FUTURE ENERGY IS HERE: Digitalization in Oil & Gas Industry

June 2017
1. Key highlights

Digital technology has a major part to play in the next stage of structural cost reduction. In expectation of more modest oil & gas prices than in the past, improving the level of digitalization is one of the ways that the oil and gas industry can stay competitive. Today, only 3-5% of oil and gas equipment is integrated and less than 1% of data is utilized to make decisions, leaving companies with significant potential to optimize assets and operations. Out of 93mln bpd of oil output, only 9-18mln bpd come from oil fields that are digitally enabled. Top national oil companies, which are responsible for 40% of world oil output, produce only 15% of output using digital technology.

* NOCs – national oil companies, IOCs – international oil companies

Source: Ernst & Young “How ready are your assets to perform in the digital world?”

Digital technology creates value within the oil and gas context by enabling better and faster operational decisions, leading to greater asset utilization, reduced operating costs and increasing efficiency. It can simplify and synchronize processes and accelerate integrated decision-making. Smarter decisions lead to faster incident correction and prevention, as well as greater insight into operations and collaboration.

The oil & gas industry is expected to generate USD1.1trln in digital value at stake from 2015-2024. The global smart oilfield market is expected to grow at a CAGR of more than 4% by 2020. Smart oilfield services are forecasted to increase the NPV of an oilfield by 25% by reducing exploration and production costs and shortening schedules, increasing productivity, and reducing downtime.

Oil & gas companies in Kazakhstan lag behind its Russian peers in terms of the level of digitalization. Total investments in digitalization of oil & gas industry in Russia may reach USD0.5-2.0bln annually during the next 5-15 years. The implementation of such projects requires substantial investments, and thus a revision of investment programs, which were recently cut down due to low oil prices. The key obstacles to allocating funds on digital projects are uncertainties associated with achieving positive effects. We recommend to start by deploying digital in areas where the technology can affect the cost curve in the short term and deliver immediate results.

There are still challenges in introducing digital technologies in Kazakhstan especially in the area of qualified human resources. This can be resolved by hiring foreign specialists or by forming corporate (governmental) competency building and development system on integrated modelling and integrated operations. Digitalization challenges increase substantially with the age of oil field and level of reserves.
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2. Digitalization in oil & gas industry

Despite the penetration of digitalization, not all industries are responding to the challenges and opportunities. In contrast to industries such as media and retail, where digital technology has been a significant disruptive force, process-oriented industries such as energy, transportation, industrial goods, have yet to experience its full effects. Currently, energy companies lag behind other industry companies in terms of adoption of and accessibility to digital technology, representing huge growth potential in this area moving forward.

Energy companies currently still lagging in the digital trend

Returns in oil & gas sector are low compared to other sectors. Lack of penetration is one of the drivers of low returns. Out of 93mln bpd, only 9-18mln bpd is produced using digital technology. Top national oil companies, which are responsible for 40% of world oil output, produce only 15% of output using digital technology.

Rest of NOCs and independents (40% of output)  Top NOCs 16 companies (40% output)  IOCs 9 companies (20% output)

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Source: Ernst & Young “How ready are your assets to perform in the digital world?”

Today, only 3-5% of oil and gas equipment is integrated and less than 1% of data is utilized to make decisions, leaving companies with significant potential to optimize assets and operations. Now, it is time to accelerate investment in the digital technology, as technology cost continues to decline. In expectation of more modest oil & gas prices than in the past, improving the level of digitalization is one of the ways that the oil and gas industry can stay competitive. This also allows the industry to improve
efficiency and safety, and reduce costs, while relying on higher oil prices to drive growth and returns is risky. Reducing unplanned downtime is one key opportunity areas for oil & gas through digitalization.

**WTI spot price vs. technology costs**

*Source: E&Y*

3. **Digital (smart) well and oilfield**

In the last few years, the need to produce cheaper and more oil from a reservoir has resulted in the development of a variety of technologies to better measure and control the production process through the wells. Typically, these technologies are installed within the well and can be operated remotely. Flexibility of smart well enabled it to adapt to changes in the oil-water and gas-oil contacts, in the reservoir properties, the completion of new wells, failure and maintenance in neighboring wells, maintenance and problems in the facilities.

Digital oil field technologies allow companies to capture more data, with greater frequency, from all parts of the oil and gas value chain and analyze it in real or near-real time, thus optimizing reservoir, well, and facility performance. These engineering-based and information-based technologies can have a profound positive or negative impact on human capital efficiency depending on how they are introduced and embedded into the organization.

**Schematic description of a smart well**

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These smart oil fields allow to manage production process and assets based on automation, integrate between processes with financial indicators and other indicators. It is worth noting that there is no ideal smart field globally, each company develops and implements those elements of digital and intellectual technology, which are most appropriate for the field.

The first smart field abroad was activated in 2001, while in Russia in 2008. Shell and BP are leading companies in terms of introduction of smart field technology. As a result of application of integrated operations at BP, the flow rate of producing wells increased by 2.5-5.5%, while labor costs declined by a quarter. At Saudi Aramco, indicators such as labor costs and the number of onsite visits fell by almost a third.

Chevron was able to improve its workover efficiency by 5-10% and decrease on site visits to oil fields by 30%. The company was also able to reduce the non-production times thanks to real-time data analysis and the adaptation of technical means deployed, hunting unexpected variations in pressure gradients. For Chevron, even though investments in digital hydrocarbon fields amounted to USD5bln during the first 5 years of the project, then several hundreds of millions in the following years, benefits reached USD700mln in 2013 and are estimated at USD1bln per year from 2016 on. Production sites show improved profitability up to 4% for the production rate and 6% for the global recovery rate, as well as a reduction of operational costs reaching 25% for a global cost of projects diminished by 2 to 4%.

Enhanced oil recovery and extraction methods accounts for 70% of innovative solutions used by oil & gas companies, while the share of intellectual methods of improving production management amounts to 30%. According to Cambridge Energy Research Associates (CERA), introduction of intellectual technology will increase average oil recovery until 50%.
4. Digitalization in oil & gas industry in Kazakhstan

Nowadays, in Kazakhstan the trend of introduction of smart field technology is slow, but positive. Currently, oil & gas companies in Kazakhstan lag behind its Russian peers in terms of the level of digitalization. As of January 2015, the number of smart fields globally has reached 240, while 27 of them were in Russia, including 10 at Rosneft, 7 at Gazprom, 5 at Lukoil, and one at Tatneft.

EP Kazmunaigas (KMG EP) is now adopting technology of smart fields, optimizing logistics processes and equipment maintenance at its subsidiary companies. Also, the company approved the project in increase of the efficiency of oil production at some fields. Successful implementation of these projects will be scaled to whole KMG EP.

4.1 Smart fields at Embamunaigas

In 2015, KMG EP implemented “smart field” project at its subsidiary, Embamunaigas’s Uaz field, which was a pilot project. At all stages of oil production at the Uaz field, equipment has been installed that takes readings and delivers them in real time to the control center. The whole cycle of oil production and processing at Uaz field is equipped with complex remote touch and control system with technological parameters in online mode. The well parameters are broadcast to the control center. Simultaneously, all the data recorded is submitted to the Center of visualization of production processes at Embamunaigas (EMBA), where it is analyzed and based on which long-term planning is being introduced.

The project allows to promptly identify the location of oil leak, to improve the quality of identifying the reasons of oil leakage, to control production equipment, to boost the effectiveness of producing and injection well stock, and to reduce operating expenses and costs. According to the preliminary forecast, production at the Uaz field could be increased by about 3% thanks to the smart field project, the time required to repair wells will be cut by 15-20%.

Installation of Smart control system at EMBA

Source: Danfoss

The implementation of “smart field” at Uaz allowed to reduce the electricity consumption by 32%, to increase active well utilization rate and consequently, to reduce the number of well remedial
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maintenance operations. Currently, records of oil extracted are kept for each field. For a detailed assessment of the effectiveness of the project a considerable time period is required.

The smart field concept after its testing at EMBA was considered by investment committee of NC Kazmunaigas. The company decided to extend the implementation of this project at other fields of the group of companies of EP Kazmunaigas, such as Uzen, Karazhanbas, S. Nurzhanov, Aktobe and others.

EMBA performed a pilot test using Sensorless Artificial Lift Technology (SALT). This technology is a well automation and control system that minimizes energy consumption, helps reduce mechanical failures, maximizes or optimizes production, and is cost effective; a control system that automatically makes intuitive adjustments to match the well’s productivity, prevents loading violations, and minimizes costly shutdowns; an automation system that helps mitigate well intervention, minimizes energy consumption, and provides a more favorable return on investment.

4.2 Smart control system at Ozenmunaigas

In 1H14, Ozenmunaigas introduced a smart control system as a part of the modernization project of 300 wells in 12 oilfields. There are more than 3,000 wells at the company. Supervisory control system (SCM) “Smart control system for sucker-rod pumping unit” is provided for supervisory control and telemetering, optimizing operating modes of the sucker-rod pumping units of oil rigs. This is a distributed system which consists of two main levels. The lowest level implements the function of smart control station of sucker-rod pumping units. The highest level consists of SCM server and operators’ automated workstations (AWS). The data between SCM server and control station is exchanged via GSM communication.

**Supervisory control system structure**

![Supervisory control system structure](image)

Source: Siemens
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The main benefits of SCM are a decrease of electricity expenses, operating expenses, improvement of working conditions and efficiency of oil production. Improving efficiency of oil production is achieved by increasing filling of the plunger with formation water to the maximum level by automatically forming optimum pattern of change of the pumping frequency within the time base. The most important point is that the operation visibility of the sucker-rod pumping unit allows to diagnose preaccidental situations or accidents in the ground and underground downhole equipment. This helps to extend the life span of mechanical downhole equipment. The selection of the most optimal operating modes for the sucker-rod pumping unit allows to reduce electricity consumption due to an increase of total KPI of SRPU by increasing pump filling rate and by using frequency controlled drive with recovery function.

4.3 State program on “Digital Kazakhstan”
Industrial sector has a high level of equipment deterioration (49% on average), low level capacity utilization (61%) which imply low labor productivity, poor and obsolete technical level of equipment. This requires a gradual modernization and inauguration of new information and IoT systems.

Within the framework of the state program on “Digital Kazakhstan”, the “national database” of mineral resources is planned to be established as a foundation for the information and communications technology (ICT) infrastructure. This will help to protect data on resources, collected from current subsoil users and to attract new investments by providing this data for potential investors. This will also allow to improve transparency in governance of mineral resource complex due to automation of the process of granting right on subsoil use. Moreover, the creation of the “national database” will allow to introduce monitoring and accounting treatment system of mineral database in real-time.

Currently, the government has only an access to the data on oil pumped to the custody transfer metering station, taking into account losses estimated based on the approved standards. Mineral extraction tax (MET) is calculated based on the oil volume at the oil metering station. We do not rule out that there may be losses and theft while transporting oil from field to the oil metering station, which might reach 10-12%. Therefore, the improvement of hydrocarbon accounting system and the creation of the state accounting information system is important.

5. Why invest in digital technology?
According to Gartner, leveraging digital technologies to improve business performance remains a top priority for oil and gas chief information officers. Chairman and chief analyst of Wood Mackenzie stated that digital technology has a major part to play in the next stage of structural cost reduction. PWC claims that digital is a critical capability to accelerate operational efficiency and drive margins in oil & gas.

It is estimated that the oil & gas industry will generate USD1.1trln in Digital Value at Stake from 2015-2024. While digital technologies and processes can improve efficiency and cost savings throughout the oil and gas value chain, the research analysis indicates that they can make the biggest impact in upstream operations: improvements in recovery efficiency and production automation drive the largest benefits.
Six areas of digitalization exist for significant value creation in upstream operations

**Oil field technology**

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<th>Data management</th>
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*Source: PwC*

The main benefits are optimization of expenses, minimization of losses, and maximization of oil output.

1) With the help of integrated model the level of oil output and oil recovery rate can be forecasted, operating and capex expenses can be optimized.
2) It becomes possible to adapt flexibly to conditions, where oil production is carried out, and provides in real time adjustments to the production planning.
3) Leading oil & gas companies in digital oil production are more resilient to highly volatile oil market.
4) Digital technology allows to increase the average oil recovery at oilfield with light crude oil by 30-50% due to a substantial decline of operating costs and relevant reserves growth.

The global smart oilfield market is expected to grow at a CAGR of more than 4% by 2020. Smart oilfield services are forecasted to increase the NPV of an oilfield by 25% by reducing exploration and production costs and shortening schedules, increasing productivity, and reducing downtime. Furthermore, smart oilfield services also improve worker safety and health and extend the lifetime of brownfield, which in turn will impel the growth prospects for this market segment until the end-2020.
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The journey to value for oil & gas companies

* NPT means non-productive time

Source: GE oil & gas

6. Top areas of digitalization where oil & gas companies should focus on:
   - **Recovery efficiency:** Enhanced oil-recovery techniques include permanent reservoir monitoring and advanced analytics of 4D seismic data analysis.
   - **Lifting-process automation:** Automate and remote manage the production process, and streamline operations through accurate measurement of critical field parameters such as pressure, flow rate, and temperature in near-real-time.
   - **Remote monitoring:** Early detection and swift reaction to leakages, theft, and rig downtime through remote monitoring. Also supports faster problem resolution by spotting the exact failure code prior to dispatching a technician.
   - **Drilling optimization:** Data management and Big Data analytics drive efficiencies through standardization and simplification. This reduces non-productive learning time and enables faster well execution.
   - **Project planning:** By using Big Data analytics to improve project outlay estimates, firms can prevent cost escalations.

The production growth rate depends on the efficiency of the chosen technical solution. Thus, methodological approach is required to determine the economic efficiency new equipment. A sample set of technologies that are receiving universal industry acceptance includes the following:

- Remote Real-Time Facility Monitoring and Control;
- Real-Time Drilling;
- Real-Time Production Surveillance;
- Intelligent Wells;
- 4-D Visualization and Modeling;
- Remote Communications Technology;
- Integrated Asset Models;
- Workflow and Knowledge Management Systems;
- Production Volume Management Systems.

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*NPT means non-productive time

Source: GE oil & gas

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* The Non-Production Times is a very high cost item for exploring and producing hydrocarbons. They are reduced thanks to real-time data analysis and the adaptation of technical means deployed, hunting unexpected variations in pressure gradients, which are still accountable for nearly 40% on NPT nowadays.
Total investments in digitalization and intellectualization of oil & gas industry in Russia may reach USD0.5-2.0bln annually during the next 5-15 years. In Russia, smart injection and commercial wells construction technology, establishment of real-time operations centers and fiber system for collecting, data transfers and management parameters are mostly in demand.

7. Key challenges

1) Digitalization challenges increase substantially with the age of oil field and level of reserves.

2) Lack of highly qualified human resources affects the intellectualization process of oilfields. This can be resolved by hiring foreign specialists or by forming corporate (governmental) competency building and development system on integrated modelling and integrated operations.

3) Technical readiness of Kazakh oil & gas companies to introduce digital technologies is high. Moreover, some of them are implementing pilot projects. The implementation of such projects requires substantial investments, and thus a revision of investment programs, which were recently cut down due to low oil prices. The key obstacles to allocating funds on digital projects are uncertainties associated with achieving positive effects, while the examples of successful stories in implemented projects by international peers are insufficient substantiation.

8. International practices

8.1 Smart fields at Salym Petroleum Development

Optimization of oil production, enhanced oil recovery, reduction of operating costs - all these are the results of the introduction of Smart Fields technology systems in the Salym group of oilfields. SPD has managed to improve production by 2–2.5% per year on average and reduced unscheduled downtime, and the average failure free performance period of the well equipment has increased.

Before operators used to regularly visit well pads and managed to service 15-20 wells, nowadays the operator spends most of the time in the office, being responsible for 30-40 wells. This has become possible due to the implementation of “smart fields”. Smart Field technology allows real time data transfer from wells to the control unit. Consequentially, the number of operator visits to the well pads decline considerably, allowing the operators to respond faster to the performance of the well equipment.

The implementation of Smart Field technology allowed SPD to create an integrated production model, which represents a reliable foundation for further projects targeting oil production growth. This system allowed the whole well and reservoir cycle to be integrated in one loop. SPD specialists receive information in real time, process this information using well stock integrated control instruments, identify the corrections needed for each well via an automatic control system.

8.2 Smart field management at Statoil

Statoil is the Norwegian largest oil & gas producer, which needed a way to offset the natural trend toward declining production levels. Statoil sought to incorporate new technologies into production processes in order to transform, streamline and improve them. Compared with a worldwide average recovery rate of 35%, Statoil sought to increase its rate to 55% for sub-sea platforms and 65% for fixed platforms. Statoil teamed with an industry consortium that includes IBM, ABB, Aker Kvaerner and SKF to combine advanced sensing technology with integrated operations to optimize the management of its oil and gas fields.
IBM provides the key elements required for Statoil to implement “smart field management” practices. Using data from wireless sensors, which monitor subsurface conditions, such as the pressure, temperature at different points in the field, the movement of gas or oil deposits within the field, the solution provides Statoil's engineers with the information they need to know when, where and how much to pump. By combining information from all of its production facilities, Statoil gains a much more comprehensive view of the state of its oil fields, vastly improving its ability to optimize its extraction activities.

9. Conclusion

Digital technology has a major part to play in the next stage of structural cost reduction. Today, only 3-5% of oil and gas equipment is connected and less than 1% of data is utilized to make decisions, leaving companies with significant potential to optimize asset and operations.

The global smart oilfield market is expected to grow at a CAGR of more than 4% by 2020. Smart oilfield services are forecasted to increase the NPV of an oilfield by 25% by reducing exploration and production costs and shortening schedules, increasing productivity, and reducing downtime. Furthermore, smart oilfield services also improve worker safety and health and extend the lifetime of brownfield, which in turn will impel the growth prospects for this market segment until end-2020.

Nowadays, in Kazakhstan the trend of introduction of smart field technology is slow, but positive. Currently, oil & gas companies in Kazakhstan lag behind its Russian peers in terms of the level of digitalization. The implementation of “smart field” at some fields will reduce the electricity consumption by 32%, increase active well utilization rate and consequently, reduce the number of well remedial maintenance operations. The most important is that it allows to diagnose preaccidental situations or accidents in the ground and underground downhole equipment.

Technical readiness of Kazakh oil & gas companies to introduce digital technologies is high. The implementation of such projects requires substantial investments, and thus a revision of investment programs, which were recently cut down due to low oil prices. The key obstacles to allocating funds on digital projects are uncertainties associated with achieving positive effects, while the examples of successful stories in implemented projects by international peers are insufficient substantiation.

There are still challenges in introducing digital technologies in Kazakhstan in relation to highly qualified human resources. This can be resolved by hiring foreign specialists or by forming corporate (governmental) competency building and development system on integrated modelling and integrated operations. Digitalization and intellectualization challenges increase substantially with the age of oil field and level of reserves.

The introduction of such technologies is impossible without integrating people, technology and business processes. The application of “smart” and integrated technologies allows the specialists to exchange the knowledge more effectively, which finds its reflection in the productivity of the operations and makes it possible to take considered and accurate decisions ensuring the largest profits.
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