

West Africa's Well Intervention Opportunities

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This report is in three parts: an introduction to the West African well intervention industry, case-studies in the region to highlight and notable service companies that work in the region.

The aim of this report is to give you an introduction to the market or an update if you're already in the know.

CONTENTS

PART 1: WEST AFRICAN OFFSHORE ACTIVITY	3
PART 2: WEST AFRICAN WELL INTERVENTION CASE STUDIES.....	4
Egina FPSO project	5
Nigeria Oyo-8 RLWI operation	6
Bonga Field.....	6
Well Intervention in Algeria – Welltec.....	7
PART 3: WELL INTERVENTION SPECIALIST COMPANIES	7
Training	10
OWI WA 2019	10

PART 1: WEST AFRICAN OFFSHORE ACTIVITY

Oil and gas development activities are continuing to heat up offshore West Africa with an increase in production from mature fields creating strong demand for Riserless Well Intervention (RLWI) services in the region.



Figure 1 Offshore Rig Offshore Nigeria

There have been significant deepwater offshore campaigns in Africa's oil and gas industry in recent years and it is estimated that some \$180 million in investment will be pumped into 88 upcoming oil and gas projects in the region by 2025. Around a quarter of this investment will be in Nigeria, while other countries in West Africa, such as Ghana and Angola, will also continue to be a focus of attention.

From shallow water licensing in Congo Brazzaville, to billion-dollar tenders in critical infrastructure, there is a growing desire by international companies to win licences and operate within the West African oil and gas sector. The Republic of Congo has an ongoing licensing round, while the Republic of Guinea is set to further develop its upstream sector in a bid to become a regional energy hub.

From an exploration and appraisal perspective, Wildcat data show that high-impact exploration in deepwater West Africa disappointed in 2018, according to Westwood Global Energy Group. The only potentially commercial discovery was at Eni's Kalimba-1 well offshore Angola. There were some high-profile failures, such as Kosmos' Requin Tigre-1 offshore Mauritania, FAR's Samo-1 offshore Gambia, and two probably non-commercial pre-salt discoveries at Boudji-1 (Petronas) and Ivela-1 (Repsol) offshore Gabon. This year will see limited exploration activity, with Total

drilling its first wells in the MSGBC Basin at the Jamm-1 and Yaboy-1 wells offshore Senegal and Mauritania respectively. Kosmos will target the large Orca prospect offshore Mauritania, while Svenska intends to drill the Atum-1 prospect offshore Guinea Bissau.

This fall in exploration activity is adding to pressure to ensure maximum extraction of oil and gas at existing and marginal fields with techniques such as Riserless Light Well Intervention (RLWI). This is proving to be a cost-effective method of intervening in the region's offshore wells, using suitable support vessels instead of rigs. The higher operating efficiency and lower spread rate of an RLWI system results in a much lower cost per intervention compared to the use of rigs. Nigeria's Department of Petroleum Resources hopes that RLWI can boost output from 2.2 million b/d currently to as much as 4 million b/d. Nigeria remains Africa's largest oil and gas producer and in the past decade, industry-wide production from deepwater fields has added over 800,000 b/d to Nigeria's output.

Well Intervention Offshore Ghana



Figure 3 Offshore Ghana Oil Fields Map

There have been many other significant oil and gas developments elsewhere in West Africa, including in Ghana, where Maersk Drilling is currently using its newly built drillship, Maersk Voyager, to provide drilling services to oil companies. Maersk Drilling’s contract from ENI to deploy the Maersk Voyager on the Offshore Cape Three Points (OCTP) Project in Ghana has been extended to 2022. The OCTP project, located about 60km offshore, features oil and non-associated gas fields, and will access approximately 41 Bcm of gas and 500 million bbl of oil. First oil was produced in 2017 and initial gas in 2018, with peak production planned to be 80,000 boe/d in 2019. The project will provide domestic gas supply to Ghana’s thermal power plants for more than 15 years.

Another key project awarded to Maersk Drilling is the Pecan-4A appraisal well in the Deepwater Tano Cape Three Points (DWT/CTP) block offshore Ghana, which

will be drilled with the Maersk Viking ultra-deepwater drillship. Aker Energy is targeting approximately 450 million boe (gross). The plan is to develop the Pecan field with a purpose-built FPSO connected to a subsea production system at 2,400 meters below sea level. First oil is targeted for 2021 at a plateau production of around 125,000 b/d of oil.

Currently, Maersk Drilling have a total of 260 locals employed in Ghana – 238 offshore and 22 onshore, some 55% of the total in-country workforce. Maersk Drilling sees West Africa as one of the few regions of the world where there are unexplored areas with huge potential. The company highlights Senegal and Mauritania as really interesting emerging offshore markets, with the Ivory Coast, Equatorial Guinea and Namibia as other hotspots going forward.

PART 2 – WEST AFRICAN WELL INTERVENTION CASE STUDIES

In this section we take a look at some of the successful projects that are up and running offshore West Africa, including examples of RLWI.

CASE STUDY: Egina FPSO project



Figure 4 Egina Oil Field. Credit: TOTAL

Total's Egina oilfield offshore Nigeria began production at the beginning of 2019 and once fully up and running, the field is expected to produce at a rate of 200,000 b/d of oil, representing about 10% of total Nigerian output.

The Floating Production Storage and Offloading (FPSO) unit used to develop the giant Egina field is the largest one Total has ever built. This project has also involved a record level of local contractors. Six of the 18 modules on the FPSO were built and integrated locally, and 77% of hours spent on the project were worked locally. Start-up has been achieved close to 10% below the initial budget, which represents more than \$1 billion of CAPEX savings, due in particular to excellent drilling performance where the drilling time per well has been reduced by 30%.

Located about 20km from the Akpo field, Egina covers an area of around 500 square miles. It is situated at a water depth of up to 1,750m.

The Egina project was a successful collaboration between LADOL, Total, and several Government agencies and has

proved that the largest industrial projects in the world can be completed in Nigeria. This is a first not only for Nigeria but also for

Africa and it represents a remarkable achievement in local content development in Nigeria.

As part of the cost reduction initiative, the Water Injector Christmas Tree installation and testing was carried out from an Offshore Intervention and Maintenance Repair (OIMR) vessel. That intervention was also designed to gather information for placement of future wells in what is a highly faulted Egina reservoir structure. The job scope included opening reservoir isolation valves, followed by an injection test to estimate well productivity and interference testing to assess reservoir connectivity and fault behaviour.

The Egina field is located in the OML 130 block, which is 150 km off the coast of Nigeria. The field is being developed by TUPNI in partnership with the company's coventurers NNPC, CNOOC, SAPETRO, and Petrobras.

CASE STUDY: Nigeria Oyo-8

Producing hydrocarbons in a deepwater environment is quite challenging and the goal is always to sustain production for as long as possible.

Any shutdown, whether intended or unintended, can prove costly. Such was the case on Oyo-8 offshore Nigeria, when the down-hole safety valve failed to open after a planned production curtailment. The several attempts to open the valve were unsuccessful due to suspected loss of hydraulic communication to the operating mechanism or the malfunction of the mechanism, a study produced for OTC 2018 reported.

A well intervention was therefore deemed necessary to re-enter the well. A vessel based riserless light well intervention (RLWI) operation was determined as the optimal solution for Oyo-8.

This entails a through-tubing operation to install a retrofit sub-surface-controlled safety valve (velocity valve) assembly across the tubing-retrievable safety valve (TRSV) to permanently hold open its flapper and serve as a sub-surface controlled safety valve.

The notable advantages of a vessel-based operation were the reduced personnel and reduced number of third-party service contractor interfaces to manage. The rig-up is significantly simpler than the requirements for rig-based completion/de-completion operations.

The fact that it is riserless also eliminates the debris management issues usually associated with the marine risers of mobile drilling units. The key components of RLWI are the subsea well-control package, subsea wireline lubricator, subsea pressure-control head, a compensated winch mounted on a module-handling tower, compensated heavy-duty over-side crane, slickline unit, and two work-class ROVs.

The RLWI operation was completed by the Island Constructor vessel within the budgeted time with less than 3% non-productive time.

A carefully planned combined operation with the FPSO ensured that control of the Oyo-8 horizontal tree was maintained during well intervention from the production topside. The intervention operation achieved the set objectives of restoring Oyo-8 to full production within allotted time and budget without any QHSE incidents. The RLWI operation was the first of its kind in Nigerian waters.

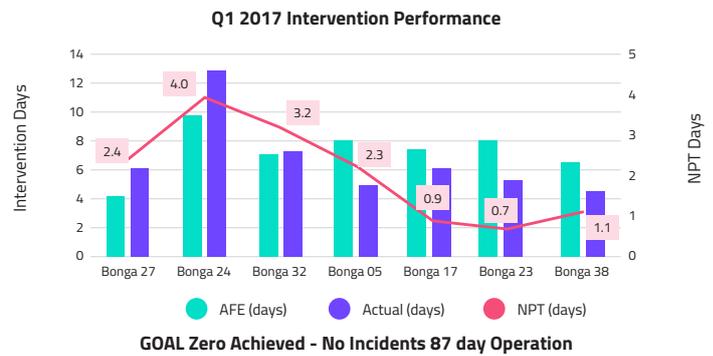
CASE STUDY: Bonga Field

Shell's Bonga field, which started production in 2005, was Nigeria's first oil and gas

project in more than 1,000m of water. Shell used one of the world's largest FPSO vessels to tap the field.

The Bonga FPSO has the capacity to produce 200,000 b/d of oil and 150 MMcf/d of gas and the vessel's capacity has been upgraded in recent years, enabling Shell to unlock new energy resources. This included the start of production at the nearby Bonga North West field, which contributes 40,000 boe/d at peak production, helping to maintain the facility's overall output.

Today, 90% of Bonga's core offshore staff are Nigerian. It was the first project to be executed under the Nigerian Oil and Gas Industry Content Development Act and supported the establishment of a local fabrication yard for subsea components, a pipe coating plant and a welding laboratory.



Early well interventions at the field were done by a rig, but this capital-intensive method was considered too expensive during the spell of low oil prices after 2014, and Shell decided to opt for riserless technology to achieve a more cost-effective solution in this deepwater environment. The project was implemented during the first quarter of 2017 and involved three stages of work, beginning with temporary well suspensions at five wells. With the tubing disconnected, field support then removed subsea Christmas Trees for servicing at an onshore maintenance depot. The next stage was acid stimulation, which was applied to one well (B-27) to address production problems. It used a mixture of acids and other ingredients, with over 1,000 bbl of the acidic mixture pumped to clear the well. This was followed by the final stage of Christmas Tree replacement, testing and plug recovery.

CASE STUDY: Algeria well intervention

Welltec plans to implement new technology offshore West Africa which it has successfully deployed in Algeria and other regions. During a well intervention operation in a well in Algeria, as part of a campaign covering reservoir analysis and surveys, a client installed a 4-1/2" retrievable bridge plug above a set of downhole gauges.

After completing the pressure build-up survey, the plug could not be retrieved on slickline, and coiled tubing attempts failed at retrieving or displacing the bridge plug. The attempts did manage to equalise the plug but also damaged the plug's fish neck. After 25 days of unsuccessful attempts with deferred and reduced production, the client reached out to Welltec for a solution.

The client chose Welltec's Well Stroker® 314 XS to free the plug. Welltec's tools were considered safer and more suitable than conventional solutions because of e-line's simpler rig up and the benefits of applying pulling and pushing forces rather than impact forces.

Within two days of the client's request, the Well Stroker® (including backup) and accessories were mobilised to the wellsite, where Welltec® successfully dislodged the plug before pulling it out of the hole. Welltec's e-line fishing solution restored access to the well, and the client returned the well to production. The whole operation took three days to successfully retrieve the plug. The Well Stroker's ability to anchor and provide maximum pull directly at the plug was key to the success of this operation.

PART 3 - WELL INTERVENTION SPECIALIST COMPANIES

In this section we highlight some of the well intervention companies which are successfully operating in the offshore West Africa oil patch.



Figure 5 Enpro Subsea FAM Technology

Enpro Subsea has a strong track record in the Gulf of Mexico and Ghana, where its patented flow access module (FAM) technology was selected by BP, LLOG and Tullow, with 41 FAMs now being adopted by operators globally.

FAM creates an enhanced production 'USB port' within the jumper envelope, enabling the use of standard Xmas Trees and Manifolds, with the FAM providing life of field flexibility within the system design.

FAM enables a range of enhanced production options including water cut metering, flow assurance, hydraulic intervention and fluid sampling, allowing the Operator to adapt the technology within the FAM to suit the needs of the reservoir.

Enpro has also seen its Flow Intervention Service (FIS) technology used to complete hydraulic intervention projects across multiple subsea wells in West Africa, and has ongoing subsea operations with a North Sea operator decommissioning its gravity based concrete structures.

Enpro's FIS systems deliver multiple scale squeeze and fluid intervention processes including acid stimulation, chemical injection, scale removal, pipeline pre-commissioning and flowline clean and tubing washes and are suitable to a range of water depths.

NOV

Throughout every region in the world and across every area of drilling and production, National Oilwell Varco (NOV) provides rig technologies, wellbore technologies, completion and production solutions with the right technical expertise, advanced equipment and operational support necessary for efficient operations.

NOV has a long, outstanding history of manufacturing advanced drilling equipment

packages to solve the industry's operational challenges. The company also offers its deep expertise to help minimise risk, increase uptime and improve performance in drilling operations around the globe.

NOV designs new technology and robotics that deliver increased automation, and is building new fabrication facilities to shorten lead times.

And the company's training programme offers to assist its clients close the industry's generational gap in a way of developing smarter, more advanced drilling solutions for all types of land and offshore environments.

In Marine and Construction, NOV products include jacking, skidding and fixation systems along with machinery for mooring, anchor handling, and deck handling.

From fluid control systems and tubular inspection services, to downhole products and automation solutions, NOV is a true partner that helps control costs, react quickly and maximise productivity.

OCEANEERING

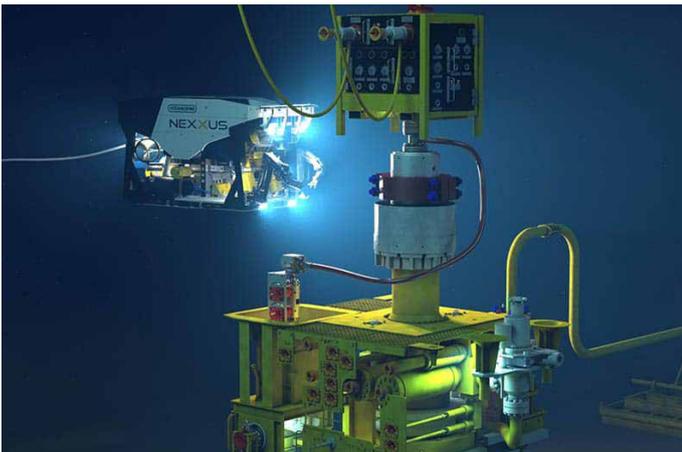


Figure 6 Oceaneering Rigless Intervention System

Oceaneering has serviced and repaired over 5,000 pipelines worldwide with its technologies and reliable solutions that minimise environmental impact and restore production quickly.

The company developed the industry's first subsea rigless stimulation system and has performed dozens of successful deepwater interventions over the years.

Oceaneering remediates migrated sand and removes scale, wax, paraffins, and asphaltene formations to restore a positive productivity index. The company has successfully stimulated subsea wells in up to 6,700 ft (2,042 m) of water. When it comes to innovative tooling solutions, Oceaneering has an industry-leading portfolio of subsea intervention tooling—including a proprietary well stimulation tool (WST) and rapid access tool (RAT)— that provides reliable access to wellbore.

During mechanical LWI, proprietary equipment and tool designs enable increased recovery while reducing costs in a wide range of subsea scenarios.

And, Oceaneering uses fit-for- purpose wireline tractors, milling, and logging tools, and gauge rings to perform a wide range of tasks such as subsea well and infrastructure diagnostics, sliding sleeve intervention, remediation on damaged wells, plugging and abandonment and workovers.

WILD WELL CONTROL

Wild Well has expanded its Montrose facility at South Ferryden, UK, enabling it to provide its services on a global basis. It responds to an estimated 80% of the global well control market. Wild Well also offers well integrity audits which will identify concerns or issues with the wellhead – such as corrosion, inoperable equipment, leaking scenarios, etc.

Based on the issues, the audits can prioritise the wells needing attention.

The teams will also review the well sites and conduct preliminary planning should a relief well be needed. With advanced engineering services, atmospheric (gas) dispersion modelling can be conducted, identifying possible concerns during an event such as evacuation of populated areas. In the event of a fire at the well site, advanced engineering can model radiant heat to determine possible threats to other assets.

At Montrose Port, Wild Well has a product known as the WellCONTAINED™ subsea containment system that provides the most comprehensive package of subsea emergency response services in the offshore oil & gas industry.

The equipment is staged in a ready-to-deploy state and includes full subsea well intervention systems, including a subsea capping stack, debris removal shears, hardware kits for the subsea application of dispersant and inhibition fluids and other ancillary equipment.

INTERWELL

Since 2012, Interwell has been working on a ground-breaking approach to permanent well abandonment of oil and gas wells. The goal of the project is to create formation-to-formation barriers across multiple strings of pipe using wireline as the deployment method.

This technology has the potential to replace today's expensive and time consuming practice of cement plugs. The technology development is currently focusing on Single Casing Solutions and the company has completed 16 plug settings in 11 different wells. Patents have been secured in Norway, Europe, Eurasia, China, USA, and similar approvals are expected in other key countries.

Interwell has also launched a product known as Matrix Platform Plug (MP), a new plug series. It is a short plug with a relatively small element expansion and is meant for applications above well restrictions. It is qualified according to the ISO 14310 international standard.

This cost effective bridge plug has over 20 years innovative experience applied to its design.

Another interesting innovation from Interwell is the Medium Expansion Retrievable Bridge Plug (ME), a high performance bridge plug /packer which features a solid elastomeric element, a robust anchoring module and an internal junk extension. This technology is ideal for workover applications; well control barrier, packer for injection valve, fixed choke, slim design (small OD/large ID), equalise and retrieve with standard GS in a single operation (no prong required). It can be run on slickline, e-line, coiled tubing and pipe.

WELLTEC

Welltec has proven to its customers that higher recovery and safer, more sustainable operations can be accomplished without increasing costs.

Welltec's latest development, the Flex-Well, is analogous to horizontal drilling for what it can bring to the oil and gas industry. The Flex-Well® provides the opportunity for the operator to diversify his capital expenditure either through reduction or by maintaining and drilling more wells. Capex can be reduced per well due to smaller rig sizes being required, fewer rig days to drill and complete, less services needed, comprehensive yet simple completion hardware, and fewer platforms required.

TIOS

TIOS UK LIMITED (formerly Island Offshore Subsea, jointly owned by TechnipFMC and Island Offshore) is the Group's global entity that performs all vessel based Light Well Intervention (LWI) services ranging from Riserless Wireline based intervention (RLWI), Riserless Coiled Tubing (RLCT), Plug & Abandonment (P&A), Pilot hole / top hole drilling, Downhole Technology.

TIOS has a track record of approximately 600 subsea wells, resulting in significant increased production from many of these. And, the company also provide products and services with focus on Increased Oil Recovery (IOR) through the use of Light Well Intervention (LWI).



Figure 7 TIOS LWI Vessel

The operations are performed from a monohull vessel and via specialised downhole tooling. TIOS operate 3 Light Well Intervention (LWI) vessels designed and built for maximum efficiency and operability.

EXPRO

With a specific focus on offshore, deepwater and other technically challenging environments, Expro provide a range of mission critical services across three key areas: Well Test & Appraisal Services, Subsea, Completion & Intervention Services, and Production Services. Expro has enhanced its cased hole services offering by signing a global agreement with downhole video and camera technology specialist Vision iO. Expro is recognised as a key provider of reliable downhole video technology to the oil and gas industry through its downhole video (DHV) range. This includes the ViewMax, high temperature and standard memory cameras. The company's suite of camera technology is successfully deployed in a wide range of operations including casing and well integrity monitoring, downhole inspection, operational verification and production monitoring for both on and offshore wells globally. Vision iO's fish eye colour camera technology visually logs the whole well in one seamless high resolution image, providing a 185/360° view of the entire wellbore. This is achieved without switching from front to lateral view, supported by a large internal 128 GB storage capacity - allowing 24 hours continuous recording.

FTAI

FTAI Offshore has acquired and developed over \$17 billion worth of infrastructure assets, with an extensive working experience in building and managing successful companies and projects.

The company also provides its clients with project management, engineering and provides marine platform to support a wide range of service offerings including well intervention; SURF; offshore construction support; inspection, repair and maintenance (IRM); remote operated vehicles; diving and survey services. FTAI Offshore operates a fleet of modern, DP-2 and DP-3 vessels that have successfully completed projects in Southeast Asia, the Middle East and West Africa, including: Well Intervention, Offshore Construction Support, Work- and Observation-Class ROV Operations and Support, Air and Saturation Diving Support, Umbilical Installation and Subsea Well Tie-in, Survey Submarine trenching.



Figure 8 FTAI Subsea 88 vessel

TRAINING

As oil and gas operations evolve across Africa, the training of local engineers, technicians and other staff is becoming more and more critical.

Many operators and service providers under-perform during their offshore campaigns due to the workforce lacking the right experience.

Train2Develop is a newly established technical and non-technical training provider who specialise in tackling cultural and managerial issues in the region.

The company specialises in training and coaching individuals and teams who work in the drilling and well intervention service lines of the oil and gas industry.

Train2Develop provides both technical and non-technical training and coaching, on location and in classroom environments.

The company's trainers have a wealth of knowledge, having worked in the field, in the office and in training, across the world. They are also passionate about helping people develop their situational awareness of specific well-related problems using simulators, as well as team building, leadership and decision-making skills.

With the right training and coaching, comes improved morale, grater staff retention and lower incident rates, all of which have a massive impact on a company's reputation and bottom line.

CEO and founder of Train2Develop, Jeanne Boles, will be presenting at OWI WA 2019 (4-5 June, Accra), giving you unique tools and methods that will enhance cohesion within your team and improve your overall campaign results.

OWI WA 2019

If you would like to learn more about the latest technologies from all of these companies and hear exclusive case studies to help improve your next campaign, register for the OWI WA 2019 conference.

The OWI WA 2019 conference allows operators to hear first-hand case studies of recent campaigns within the region. Presenters will explain the main challenges faced during the campaigns and how they solved them.

For Well Service providers it gives them the opportunity to showcase their products and services to local and international operators. It also informs them of the main challenge's operators are facing and what operators need from service providers to improve overall efficiency.

Please contact Will Hurl at whurl@offsnet.com for more information.