The Power of Digitalization: Driving the Energy Transition Forward with Digital Innovations

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As the world and the energy industry focus on the Energy Transition, most attention has been given to technologies that provide energy from renewable sources and directly reduce greenhouse gases. However, there is a potentially massive driver of the Energy Transition that few investors and consumers associate with the energy industry: the power of digitalization. **Applied to all stages of energy sourcing, production, and distribution, digitalization presents opportunities to facilitate and accelerate the Energy Transition globally.**

History of digital transformations: 1990s, 2000s, and today

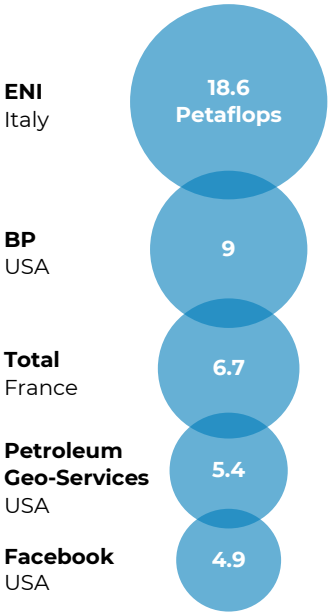
For decades, the energy sector has been one of the most active adopters of advancements in supercomputing, driven by the sheer volume of data and need for advanced analytical capabilities. While you may not be surprised that the Boeing 787 Dreamliner generates half a terabyte of data per flight,[1] did you realize that deep-water offshore drilling rigs produce two to four times that amount of data?[2] Similarly, you might expect that Facebook has one of the five fastest privately owned supercomputers in the world, yet would you guess that the four fastest are owned by energy companies?[3]

Historically, exponential advances in high performance computing capabilities have led to three distinct digital transformations across the energy sector.

In the 1990s, supercomputers broke a critical data processing barrier, the teraflop, or one trillion operations per second.[4] This breakthrough allowed for more detailed subsurface images used to locate energy deposits. With resulting higher levels of confidence in the data, capital was deployed to successfully develop those newly identified resources. What previously took months of analysis could now be completed in hours, setting the stage for an extraordinary increase in efficiency in sourcing energy.[5]

In the 2000s, computer processing improved by 1,000-fold.[6] Advances in quantifying energy deposits challenged conclusions previously reached by the US Department of Energy about the expected decline in petroleum reserves. As a result of the second digital transformation, exploration scientists were able to identify opportunities to unlock extensive resources, supporting growing global demand for energy.

Top Commercial Supercomputers



Source: Wall Street Journal; TOP500

The current transformation through digitalization represents the third and potentially highest-impact digital transformation for the energy industry. Connecting processes across the supply chain through IoT and cloud computing, as well as applying increasingly available artificial intelligence, moves beyond the digitization of manual work to truly changing how the energy supply chain operates. Additionally, the development of Exascale computing, which refers to an additional 1,000-fold improvement (systems

capable of a million trillion calculations per second or 50 times faster than the most powerful supercomputers being used today), promises future step-change improvements to data-hungry energy processes.

Just as the sector has twice before transformed its business model using the power of computing, today's strategic goals also rely on integrating digital innovations to enable a new era of sourcing and providing energy via cleaner, more efficient mechanisms.

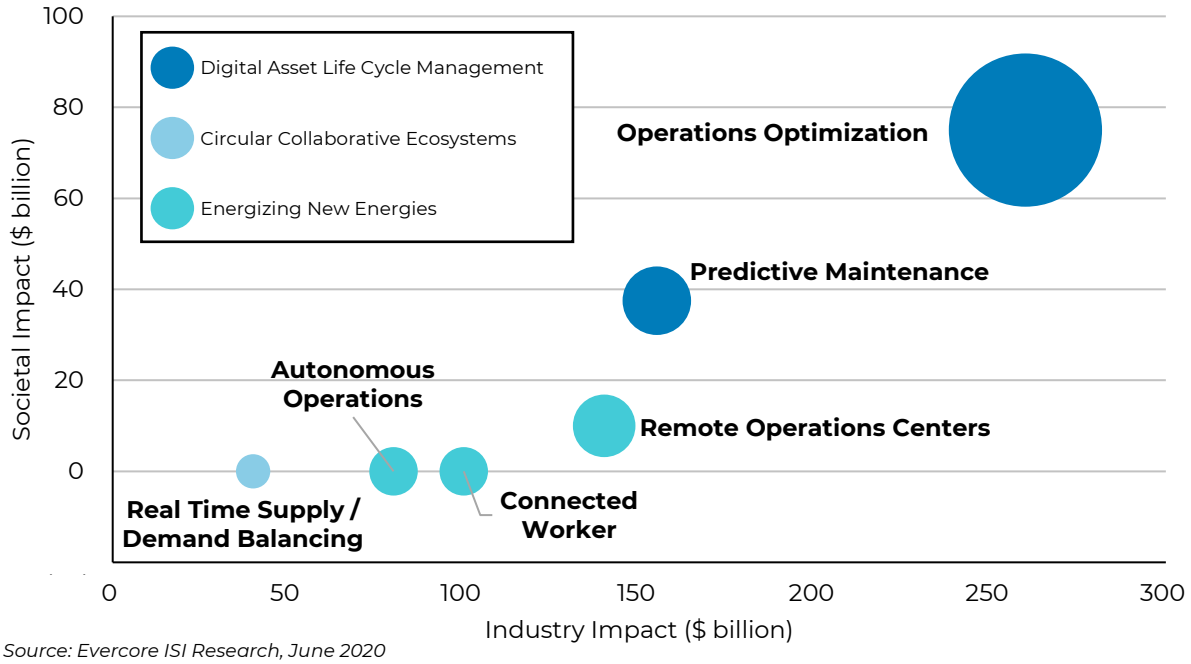
Digitalization's impact on the Energy Transition in oil and gas

We believe that industrial adoption of digital initiatives and technologies can provide significant societal benefits by moving the industry toward the Energy Transition, as well as create material economic incentives. The increased pressure from regulators, investors, and society at large provides strong encouragement to participants in the energy complex to integrate technology, data analytics, and process automation across the entire energy supply chain. In an integrated, digitalized business, data from separate steps can be analyzed simultaneously to optimize operations (e.g., by utilizing AI to decrease costs, reduce emissions, and improve production), as well as conduct predictive maintenance (e.g., increasing safety through IoT-based remote operations for the connected worker). Leveraging these technologies can enable digital management of the "Asset Life Cycle" and create a "Circular Collaborative Ecosystem", both of which can optimize energy sourcing and lead to significantly reduced emissions.

Many energy service companies supporting energy capture and production activity are targeting specific sustainability goals, in keeping with their customers' strategic objectives. In the traditional energy space, an evolution is taking place in the critical areas of operations optimization, real-time supply/demand balance, and predictive maintenance through the following initiatives: emissions reduction, reduced flaring, water conservation, human safety, and remote operations centers. Let's take a deeper dive into how digitalization helps ESG-conscious energy providers make an impact.

Operations optimization

Reduced emissions: Regulatory authorities in traditional energy producing states including Texas, Colorado, and Pennsylvania have passed stricter laws to reduce pollution and improve air quality. To encourage investments in technologies that would enable such improvements, some states approved tax incentives that render



Source: Evercore ISI Research, June 2020

switching to these innovations an obvious economic choice. One opportunity is to prevent dirty air by reducing the open-air exposure of proppants. This has been achieved by digitalizing the supply chain and automating the transfer processes of these materials from the sand mines where they are produced to the sites where they are used. Solaris Oilfield has developed the AutoHopper software platform that "automatically controls the pace of sand delivery from the silos in the blender based on the rate of sand consumed at the blender."[7] Using machine learning, the AutoHopper system predicts sand needs in real time based on blender screw speed and the level of sand in the hopper, reducing the amount of required proppant by 50%. Before the digitalization of these processes, the industry relied on pneumatic, vacuum-based transfer technologies that are known to release significant emissions.

Digitization refers to encoding analog information into zeroes and ones so that computers can store, process, and transmit such information.

Digitalization is the use of digital technologies to change a business model, i.e., moving to a digital business.

Several innovative companies are utilizing alternative fuel sources to power the growing presence of data centers. For example, Crusoe Energy Systems has developed digital flare-mitigation systems that "convert otherwise wasted or flared natural gas into electrical power."[8] The electrical power is subsequently consumed by mobile, modular data centers deployed directly at the well site in order to access the fuel source. While these methods offer cost efficiencies, they also offer environmental benefits. If not used in field operations such as the mobile data centers, the stranded associated gas would otherwise likely be disposed of via flaring.

Completion design: Traditional energy operators have options to employ innovative well completion technologies that optimize resource production. The most effective of these innovations, we believe, are those that move beyond improvements in physical technology to integrate digitalization. For example, producers can now conduct real-time sampling tests while completing a well, to determine which rock formations are most capable of production. Intertek is an energy services company that offers geochemistry fingerprint analysis using a digital data science scan (similar to other reservoir monitoring tools such as microseismic, fiber-optics, and tracers) that matches produced oil cores and cuttings to a specific production contribution database. This analysis allows Intertek to measure and visually model fracturing effectiveness, which in turn allows operators to modify the remaining steps without delaying the process. By using the minimum amount of water, proppant, and power necessary to stimulate the productive portions of the rock, the completion is optimized to generate the same amount of production while reducing environmental and cost impact.

Real-time supply/demand balancing

Water resource efficiency: A byproduct of energy production is water production and use, presenting another opportunity for digitalization. Despite the current macro environment, US onshore E&P operations are expected to continue at a pace that will generate 18 to 22 billion barrels per year of associated water production.[9] With a ratio of 8 barrels of water produced for every 1 barrel of oil,[10] the disposal of produced water is the largest operating expense for many operators, approximately 40% of regular monthly costs.[11] In addition, only 10% of produced water is useful in the operations process, meaning that even if an operator chooses to clean and recycle their produced water for on-site use, 90% of those volumes still require removal and storage.[12]

This volume of water demands sensible, integrated water logistics and transport. Several technologies have been developed that digitally automate measurement and remotely control these substantial water volumes. These software-based tools enable water management facilities to optimally inject, transport, and recycle water through sophisticated midstream logistics. Wireless sensors remotely open and close valves, verify custody transfer of fresh and produced water, and eliminate substantial water-hauling

Case Study: Adding software-enabled technology to increase impact

Flowco Production Solutions

Digitalization of the energy supply chain is not only about new digital business, but more importantly about integrating beneficial digital technologies into existing businesses. An example of this is Flowco Production Solutions, which developed and implemented software-enabled technologies that enhanced its artificial lift business (market leader in gas lift and plunger lift) and provided more efficient, cleaner energy solutions.

Artificial Lift – Clean Fuel Alternatives: Over 90% of existing wells require some type of artificial lift to lift the produced fluid to surface, where it can treated, transported, and sold.[13] The traditional artificial lift methods of electric submersible pump and many rod lift installations are powered by electricity, a costly external fuel source. However, alternative methods such as gas lift and plunger lift technologies are powered by associated gas, rather than electricity or diesel fuel.

Software-Enabled Technologies: Flowco has transformed its traditional business model (using manual intervention) into a leading innovator by developing software-enabled technologies. These digital technologies, protected by 20 patents, focus on well completion design, production enhancement, and well monitoring. Flowco's proprietary software uses nodal analysis to determine proper placement of gas injection valves. The company employs proprietary gas-lift algorithms to continuously calculate the optimal gas injection rate and plunger lift algorithms (alongside a solar-powered controller) to remotely manage the frequency and speed of a plunger fall. Flowco's software-enabled capabilities allow the operator to remotely monitor and optimize production, reducing personnel required to monitor and repair its existing facilities.

Switching producing wells from electric diesel-powered to gas-powered lift reduces annual CO_2 emissions by ~900 metric tons, a GHG emissions impact equivalent to removing ~200 passenger cars from the road each year.[14]

Through its embrace of digitalization including the continued development of software-enabled technologies, Flowco has increased its market leading position by providing more efficient, cleaner-energy digital solutions to its customers.

trucking fleets. Waterbridge, a leading player in the produced water management space, estimates that based on its utilization of water management logistics technologies, it "reduced over 95,000 metric tons of carbon emissions during 2019 alone. This reduction in carbon emissions represents the elimination of approximately 52 million truck miles from the road, or nearly 120,000 round-trip commercial flights from Houston to New York."[15]

Predictive Maintenance

Safety/remote operations centers: In addition to increasing efficiency and decreasing environmental impact, digitalization can save lives. Ongoing operations monitoring is a significant opportunity for digitalization. Today's remote and sensing technologies greatly reduce the number of personnel required for routine field operations; many such procedures no longer require humans to endure dangerous conditions simply to make manual adjustments to valves and machinery. Producing wells can be remotely monitored and maintained with IoT measurement technology. For example, Schlumberger's VX Spectra enables wireless remote, solar-powered multiphase monitoring and provides a complete feedback loop to the technical personnel who control these operations from their offices.

Predictive assistance maintenance: Several companies have also focused on developing a digital twin of existing assets to better predict potential failures and minimize downtime. For example, Baker Hughes' BHC3™ Predictive Asset Maintenance software platform utilizes a range of digital technologies including asset failure prediction, geospatial visualization across a portfolio of assets, asset-level diagnostics,

maintenance prioritization, asset renewal planning, asset health/usage monitoring, and risk management.

Together, these remote operation and predictive maintenance digital technologies reduce required personnel, minimize environmental and safety incidents, and ultimately enable a cleaner, more cost-effective maintenance and monitoring of existing assets.

Conclusion

With the global focus on moving toward a net-zero carbon future, the energy industry needs to use every available lever to make meaningful progress in achieving this goal. As an experienced adopter of high-performance computing in prior digital transformations, the energy sector (encompassing both traditional and alternative energy) is already pursuing digitalization via the integration of IoT, AI, cloud computing, and next-generation processing power computing. **We believe that digital innovation together with operational innovation is an essential partnership that will continue to generate environmental, efficiency, and safety benefits, as well as make good business sense for the entire energy sector.**

Contact GEC to learn more:

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