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SUSTAINABILITY

An Internet of intelligent things for more sustainable operations

Edge computing, AI and machine learning, and IIoT technology serve as key enablers to deliver safer and more environmentally sustainable operations by reducing human and carbon footprints, while increasing operational efficiency and productivity.

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The oil and gas industry is evolving rapidly. This evolution is influenced by a plethora of factors that are transforming practically every aspect of how the industry operates—from new product development to financial reporting. For example, adoption of remote operations has accelerated heavily as a result of the Covid-19 pandemic. Further, pervasively low Capex budgets are pushing operators to extract maximum value from existing assets. In addition—and of significant long- and short-term importance—is the call for the industry to drive safer and more environmentally sustainable operations.

Sustainability is a responsibility shared amongst all along the oil and gas value chain. Technology providers and service companies are tasked with enhancing their own sustainability efforts, while partnering with oil and gas operators to deploy technologies that enable them to meet their own sustainability objectives. Further, the industry must also ensure its suppliers—steel, cement and chemicals—are aligned with this focus on sustainability.

Climate-related risk. Sustainability must now be embedded and integral to all operations. Organizations are being held accountable for measuring sustainability efforts, and there are direct impacts on overall financial performance. Through greater transparency and disclosures specific to sustainability performance, investors are able to take into account whether organizations are making strides toward sustainability priorities. A good example of this is the Taskforce on Climate-Related Financial Disclosures (TCFD), which was created in 2015 by the Financial Stability Board to develop consistent climate-related financial risk disclosures for use by companies, banks and investors in providing information to stakeholders. The TCFD was created with the specific purpose of improving and increasing reporting of climate-related financial information. Furthermore, organizations often engage in various sustainability rating agencies on behalf of their investors and other key stakeholders, in an effort to communicate progress made on sustainability efforts.

Given the influence of these factors, today's oil and gas industry must operate safer, more efficiently and effectively, and in a more environmentally responsible manner than ever before. Many organizations have developed aggressive targets to reduce Scope 1 and Scope 2 emissions. Per the Environmental Protection Agency, Scope 1 emissions are direct greenhouse gas (GHG) emissions that occur from sources that are controlled or owned by an organization; Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity, steam, heat or cooling.

Fig. 1. A camera is positioned facing the analog gauge, providing a continuous feed to the AgoraGateway running a machine learning algorithm to digitize the data in real time.

DIGITAL TRANSFORMATION

To meet these aggressive targets, the industry is leaning on technical innovation—and specifically the impact of digital transformation. Organizations must first adopt digitalization, which can improve business processes by leveraging digital technologies such as the cloud, the edge and smart things. Moving forward, there is a need for converting and using "intelligent things" as an imperative to achieve optimized performance with a measurable sustainability index. As such, a key next step is embracing digital transformation, which translates to leveraging emerging technologies to build

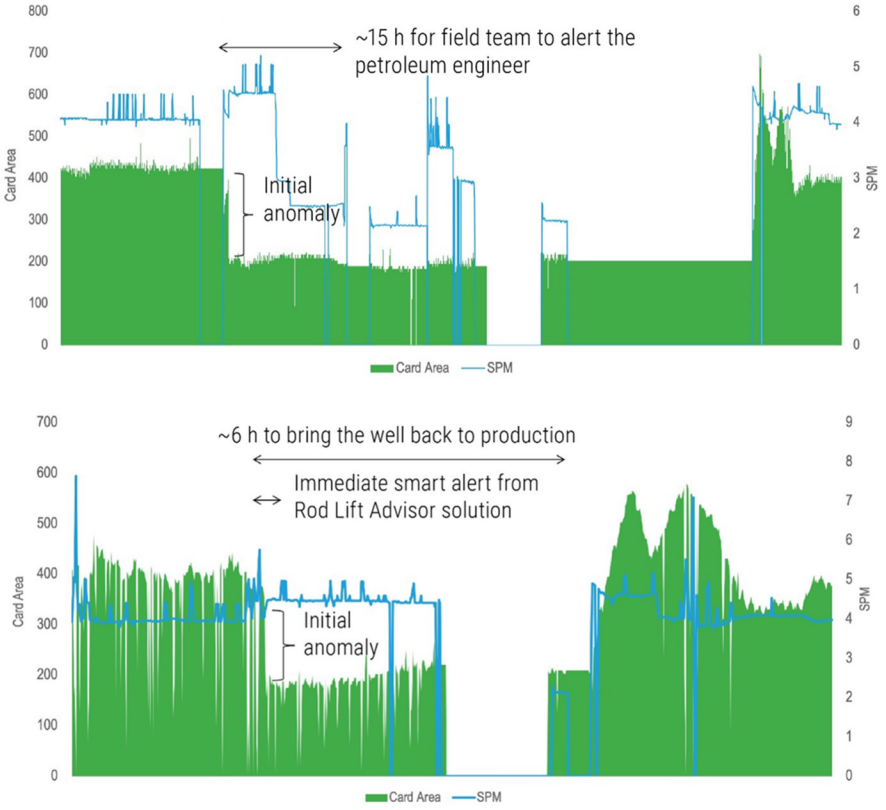
new business systems, business models and user experiences in a partnered model.

Stepping to the edge. The oil and gas industry has always utilized technical innovation to improve operations, with the ultimate objective of optimizing overall performance. The industry was an early adopter of digital innovations, such as machine-to-machine communication, satellite connectivity, and remote operations enabled by SCADA systems. This is due, in large part, to the level of desperate and challenging environments in which the industry operates. While driving some advanced capabilities, SCADA systems are constrained, due to being closed-loop and also lacking the ability to benefit from recent innovations in AI and machine learning. As such, implementation is focused mostly on the most critical equipment. A majority of operating equipment in the field remains un-instrumented, thus left to human operation and the associated carbon footprint. Further, high costs and difficult ability to scale have limited wide adoption of SCADA systems.

Traditional SCADA systems and associated data historians utilize very small amounts of the total data collected for any type of intelligent operation, all of which is focused on managing the integrity of operations. A typical U.S. land well with manual production operations can emit approximately 20 tons of CO_2 per calendar year. Thus, there is significant opportunity to simultaneously optimize overall performance while also delivering safer, more sustainable operations. This can be achieved by leveraging the vast amounts of data generated in the field to augment operations using advanced digital technologies that are capable of enabling remote control and automated field operations.

The recent emergence of Industrial Internet of Things (IIoT) technologies has now made it feasible to digitize every piece of field equipment utilized in oil and gas operations. Recent advances have made IIoT implementation scalable and affordable, while also providing built-in physical and cyber security measures. Moving beyond industrial sensors, the latest IIoT technology includes new and emerging intelligent sensing devices, such as cameras, LoRA, BLE and acoustic devices to name a few, which are used to collect data and enable digital access to physical devices. While IIoT technology has been advancing, cloud computing has

Fig. 2. The data from an event on May 10, 2020, showing the existing monitoring scenario when the smart alerting feature was not in place. It took the operator 60 hr to revive the well (top). The data are also from an event on May 25, 2020, where the Rod Lift Advisor smart alerts detected the problem immediately, enabling the user to apply corrective action to revive the well in just 6 hr (bottom).



enabled the ability to ingest high-frequency data directly into an application. This is achieved through the use of advanced data analytics, machine learning, and digital twin technologies that generate intelligences—foresight, insight and hindsight.

While IIoT technology has helped the industry overcome challenges and limitations associated with SCADA systems, it has also brought along new challenges that the oil and gas industry must address. Firstly, IIoT sensors generate billions of data points at very high frequencies, and transmit these data to a cloud system or data environment. Given the remoteness of many oil and gas operations, reliable network connectivity and communication can be challenging. Secondly, the number of insights or foresights generated in the cloud infrastructure for thousands of connected devices creates significant challenges related to managing alerts and alarms, and how to execute responses effectively.

To overcome these new hurdles, Agora has created an intelligent computing layer around legacy oilfield equipment that exists at an operational site. This intelligent computing layer is defined by AI, data analytics and domain science. The deployment of distributed intelligent sites directly addresses and overcomes the previously mentioned challenges associated with IIoT technology and centralized cloud computing systems. When viewed holistically, this approach converts legacy oilfield equipment—rod pumps, compressors, valves, etc., —into "intelligent" things. This equipment is connected to a cloud service manageability, thus delivering a true "Internet of Intelligent Things."

The edge AI and IIoT solutions developed by Agora are geared toward making machines or things "intelligent," so that humans can focus on more complex issues and leave machines to manage the growing repeatable tasks and controls. By utilizing AI and machine learning to intelligently automation mundane tasks, operational consistency is greater, and overall efficiency is optimized. Taking "intelligent" things a step further, Agora solutions help to drive profitability objectives by increasing uptime and providing prognostic health management of equipment. Developed

through a partnership ecosystem, cloud provider services and in-house build stack of service, Agora solutions transform how remote operations are typically defined. While these solutions help to optimize overall performance, end-users also benefit from safer and more sustainable operations. An "Internet of Intelligent Things" enables access to remote control, automation tools and visual analytics tools that can be used to transform how energy companies operate, while also make significant strides toward reducing Scope 1 and Scope 2 emissions.

CASE STUDIES

Agora provides an open, secure and scalable IoT platform, built specifically for the oil and gas industry. The AgoraGateway ruggedized edge computing device is at the center of the platform. The gateway is intelligent and extensible, and it collects, integrates and transmits data from field devices to end-users (utilizing cellular or satellite connectivity or customer network). Edge applications, which are domain-specific workflows and algorithms, are deployed to the gateway to enable insights derived on location.

Visual analytics, offshore Asia. An offshore Asia operator utilized the Agora platform to enable remote visual analytics in order to reduce HSE exposure and improve production surveillance and optimization. Due to aging assets, there was no distributed control system on the rig, resulting in inefficient process surveillance for immediate intervention. Further, HSE exposure was increased because the operator was sending technicians to a remote rig for manual data acquisition of analog gauges. Due to the manual process to collect the gauge data, there was a lack of continuous processing of the variable data, which resulted in limited troubleshooting and optimization.

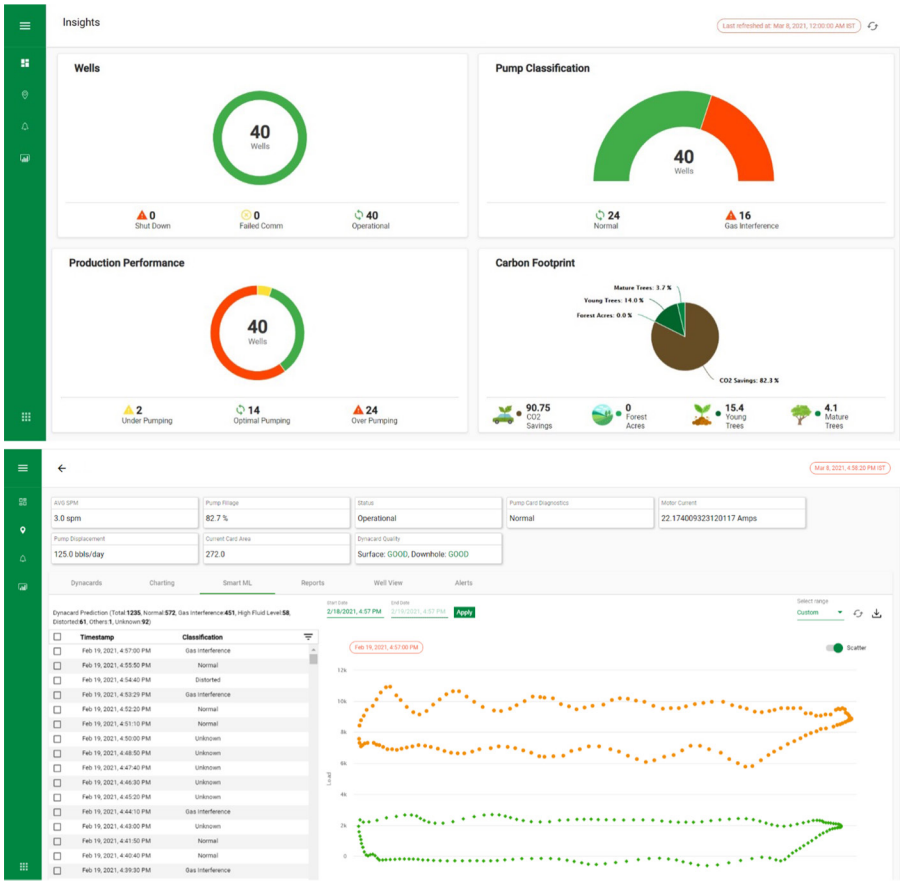
Agora customized a visual analytics application that digitized analog gauges, provided remote visualization and enabled data-driven decision-making without having to send technicians offshore. Cameras connected to an AgoraGateway device were used to provide real-time visualization of analog gauge data on the rig. The cameras were positioned to face multiple analog gauges to enable the reading of production on the rig. A machine learning algorithm was applied to digitize the analog information into a real-time dashboard to process the continuous stream of variable data. The newly implemented remote interface helped the operator to immediately improve production surveillance, while the continuous processing of high-frequency data enabled new optimization workflows with fewer trips to remote rigs for surveillance. As a result, the operator was able to reduce its HSE exposure while lowering Capex. **Fig. 1.**

Rod lift optimization, India. The Agora Rod Lift Advisor application is used to monitor the status of a rod pump and performs real-time analysis to optimize production and mitigate damaging conditions. The application is based on a combination of pattern recognition and machine learning, which are utilized to derive meaning and context of the data being captured in real time. The application runs machine learning applications at the edge to classify dynacards at high frequency and enable smart alerts that proactively notify users if anomalies are found when monitoring data. Further, the application has the ability to update speed changes and alter pump cycle (shutoff) times in an intelligent manner that understands the production challenge the pump is facing. Because of its continuous surveillance and remote control/automation capabilities, the application helps to significantly reduce miles driven to well sites for operational and monitoring efforts, **Fig. 2.**

In India, one operator sought an innovative solution to increase operational efficiency and production of its rod pump wells. The operator manages the majority of its satellite field wells with rod pumps, and required a solution for continuous monitoring to reduce downtime. The wells lacked digital enablement for continuous monitoring and management of rod pump operations, and the lack of data availability resulted in downtime and production loss.

The operator initially hired a third-party company for maintenance and daily data monitoring of the satellite field. Tasks included acquisition of rod pump data from the satellite field, and delivery of the data

Fig. 3. The Rod Lift Advisor application daily management reports can be created on a well-by-well basis (top). Visualize dynacard classification, using the convolutional neural network technique to get minute-by-minute pump status updates (bottom).



to the operator's petroleum engineering team. Despite rigorous collection by the third-party company, only discrete data were available, which was insufficient for rod pump optimization, and all decisions were made based on discrete data points.

To provide continuous monitoring and the ability to optimize its rod lift operations, the operator opted to deploy the Rod Lift Advisor application. The operator leveraged the application's machine learning capabilities to feed a minute-by-minute dynamometer card of the pump through a deep-learning model to classify the status of the rod pumps in the satellite field. Based on previous production data, the Agora team developed and implemented an algorithm to detect anomalies in the pumping operation and send smart alerts to designated users via email.

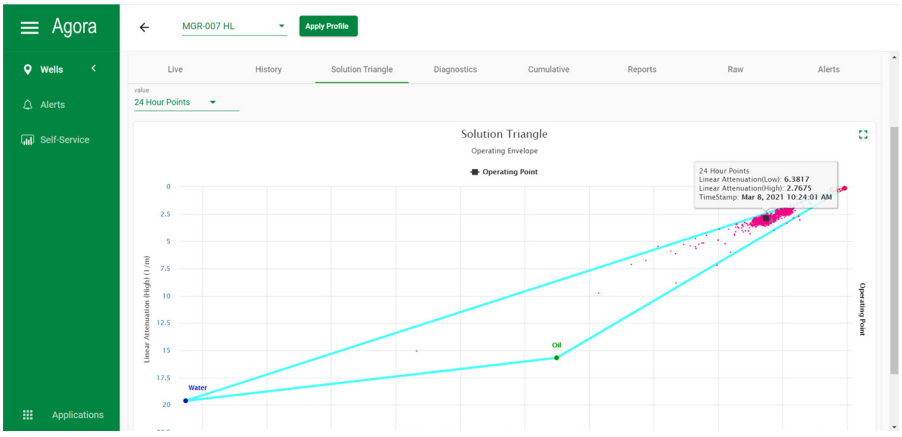
This process enabled a single petroleum engineer to have a 24/7 view of each pump's health. In addition, instead of spending time collecting, cleaning and analyzing data, the petroleum engineer was equipped to directly implement corrective actions to optimize production. Anomaly downtime was reduced by 70% of wells utilizing the Rod Lift Advisor application, while miles driven were reduced to limit environmental impact, **Fig. 3.**

Multi-phase flowmeter optimization, U.S. land. The Agora MPFM Advisor application provides real-time monitoring of well performance of multi-phase flowmeters, which enables insights to well behaviors that enable proactive management of production and extends equipment run life. The application provides operators with the ability to remotely control well profiles, in addition to integrated visualizations and control for various artificial lift or surface facilities.

A Permian basin operator used the MPFM Advisor application to enable remote management and production optimization workflows for its multi-phase flowmeters. The operator was managing multiple flowmeters that were not connected to a SCADA system, thus requiring manual data gathering. The operator was sending personnel into the field daily to read data from flowmeters, resulting in unnecessary HSE exposure and occasional reporting errors due to human entry.

In addition, the operator was also sending a third-party service provider to field locations to regularly check and calibrate the flowmeters. Due to the quantity of flowmeters in the field, and the need for a continuous data stream to manage fiscal allocation, the data that the operator was acquiring were limited and infrequent, which resulted in failed equipment and deferred production.

Fig. 4. The MPFM Advisor application visualized a multitude of data from the flowmeter and derived KPIs to provide accurate reporting of flowrates.



Agora deployed its MPFM Advisor application to enable remote visualization of data from flowmeters, which provided data required for petroleum engineers to optimize artificial lift strategy. The application, which is installed with minimal Capex required, provided the operator with minute-by-minute high-frequency data accessible to all users. The operator leveraged pre-determined intelligent alerts, which were specifically based on well condition parameters. This enabled the team to prioritize data from the flowmeters to proactively manage the well conditions while reducing field visits. The minute-by-minute visualization was available via mobile device or computer, and well profiles could be switched within the application.

The third-party service provider also benefited from continuous access to the data, as it enabled proactive recalibration of the meters to reduce fiscal allocation errors. The solution reduced field visits by 30% per month, resulting in minimized HSE exposure. Due to the increased uptime, the operator realized a 3% improvement in production on 20 wells, an increase of 14,000 bbl over the first year, **Fig. 4.**

Key enabler. This combination of edge computing, AI and machine learning, and IIoT enables unprecedented remote operation and automation capabilities, which provides end-users with a means to achieve environmental sustainability goals and reduce Scope 1 and Scope 2 emissions, while also reducing human exposure to hazardous conditions. Furthermore, greater adoption and proliferation of distributed intelligent oilfield operations will enable the industry to collectively minimize environmental impact and increase overall safety—while also optimizing overall performance. Edge applications for critical activities, such as greenhouse gas detection, flare monitoring and valve monitoring, are already being transformed by this innovative approach. As the industry moves forward and focus continues to increase on extracting maximum value from existing assets, while also delivering safer and more sustainable operations, an Intelligent Internet of Things approach serves as a key enabler to meet these objectives. WO

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