India Oil & Gas Summit

“Navigating the Future through Technology & Innovation
Drive Energy Efficiency & Sustainability”

28 August 2019
Embrace Innovation or Get Left Behind

Evidences from history suggest that companies who have adopted advanced technology survive and grow. The financial performance of Oil & Gas companies started declining in 2005 when productivity was declining, costs were increasing and competition was getting intensified, even when crude oil prices were increasing.

Innovative Technology helps hydrocarbon industry in two main fronts:

- To enhance the short-term production levels, thereby reducing cost per barrel
- Reducing capital and operating expenses

a) Role of Emerging Technologies in Oil & Gas Sector

Enhanced oil recovery, unconventional gas and oil extraction techniques are perceived as the emerging technologies that can have a significant impact on the Oil & Gas industry.

**Figure 1: Impact of Technology on the Oil & Gas sector**

- **30%**
  - NEW EOR Technologies increase recoverable volumes by

- **30%-50%**
  - Advanced Seismic Technologies can pinpoint the deposits with accurate precision

- **35%**
  - Innovative technologies can increase recoverable volumes by

- **25%**
  - Advances in drilling, digital technologies and subsurface imaging can reduce cost of oil supply

*Source: Significance of Innovative Technologies in Oil & Gas Sector*
Innovative technologies increase efficiency and enhance reliability and safety at higher risk zones. Other technologies worth mentioning are automation and mechanization of capital-intensive repetitive oil and gas activities, data driven analytics to analyze the high-volume data, robotics and unmanned systems to access difficult offshore areas and optimization tools – simulation and modeling tools to run equipment close to their designed capacities.

Another innovation that has become prominent in the Oil & Gas industry is IIoT (Industrial Internet of Things). IIoT is a system of interconnected computing, digital and mechanical devices, individuals or other objects that are furnished with unique identifiers and can communicate data on a network without interaction between human to human/computer.

b) Digital Transformation in Oil & Gas Sector - Value at stake Analysis

**Figure 2: Value at stake Analysis**

- Digitalization could create approx $1.6 trillion of value for the Oil & Gas industry
- Digital Transformation has the potential to create benefits worth $640 Billion for the wider society
- Environmental benefits: reducing CO2 emissions by 1300 million tonnes, saving about 800 million gallons of water
- Digitalization helps in avoiding Oil spills worth about 230,000 barrels of oil

*Source: World Economic Forum*

**Figure 3: Investment in Digital Technologies**

- **TOP AREAS OF FOCUS OVER THE NEXT 3 TO 5 YEARS**
  - Big Data/Analytics: 36%
  - IoT: 38%
  - Mobile Devices: 44%
  - Cloud: 57%

- **FASTEST AREAS OF GROWTH OVER THE NEXT 3-5 YEARS**
  - Robotics and Drones: +15%
  - Artificial Intelligence: +7%
  - Wearable Technology: +10%
  - Collaboration and Social Tools: +20%

*Source: World Economic Forum/Accenture Digital Energy Trends*
In Figure 3, the percentages in the bars show the proportion of Oil & Gas companies surveyed. About 36% of Oil & Gas companies have already invested in Big Data Analytics and only 13% of them use the insights from the technology. The difference shows that the companies have not embedded Big Data Analytics into their system completely.
Future of IIoT in Oil & Gas Industry

The Internet of Things (IoT) is constantly enhancing the efficiency, profitability and revenues of the Oil & Gas sector. IoT applications in the industry are predicted to boost crude output by 10 percent over a two-year period, increase profits by $1 billion for large O&G companies and increase GDP by 0.8 percent or $816 billion, over the next decade.

Figure 4: Impact of IIOT in the sector

Source: How internet of things is powering Oil & Gas industry

a) Advantages of IIoT in Oil & Gas sector

- Big Data Analysis and remote visibility will help companies better manage their assets and use their findings to optimize production.
- IIoT can reduce troubleshooting time from days to minutes, which leaves more time to spend on other operational aspects of the business.
- According to Oxford Economics, industry-wide adoption of IIoT will increase the global GDP by as much as 0.8% in the next decade.
- With IIoT integration, the oil production can be captured in real-time through embedded sensors and the right automation of data communications
systems, enables companies to gather information from assets anywhere and make informed decisions.

- IIoT can lessen risk taken by identifying potential issues before they become actual problems or safety hazards.
- IIoT adoption can significantly reduce the environmental impact of the oil and gas industry. E.g. Using less energy, avoiding oil spills and other accidents, and emitting less carbon

b) How IIoT Technology is creating value for Upstream, Midstream and Downstream companies

- **Upstream**: IoT technologies are helping businesses protect valuable in-field assets. Extraction sites are filled with highly complex and expensive equipment where inexpensive IoT devices are installed to remotely monitor equipment, track maintenance schedules, and prevent malfunction. If a piece of equipment begins to malfunction or underperform, the IoT device will instantly issue an automated alert. These limit losses caused by inefficiency and help prevent full-scale failures and equipment damage.

- **Midstream**: IoT device can be deployed in the field to remotely monitor essential compliance metrics, such as oil leaks and gas emissions. As a result, this reduces the costs associated with field monitoring and is much more responsive. IoT devices limit an oil & gas company’s exposure to penalties by allowing them to respond to leaks proactively.

- **Downstream**: IoT devices provide distributors with real-time data, distributors use this information to predict consumer consumption in future weeks, months and years. Example, real-time data has helped TankClarity in improving their relationship with oil distributors and creating an ecosystem that is valuable to both suppliers and customers.

*Figure 5: Advantages of IIoT in different sectors*
Emerging Technologies in Upstream, Midstream & Downstream

a) Upstream Sector

Digitalization or the Fourth industrial revolution, helps the Upstream sector in achieving various goals like – exploration, appraisal, concept development, project definition & execution, drilling and production. Figure 6 shows some industry solutions that will help the Upstream sector achieve these goals.

**Figure 6: Industry solutions to help upstream sector**

- Geological data analyzing
- Digital Modelling
- Digital Twin building
- Project predictive analyzing
- Project data analyzing
- Autonomous material transporting
- Remote Surveillance
- Automated Drilling
- Predictive maintenance
- Reservoir real time monitoring
- Reservoir model real time update
- Remote Surveillance

Source: The disruption in Oil & Gas upstream business by Industry
Exploration companies can build capacities to analyze geological data by digitizing all the data and knowledge collected. Using advanced analytics and machine learning techniques provide exploration teams with relevant insights.

When advanced analytics and digital modelling are used, they create a digital framework that can generate and evaluate an exhaustive number of projects. Hence companies can choose the projects according to their chosen parameters.

Digital Twin technology is used in production processes to provide comparisons between actual and ideal as well as provide a safe environment for upskilling and innovating. It can be used by energy producers even in subsurface Oil & Gas exploration and production.

Digital solutions enable better coordination among different stakeholders involved in executing and automating drilling. For instance blockchain technology can set the standards of collaboration among service providers and boost data security by enabling secure sharing. Blockchain also saves cost by eliminating transaction fees.

Fourth Industrial Revolution helps the upstream companies to digitally connect operational assets and evaluate asset performance for damage, efficiency and maintenance needs.

**Figure 7: Technology advances Changing the recoverable volume**

![Graph showing cost per barrel of oil equivalent vs technically recoverable volume](image)

Technology improvement to 2050 will enable us to recover more resources than we can today.

Technology innovation will enable us to access resources more cost effectively and they will have a major impact on unconventional resources that today are high cost and complex to recover.

*Source: BP*
By applying the best technologies to conventional fields including unconventional resources, the technically recoverable Oil & Gas resource base could be increased by about 1.9 trillion boe to 4.8 trillion boe. The developments taking place between now and 2050 will also drive improvements in field recovery factors. Technology improvements will not only extend supply from current Oil & Gas resources, but will also open access to resources in inaccessible geographies. Advances in technology could reduce industry extraction cost by 25% by 2050.

Example: The most significant change in the Oil & Gas Industry in the past decade has been development of production from shale and tight rocks.

New technologies in the oil and natural gas sectors have enabled the explosion of production growth in the United States known as the Shale Revolution. A combination of hydraulic fracturing and horizontal drilling allows producers to access reserves of oil and gas from low-permeability geological formations that were previously too expensive to extract. The diffusion of new oil and gas production technologies is not limited to the United States. Unconventional hydrocarbon reservoirs are already being exploited in Canada, South America and Africa as price signals send international oil companies to new frontiers in search of higher profits. The most significant of these new production technologies include tar sands and deep-water water drilling.
b) Midstream Sector

As new oil and gas technologies, namely fracking and horizontal drilling have been introduced; crude is being produced faster than the market demand which is creating pressure on midstream companies like those operating out of Cushing to keep pace with more productivity and efficiency. Hence midstream companies depend on Mobile solutions.

**Seven ways in which Mobile Solutions support the Midstream companies**

<table>
<thead>
<tr>
<th>Manage Real-Time location of Assets</th>
<th>Mobile applications with GIS/GPS tracking can provide the management team with a full picture of the real-time location of Oil &amp; Gas assets and their status, empowering more accurate financial reporting and supply estimates</th>
</tr>
</thead>
</table>
| Easier compliance with health and safety observation regulations | - For drivers mobile application with GPS helps in identifying the route with the least traffic and lowest chance of the inclement weather.  
- Improving the safety of drivers and operators becomes more cost efficient by using a mobile application |
| Mobilize SCADA data to shorten response times | - Mobile applications providing real time data can exponentially increase the response to potential incidents |
| Make “Safety walks” more actionable | - Instead of relying on a safety walk to monitor equipment, a mobile application can translates that data into actionable insights for the supervisor, allowing him or her to anticipate an incident and respond quickly |
| Decrease Asset downtime by mobilizing asset data | - Having data readily available can make the alert process and response time to a failing asset much more efficient |
| Tighten communication loops for crucial information | - Push notifications, BLE beacons, messaging—communication between teams, as well as with their machines, becomes much more streamlined with mobile technology |
| Create more accurate forecasts | - Real-time operations monitoring dashboards provide more accurate forecasts of projected performance |
c) Downstream Sector

The main aim of technology and innovation in Downstream sector is to increase flexibility and efficiency of refining cycles, to process unconventional crudes and to produce fuels with minimal environmental impact.

Main efforts in the Downstream R&D are listed below:

**Innovations in Refinery**

<table>
<thead>
<tr>
<th>Advanced Control and Analysis Technologies</th>
<th>Fuel Specifications</th>
<th>Heavy oil production and upgrading</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Necessary for optimization of operations and blending of products.</td>
<td>• The refinery industry has to achieve two goals: minimize sulphur content on gasoline &amp; heavy fuel oil and Reduce aromatic components in gasolines and in gasolis. • These goals could be reached through several technologies, the majority of which are based on high pressure hydrogenation processes (desulphurization, hydrocracking, mild hydrocracking).</td>
<td>• Conventional technologies like visbreaking, thermal cracking and delayed coeking were used for upgrading of crude oil. • New technology is now focussed on heavy residue catalytic conversion.</td>
</tr>
</tbody>
</table>

**Innovations in Petrochemical industry**

The focus of research carried out in this sector is on increasing the flexibility of technologies to ensure production continuity using various feedstocks, improvement of both chemical and energy efficiency to reduce the impact on the environment.
R&D initiatives in India by downstream majors:

- Technology developed by Indian downstream majors include hexane hydrogenation process for production of food-grade hexane with indigenous catalyst, diesel hydrotreatment technology and isomerization technology for meeting gasoline quality requirements, etc.

- INDMAX technology developed by Indian Oil can convert heavy distillate and residue into LPG/light distillate products. This technology has been implemented successfully at Guwahati and Bongaigaon Refineries.

- The major focus of Indian refiners is development of refinery process technologies, catalysts development for refining processes, refinery process modelling, optimization in refineries, material failure analysis, corrosion and remaining life assessment, etc.

- The major focus of R&D in lubricant technology includes development of lubricants, greases and specialties, as well as boundary lubrication, metal working tribology and fuel additives, etc.
Case Study 1: Repsol - Deploying Cognitive Computing in Upstream Operations

Repsol has collaborated with IBM to bring Cognitive computing to the upstream business. Companies spend millions to drill a single offshore well and only 20-25% of wells are successful due to limited information available.

Cognitive technologies can carry out target analysis and simulation, reducing the risk involved in these operations.

Repsol has invested in two prototype applications designed to augment its strategic decision making- in optimizing oil reservoir production and acquiring new oilfields. The cognitive technology helps Repsol to increase its current Oil and Gas field productivity and minimize exploration risks during searches for new resources.

Case Study 2: Apache - Using Predictive Maintenance to Anticipate Critical Equipment Failures

Apache Corporation is a US-based independent Oil & Gas company which is using predictive analytics to anticipate failure of critical pumping equipment, such as electronic submersible pumps (ESPs).

The firm has tied up with Ayata to implement this solution. ESPs have been a source of operational challenges, and ESP failure had been causing losses of 10,000 barrels a day for Apache. To tackle these issues, a collaborative industry database (Electric Submersible Pump-Reliability Information and Failure Tracking System) was set up which documented and quantified the locations and operating conditions of more than 100,000 pumps.

Using this data, Apache identified 40 actionable variables to improve its ESPs. As a result, production losses reduced, output increased which was made possible due to higher overall equipment uptime.
Digital Transformation in India – Oil & Gas sector

Recent commercialization and development in technologies like IoT, Big data and Analytics have huge potential to move Oil & Gas companies beyond sluggish growth. According to a survey conducted by FIPI the following trends were observed-

Figure 8 shows the top priorities from digital transformation, among which 60% of the responses were around 3 priorities- improve customer experience and engagement, transform the business and reducing cost of operations.

![Figure 8: Top Priorities from Digital Transformation](image)

Source: FIPI

According to the survey in Figure 9, the Top 3 technologies that can transform the industry are - Big Data and Analytics, Internet of Things and Machine learning.

![Figure 9: Emerging Technologies](image)

Source: FIPI
According to FIPI’s assessment, possible areas for innovation were identified as:

- Intelligent Asset Management and Safe Operations
- Collaborative and Ecosystem Based Approach
- Energy Outcomes for Customers
- Step Change in Productivity
- Operational Transformation

The survey also demonstrated few challenges which organizations could face. Figure 10 shows Top 3 challenges faced – Organization readiness, demonstrating business value and lack of knowledge of emerging technologies.

**Figure 10: Challenges faced by Oil & Gas companies**

![Bar chart showing challenges]

Source: FIPI

**Figure 11: Key points for Managing Digital Transformation**

- Support from senior management for transformation
- Dedicated fund to support digital led innovations
- Economics of the solution
- Skill set of people should be augmented. Training and education for new technologies
- Cloud is a reality and needs to be explored
- Large scale enablement for all the employees to make them aware of new technologies and their possibilities
Conclusion

The three main drivers of technology and innovation are Increasing Efficiency, Reducing Cost and Reducing Environmental Impacts.

According to Oil & Gas Authority (2016), the industry has comparatively slow adoption rates due to low technology focus and R&D funding. The Oil and Gas industry is resistant to change and extremely slow in adopting the innovative technologies. The slow adoption of innovative digital technologies leads to:

(1) Lower oil & gas production by 2 - 8%
(2) Higher capital cost by 1 - 3%
(3) higher operating cost by 5 - 25%

The non/slow adoption of automation and communication technologies can increase the OPEX by 70% and CAPEX by 3 - 15%. (Blair, 2016).

In the current scenario, Oil & Gas companies should not focus on cutting down the cost, instead the focus should be on adopting the new technology for competitive advantage in future. To become competitive with other sources of energy, the industry must accelerate its rate of adoption of innovative technologies.
For more information, contact:
Gurpreet Chugh
Gurpreet.Chugh@icf.com
Ankit Gupta
Ankit.Gupta@icf.com

Visit us at icf.com/india

About ICF
ICF (NASDAQ:ICFI) is a global consulting services company with over 5,500 specialized experts, but we are not your typical consultants. At ICF, business analysts and policy specialists work together with digital strategists, data scientists and creatives. We combine unmatched industry expertise with cutting-edge engagement capabilities to help organizations solve their most complex challenges. Since 1969, public and private sector clients have worked with ICF to navigate change and shape the future. Learn more at icf.com.

Any views or opinions expressed in this white paper are solely those of the author(s) and do not necessarily represent those of ICF. This knowledge paper is provided for informational purposes only and the contents are subject to change without notice. No contractual obligations are formed directly or indirectly by this document. ICF MAKES NO WARRANTIES, EXPRESS, IMPLIED, OR STATUTORY, AS TO THE INFORMATION IN THIS DOCUMENT.
No part of this document may be reproduced or transmitted in any form, or by any means (electronic, mechanical, or otherwise), for any purpose without prior written permission.
ICF and ICF INTERNATIONAL are registered trademarks of ICF and/or its affiliates. Other names may be trademarks of their respective owners.