SOLUTION.²⁴



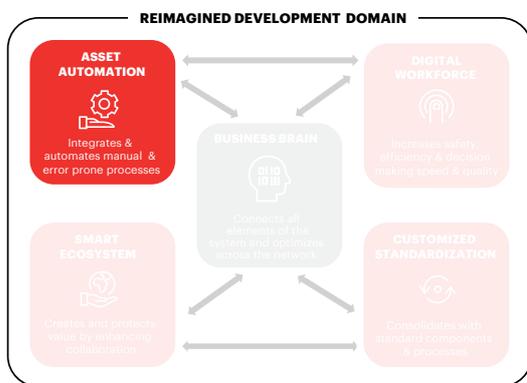
End-to-end network management

– During production, pneumatic controllers maintain the pressure in the network. These controllers and valves often bleed methane while stabilizing the network pressure.

“CERTAIN TECHNOLOGIES IN THE INDUSTRY, LIKE METHANE-ACTUATED PNEUMATIC VALVES, WILL BE VERY DIFFICULT TO REPLACE BECAUSE THEY ARE VERY EFFECTIVE AND ARE ALREADY INSTALLED. THE BEST WAY TO ADDRESS THOSE SOURCES OF EMISSIONS WOULD BE TO WORK ON SYSTEM-LEVEL OPTIMIZATION TO DRIVE MORE EFFICIENT OPERATIONS AND REDUCE THE FREQUENCY OF UTILIZING THOSE DEVICES RATHER THAN REPLACING THEM.”

**- M.J. MALOOF, VP,
SALES & STRATEGY, KELVIN INC.**

With digitally enabled “asset automation” capabilities, operators can manage network pressure in real time. This can lead to less gas bleeding from the methane-actuated pneumatic controllers. Effectively regulating pressure across the system also means less damage to components. Advanced connected technologies for asset management are already being deployed and are helping operators maximize production, while increasing efficiency and improving safety.



INNOVATIVE BUSINESS/ COMMERCIAL MODELS ARE NEEDED TO SCALE FASTER AND SHARE INVESTMENTS AND RISKS

Oil and gas operators that do not see digital as a priority are foregoing efficiency gains, cost savings and higher production. Similarly, operators that fail to embrace new business models are sacrificing an opportunity to overcome challenges associated with asset ownership and methane management.

In a cost-sensitive and competitive environment, with a strong focus on capital returns, operators often are not willing to invest in the digital capabilities and technologies that would allow them to address environmental challenges. In some instances, intangible benefits and other uncertainties associated with emission mitigation can impede appetite to invest in the infrastructure required to curb or prevent methane leaks. New commercial models are needed to help assure companies that positive returns are possible.

Technology organizations and startups working on the methane emission challenge can offer new business models that will encourage operators to act. For example, product-as-a-service models can help operators prevent methane leakages without having to own the solution. The cost of sensors can be amortized over time, with technology providers retaining asset ownership. Such a model could be a game-

“ULTIMATELY, OPERATIONAL EXCELLENCE DRIVES REDUCTIONS IN METHANE EMISSIONS, NOT JUST DETECTION OR ANALYTICS. CONSEQUENTLY, RATHER THAN FOCUS ON A ONE-TIME PURCHASE OF EQUIPMENT, THE INDUSTRY SHOULD LOOK AT CONTINUOUS, REAL-TIME OPTIMIZATION SERVICES ON A SUBSCRIPTION BASIS. HARDWARE IS A NECESSARY, THOUGH NOT SUFFICIENT, COMPONENT OF THAT SERVICE.”

- M.J. MALOOF, VP, SALES & STRATEGY, KELVIN INC.

changer – especially for smaller operators, which are more conservative about spending upfront on capex.

Oilfield service (OFS) companies have also shown a growing interest in new business models that will allow them to engage with operators in new ways. With the advent of performance/time-based contracts, some OFS companies are taking partial ownership of production assets, which means they can share risks and rewards

with operators more directly – including, for instance, a percentage of revenue gained from higher production due to the decline in fugitive emissions. Such arrangements might be particularly relevant for national oil companies (NOCs) that may lack field-operating experience.²⁵

Business models can also be crafted to monetize certain digital capabilities. For example, OFS companies could provide predictive maintenance services and benefit from a share in the value realized due to reduced downtime.

“DRIVING THE DIGITAL AGENDA WITH SMALLER COMPANIES WILL REQUIRE CREATIVE SOLUTIONS. THE LARGE SERVICE COMPANIES THAT PROVIDE TRADITIONAL SERVICES COULD OFFER DIGITAL TO SMALLER PLAYERS WITH INNOVATION ON HOW BEST TO POSITION AND DELIVER THIS SERVICE.”

- DR. SHAREEN YAWANARAJAH, INTERNATIONAL POLICY MANAGER, ENERGY, EDF



THERE IS A GROWING NEED TO DEVELOP A SHARED INDUSTRY COMMITMENT

Developing a shared industry commitment to managing methane emissions is the first critical step to accelerate action. C-suite executives, investors and regulators all play a vital role.

Role of the C-suite

Lately, methane has started to appear on the leadership agenda, and individual public commitments on methane reduction have been announced. As noted earlier, OGCI member companies collectively committed to reduce methane emissions to 0.25 percent by 2025.²⁶

“OUR AIM IS TO WORK TOWARD NEAR-ZERO METHANE EMISSIONS FROM THE FULL GAS VALUE CHAIN ... WE HAVE WORKED TO MAKE OUR AMBITION CONCRETE, ACTIONABLE AND MEASURABLE, HELPING TO ENSURE THAT NATURAL GAS CAN REALIZE ITS FULL POTENTIAL IN A LOW-EMISSIONS FUTURE.”

- STATEMENT FROM HEADS OF OGCI MEMBER COMPANIES

Despite growing interest in methane emissions mitigation, there is all too often a disconnect between the strategic intent and the tactical initiatives at the asset level. Field personnel’s performance metrics are generally driven by production optimization and cost reduction. This approach limits the industry’s ability to integrate methane into the broader operations excellence, and thus

digital, agenda. Leadership plays a key role in bridging this gap. The C-suite, including CTOs or CDOs (chief technology/digital officers), need to play a more active role in driving the broader agenda and taking decisive action such as linking emissions reduction performance to compensation. These leaders can help drive the industry, as well as technology companies, toward a digital methane future.

INVESTOR ACTIVISM AT EXXONMOBIL

IN 2016, NEARLY 40 PERCENT OF EXXONMOBIL SHAREHOLDERS VOTED FOR THE COMPANY TO INCREASE TRANSPARENCY ON METHANE MANAGEMENT, WHILE 60 PERCENT VOTED FOR GREATER TRANSPARENCY ON CLIMATE RISKS ACROSS THE BOARD. THE VOTE HAPPENED BECAUSE ASSET MANAGERS WERE BEING PRESSURED BY CLIENTS, WHO HAVE A LONG-TERM PERSPECTIVE AND SEE CLIMATE CHANGE AS A RISK TO THEIR FUNDS.²⁷

Role of investors

Investors indirectly face financial, reputational and regulatory risks from methane emissions in their oil and gas portfolios. However, it is essential that investors not only engage on the methane leakage issue from a risk mitigation perspective, but also encourage and appropriately reward companies actively exploring and investing in methane innovation that drives material reductions.

The investor community can further wield its influence by supporting organizations in their efforts to scale up initiatives, channeling investment into methane management, and broadening its thinking beyond the short termism of quarterly returns.

Role of regulators

In a UN Global Compact study, conducted in collaboration with Accenture Strategy, 55 percent of CEOs surveyed in the energy sector suggested “regulation and standards” were one of the most effective tools for promoting sustainability.²⁸ With regard to methane emissions, there is a distinct opportunity to strengthen the regulatory framework. The IEA has noted, “Outside North America, the absence of robust policy action in this area represents a major missed opportunity to tackle near-term warming”.²⁹ Regulators should design frameworks to encourage adoption and scaling of innovative approaches – including digital methane management – to provide an additional incentive for operators to advance through the maturity continuum.

SUCCESS STORY: COLORADO ROLLS OUT REGULATIONS TO CATALYZE ACTION

IN 2014, COLORADO WAS THE FIRST STATE TO DEVELOP AND IMPLEMENT REGULATIONS DIRECTLY ADDRESSING METHANE EMISSIONS. SINCE THE 2014 LAUNCH, THE STATE HAS SEEN AN APPROXIMATE 75 PERCENT DECLINE IN THE NUMBER OF SITES THAT NEED FIXING.

THE RULE HAS COST OIL AND GAS OPERATORS ABOUT US\$40 MILLION. HOWEVER, A RECENT STUDY FOUND THAT 70 PERCENT OF THE REPRESENTATIVES FROM OIL AND GAS COMPANIES AGREED THAT THE BENEFITS OF COLORADO'S REGULATIONS OUTWEIGH THE COST. THEY ALSO REPORTED ASSOCIATED IMPROVEMENTS IN WORKERS' ATTENTION TO DETAIL AND SAFETY.³⁰



THE ROAD AHEAD

The oil and gas industry has no choice but to take concrete actions to reduce methane emissions. Such actions will require commitment, innovation and collaboration. They will also require digital investments to accelerate initiatives that will change how the industry manages methane moving forward.

Through collaboration and multi-stakeholder engagement, methane emissions can be managed. This might require new partnerships between industry, service companies, technology firms, NGOs and other unconventional players, but with the right people at the table, and a collective commitment to eliminating emissions, a mature digital methane management future is possible.

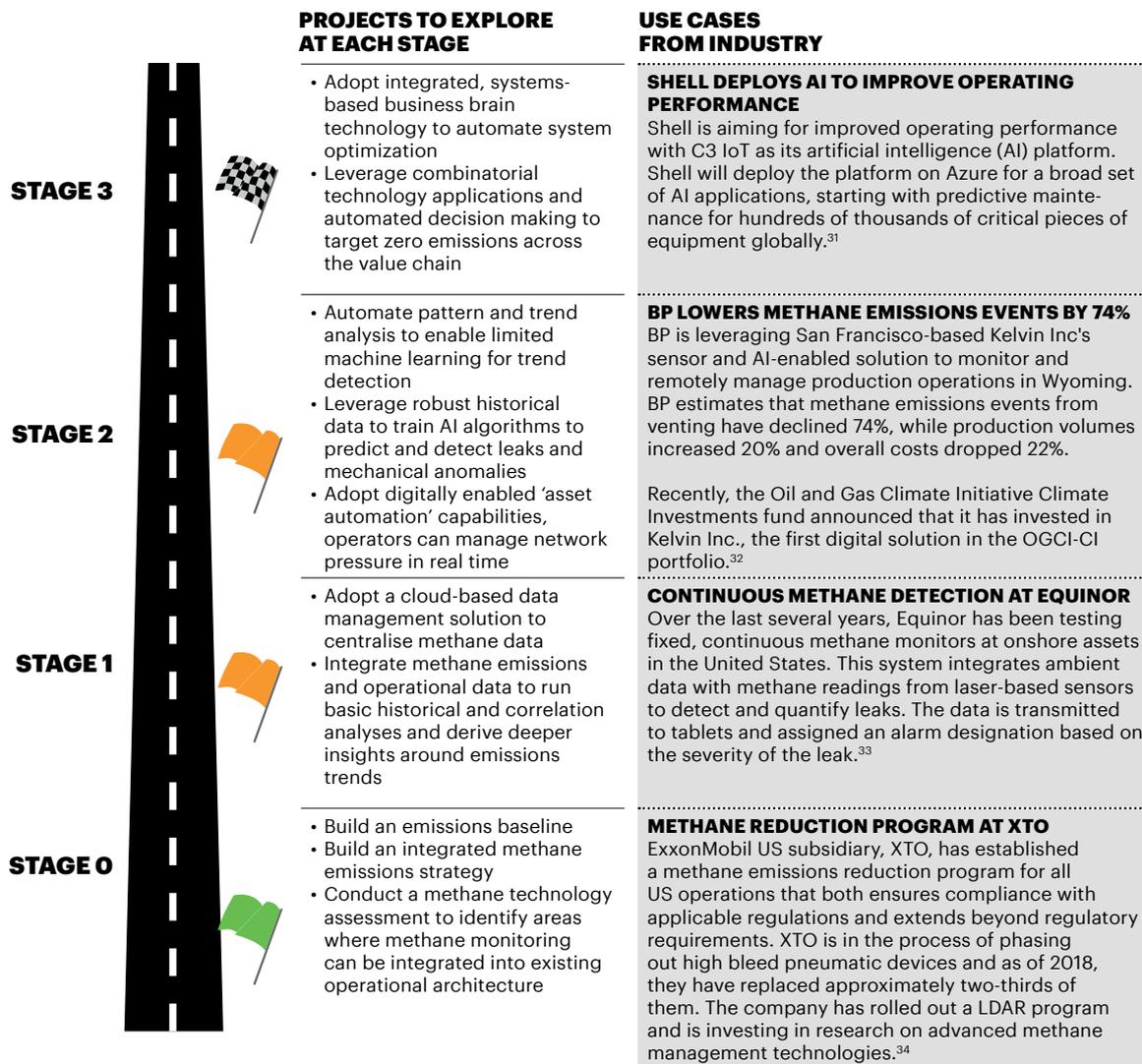
Methane management is ripe for digital transformation. Today, many companies may view digital methane management as an elusive, complex concept. It need not be. Any company, regardless of where they are in their methane journey can and should take action towards a digital methane future. Doing so can unlock

efficiencies, push revenues through zero-loss value chain, and promote a greater social license to operate. This is as true for smaller or less digitally mature organizations as it is for the most digitally sophisticated players. There is opportunity for everyone.

The first step is for a company to accurately diagnose its current position on the maturity continuum (see Figure 3) and thus illuminating the potential to make a step change improvement exists. There are opportunities to pursue high-impact projects at every stage of the digital methane journey. Figure 5 illustrates some actions companies might consider, as well as existing use cases that are gaining traction.



Figure 5: A road-map for the industry



For example, oil and gas companies that have yet to embark on their methane management journey might find that a natural place to start is with the creation of an emissions baseline against which future progress can be measured. Companies in Stage 1 of their journey might look to apply data management technologies and analytics to gain insights that will allow them to accelerate actions and make better, faster decisions. In Stage 2, the real digital firepower comes into play. Automated processes, AI and machine learning can be used in tandem to make step change improvements in leak detection and remediation. At Stage 3, companies have the opportunity to bring their fugitive emissions to zero. A digitally enabled

business brain, fully integrated with operating systems, will boost production, while predicting and mitigating leaks before they occur.

Achieving Stage 3 methane management maturity is not the stuff of science fiction. It is possible today with digital technologies. With ecosystems of like-minded peers. With innovations borne of collaboration. And, above all, with an unwavering commitment to make a lasting positive change.

It is in every oil and gas company's interest to mitigate methane emissions. It is also in every company's sphere of influence to contribute and accelerate an emission-free energy future.

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