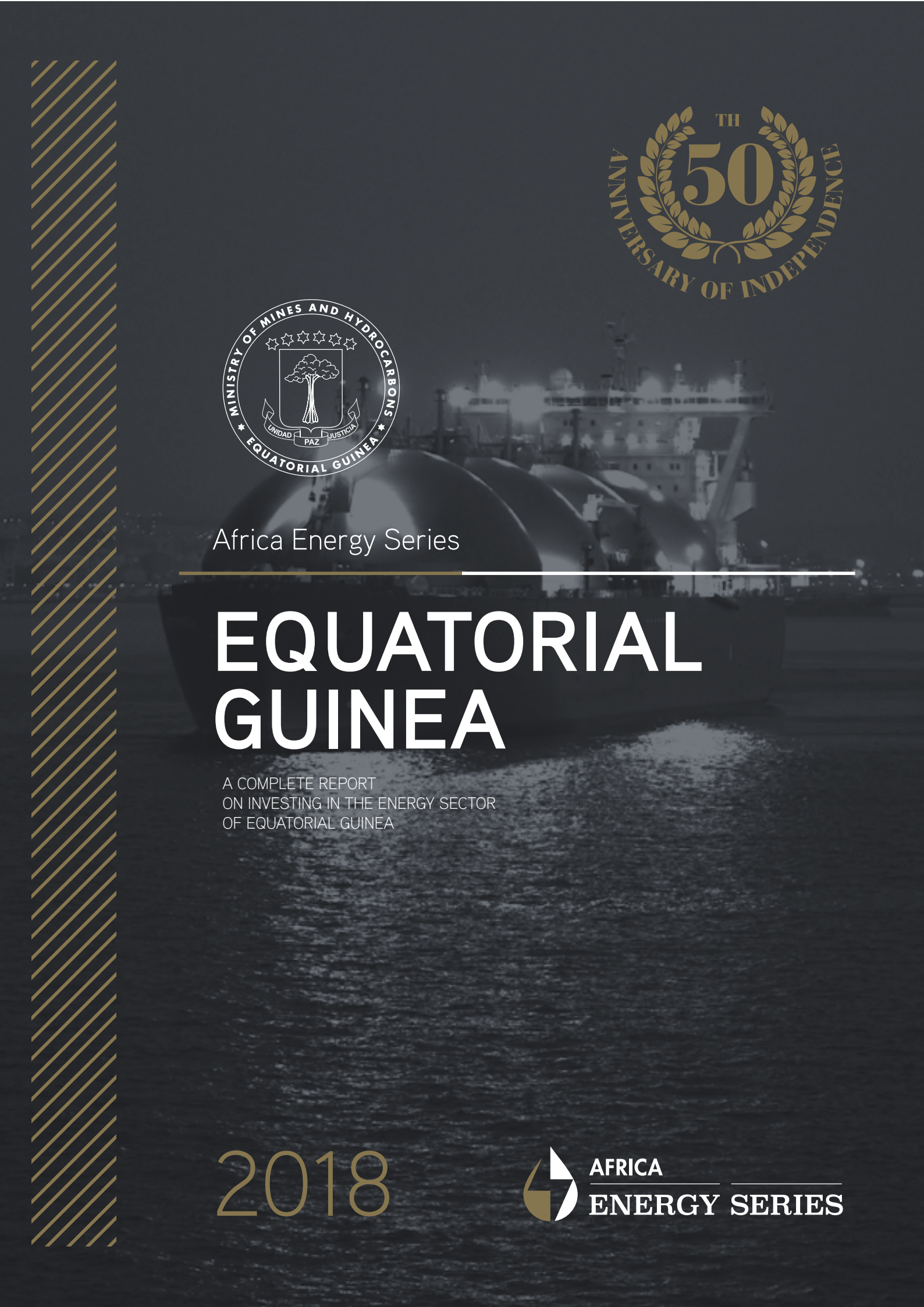


Africa Energy Series

EQUATORIAL GUINEA

A COMPLETE REPORT
ON INVESTING IN THE ENERGY SECTOR
OF EQUATORIAL GUINEA

2018

AFRICA ENERGY SERIES

Article

WORKFLOWS AND TECHNOLOGY TO MAXIMIZE FIELD PERFORMANCE

Schlumberger provides its perspective on the methods that can optimize production at mature oilfields in Equatorial Guinea.

The oil and gas industry in Equatorial Guinea has grown rapidly since the first large oil reserves were discovered in 1996, with production peaking at more than 375,000 barels per day in 2005 and then declining by over 30 percent in 2015. Maximizing production from these fields has required thoughtful evaluation of current drilling and completion practices in light of best practices for improvement using conventional or new technologies. Moving forward, the most important services will help operators squeeze as much value as possible from each asset, using state-of-the-art digital workflows to mine a broad array of data sources for new insights and opportunities.

Production enhancement opportunities in brown fields can be identified using a multidisciplinary integrated production optimization workflow from Schlumberger. Developed using expertise in production, reservoir, petrophysics, geology, and completions domains, the workflow is a systematic, rapid screening approach to candidate selection, problem diagnosis, production enhancement recommendation, and candidate ranking. The ranking result incorporates the expected production gain, risks (number of runs, well configuration, operational complexities), and intervention costs.

The workflow was recently used in a brown field in West Africa where production had declined by over 50 percent to around 4,000 bpd. The sandstone reservoir in this field is made up of 16 oil-bearing sandstone layers, with permeabilities ranging from 100 to 1500 measured depth. The reservoir was initially completed with 12 wells, six of which were still on production when analyzed. The production challenges in the field are typical of brown fields: declining production, increasing water cut, declining reservoir pressures, and sand production.

Field-level assessment and individual well review resulted in an identification of short-term candidates for saturation logging, stimulation, water shutoff, and reperforation; medium-term candidates for surface network optimization and gas-lift optimization; and long-term opportunities for side-tracking and infill drilling. Successfully executing the short-term optimization plan resulted in incremental oil production of 3,600 bpd from two wells, almost doubling the total field production.

Optimizing completions to maximize horizontal well production

The completion strategy applied to a field development greatly impacts recovery. In one of Equatorial Guinea's first and largest oil fields, most wells are drilled horizontally to maximize the reservoir-wellbore contact area, enabling the wells to produce at high rates with low drawdown pressures. However horizontal wells have unique production challenges, such as heel-to-toe effect, unwanted fluid breakthrough from the heel and high-permeability zones, and uneven reservoir sweep. In addition, most sandstone reservoirs in the West African Coastal Hydrocarbon Province range from weak to semi-consolidated; this results in additional challenges of sand production and potential for loss of wellbore integrity.

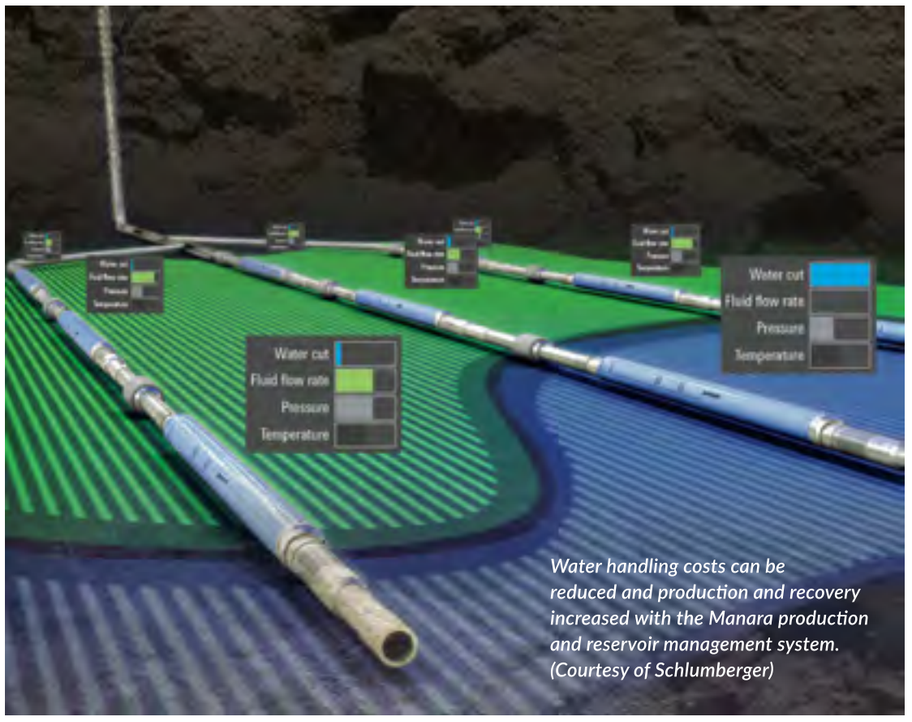
The sand control challenge in these horizontal wells has been addressed by designing wells with open-hole gravel pack (OHGP) completions using Alternate Path** gravel-pack shunt tube technology screens, which improve gravel packing efficiency in the event of annular bridging or wellbore collapse.

The challenges of optimizing production and flow distribution are resolved with selective and intelligent production technologies such as:

- Inflow control devices (ICDs): By balancing flow or reservoir sweep across a long horizontal well, ICDs improve the production performance of the well. Long used elsewhere in West Africa, these devices are poised to revolutionize sand control completions in Equatorial Guinea.

- Flow control valves (FCVs): These devices can be remotely controlled from surface to open, choke, or close an interval, and they are usually installed with downhole gauges, which can be used to infer downhole zonal flow compared with ICDs, FCVs add flexibility to improve field production performance - but they also increase complexity because of the required components and control lines.

- Intelligent completions: Innovations in technology have resulted in a smart reservoir and production management device, which expands on the benefits of conventional flow control valves with a simpler, compact design. For example, the Manara* production and reservoir management system gives the operator infinite production control. The real-time downhole flow rate and water cut measurements enable identification of the exact location of water breakthrough, and infinite-position FCVs enable rapid choking or complete isolation of the zone. The result is high confidence in longer horizontal or multilateral well production and control from heel to toe. That means wells can be drilled across multiple compartments without concerns about crossflow - ultimately resulting in higher oil recovery with lower capex and opex.



Water handling costs can be reduced and production and recovery increased with the Manara production and reservoir management system. (Courtesy of Schlumberger)

Accelerating activity with collaboration and digital intelligence

As production performance of oil and gas fields improves, operators must endeavor to continuously increase available reserve opportunities, especially as exploration and drilling activity begins to recover. For optimal performance, the service company and operator relationship is a collaboration with a common goal of efficient, productive wells and operations. This can be achieved through increased focus on:

- Selecting the best technology to achieve the required objectives,

- Working with operators in a mutually beneficial relationship;

- Ensuring data and lessons learned from previous exploration and field development activities are integrated into future operations.

In September 2017, Schlumberger introduced the DELFI* cognitive exploration and production environment - a multi-dimensional environment that unites planning and operations by integrating data and workflows with digital technologies. Bringing together advances in technical disciplines, such as artificial intelligence, data analytics, and automation, this secure, cognitive, cloud-based environment defines a new standard in cross-discipline collaboration. More than individuals collaborating, the DELFI environment is everything working together continuously: teams, systems, software, legacy data, and live inputs - all feeding into a unified environment that grows to become greater than the sum of its parts.

As the global leader in the provision of oilfield services from exploration through production in over 85 countries, Schlumberger continues to work with Equatorial Guinea and its operators to increase production output, oil recovery, and reserves.

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