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FEATURES

24

"See Spot Run"

In the last 12 months a series of significant steps have been made in the world of offshore robotics; a number of legged and tracked robots made their first steps onto and around offshore facilities in Malaysia, the Netherlands, Norway and the U.S. For operators, it's a big leap to have these things on facilities. For technology developers, it's a big step towards future potential adoption offshore.
By Elaine Maslin

ON THE COVER: **Kongsberg Ferrotech's Nautilus subsea pipeline repair habitat.**

Photo from Kongsberg Ferrotech

FEATURES


Source: Subsea UK


Source: © Zacharias/AdobeStock

DEPARTMENTS

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BY THE NUMBERS

RIGS

Worldwide

Rig Type	Available	Contracted	Total	Utilization
Drillship	14	54	68	79%
Jackup	144	292	436	67%
Semisub	23	55	78	71%

Africa

Rig Type	Available	Contracted	Total	Utilization
Drillship	1	9	10	90%
Jackup	18	16	34	47%
Semisub				

Asia

Rig Type	Available	Contracted	Total	Utilization
Drillship	6	5	11	45%
Jackup	59	82	141	58%
Semisub	10	13	23	57%

Europe

Rig Type	Available	Contracted	Total	Utilization
Drillship	2	1	3	33%
Jackup	11	37	48	77%
Semisub	6	23	29	79%

Latin America & the Caribbean

Rig Type	Available	Contracted	Total	Utilization
Drillship		21	21	100%
Jackup	2	3	5	60%
Semisub	1	10	11	91%

Middle East

Rig Type	Available	Contracted	Total	Utilization
Jackup	27	113	140	81%
Drillship	1	1	2	50%

North America

Rig Type	Available	Contracted	Total	Utilization
Drillship	4	17	21	81%
Jackup	25	31	56	55%
Semisub	1	4	5	80%

Oceania

Rig Type	Available	Contracted	Total	Utilization
Drillship	0	0	0	
Jackup	0	1	1	100%
Semisub	0	4	4	100%

Russia & Caspian

Rig Type	Available	Contracted	Total	Utilization
Jackup	4	7	11	64%
Semisub	4	1	5	20%

This data focuses on the marketed rig fleet and excludes assets that are under construction, retired, destroyed, deemed noncompetitive or cold stacked.

Data as of July 2021.
Source: Wood Mackenzie Offshore Rig Tracker

DISCOVERIES & RESERVES

Offshore New Discoveries

Water Depth	2016	2017	2018	2019	2020	2021
Deepwater	12	16	16	20	13	7
Shallow water	66	74	53	85	39	21
Ultra-deepwater	16	12	17	18	8	2
Grand Total	**94**	**102**	**86**	**123**	**60**	**30**

Shallow water (1-399m)
Deepwater (400-1,499m)
Ultra-deepwater (1,500m+)

Offshore Undeveloped Recoverable Reserves

Water Depth	Number of fields	Recoverable reserves gas mboe	Recoverable reserves liquids mbl
Deepwater	565	43,989	22,209
Shallow water	3,216	422,364	141,465
Ultra-deepwater	326	40,734	24,062
Grand Total	**4,107**	**507,087**	**187,737**

Contingent, good technical, probable development.

The total proven and probably (2P) reserves which are deemed recoverable from the reservoir.

Offshore Onstream & Under Development Remaining Reserves

	Water Depth of fields	Remaining reserves gas mboe	Remaining reserves liquids mbl
Africa	609	19,888	12,402
Asia	888	16,932	8,369
Europe	760	12,497	13,533
Latin America and the Caribbean	203	6,286	40,458
Middle East	130	78,614	144,795
North America	536	3,159	14,505
Oceania	89	11,904	1,397
Russia and the Caspian	60	17,601	14,572
Grand Total	**3,275**	**166,882**	**250,030**

Onstream and under development.

The portion of commercially recoverable 2P reserves yet to be recovered from the reservoir.

Source: Wood Mackenzie Lens Direct

SECTOR IN FOCUS
SOUTH AMERICA

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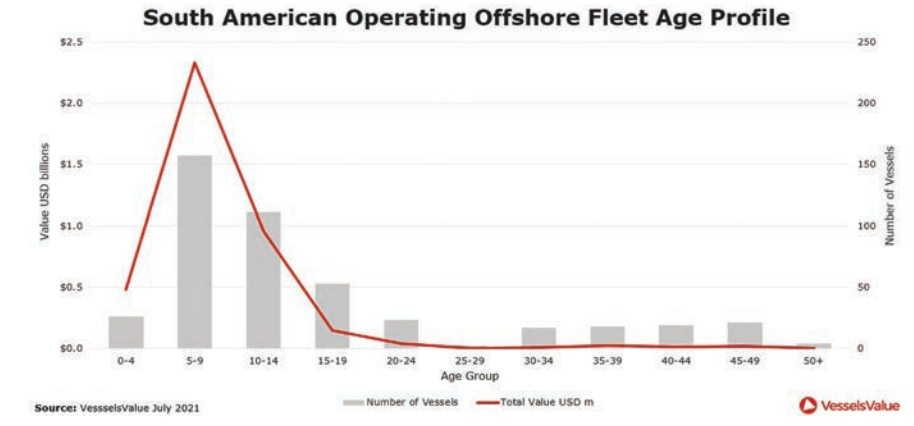
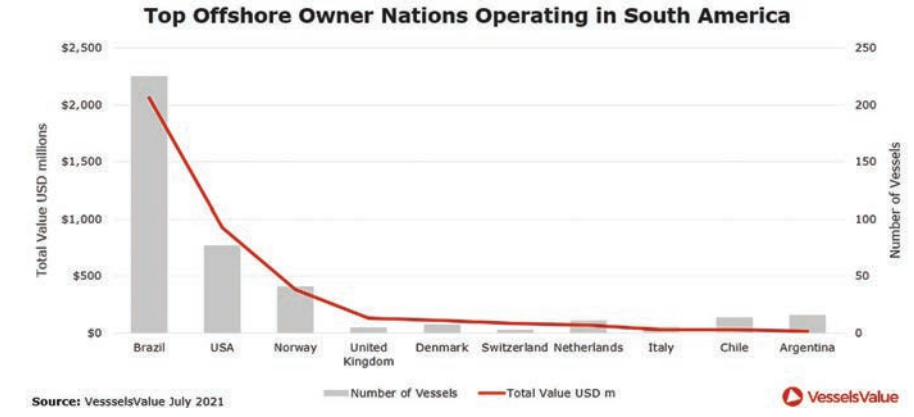
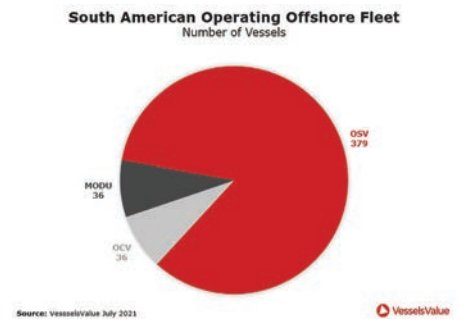
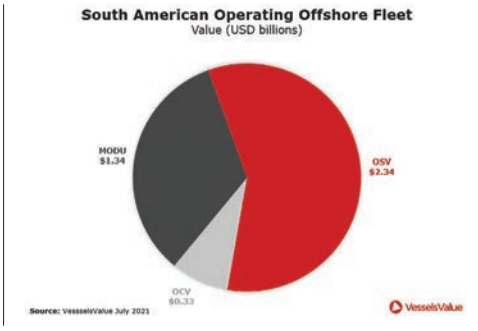
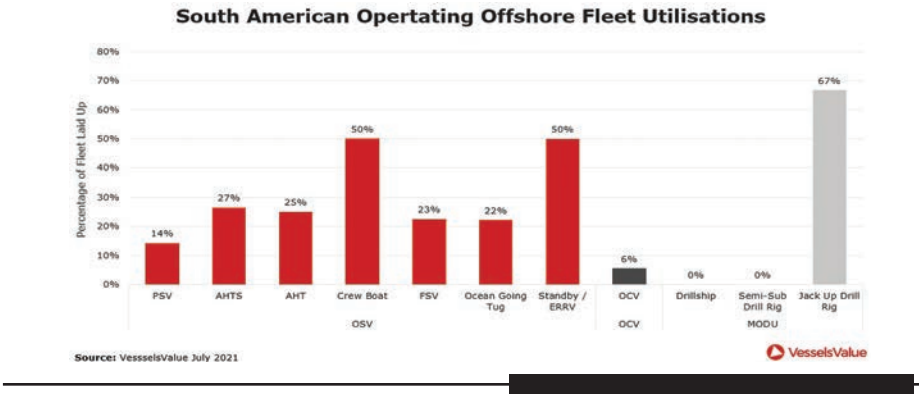
July 2021











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OE WRITERS


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Elaine Maslin is *Offshore Engineer's* Aberdeen correspondent and an offshore upstream and renewables focused journalist, covering technologies, from well intervention and asset integrity to subsea robotics and wave energy.

Jim McCaul is Managing Director and founder of International Maritime Associates. He has extensive market analysis and strategic planning experience in the maritime and offshore oil and gas sectors, and has managed more than 400 consulting assignments in over 40 countries.

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Bartolomej Tomic is managing editor of Offshore Engineer. He has, since 2010, written hundreds of articles covering the international offshore industry. The coverage includes E&P, Drilling, Seismic, interviews with oil and gas professionals, and reporting from industry events.

Teresa Wilkie is a senior offshore rig market analyst for Esgian, she has over 10 years of experience as a reporter and analyst in the oil and gas business working within companies such as IHS Markit, RigZone and Westwood Energy.


Milito


Mulligan


Pescarini


Tomic


Wilkie

HOUSTON-BOUND

I never thought I'd utter these words, but I'm looking forward to being in Houston in August. Don't get me wrong, Houston is a great city with some of my favorite people, restaurants and watering holes. But I've been there many, many times in August, and it gives a new definition to the word 'hot'. But this year – for so many reasons – is different.

I and most of our Offshore Engineer crew were 'road warriors' in every sense of the word, traveling relentlessly to exhibitions, conferences and to visit individual clients globally. Then came COVID, and I literally have not traveled on business from New York City for 518 days (and counting). The good news: my wife and my dog still like me. The bad news: I sorely miss the in-person, one-on-one interaction. We, like the rest of the planet, have embraced the efficiency of online video meetings via the platform of your choice, and with Zoom, Teams and GoogleMeet I'm able to literally skip through several continents in the course of a normal business day. While the challenges – both from COVID for the past 18 months and courtesy of the energy markets for the past 6+ years – have mounted, it has failed to stop innovation, which is at the heart of *OE's* coverage 24/7/365.

Front and center in this edition is Elaine Maslin's coverage on the evolution of robotic solutions across the industry, from the creatively named metal, composite and chip driven critters climbing on a rig near you to the innovative 'pipeline repair habitat' which graces our cover, a system that is seeking to bring 3D printed repair solutions to the seafloor. Our 12 pages of robotics coverage, with updates on some of the most compelling recent trials globally, starts on page 24. While the price per barrel has made a strong rebound and the immediate future looks bright indeed for solid footing in the offshore oil and gas sector, you cannot ignore energy transition and all that it entails. Phil Lewis, Director of Research at World Energy Reports, offers and encyclopedic knowledge of all matters offshore wind, from insights on the supply chain to the latest technologies to the maritime side of the equation. Most importantly, he has detailed insights on the major projects, from the financials to the timelines. In this edition he shares two features: the first on the evolution of the U.S. offshore wind sector, which today is 40 projects in the planning stage representing $135B in CAPEX and $4.2B in annual OPEX; and the second on the international WTIV market, highlighting the tremendous need for investment and installation ships to fuel the global demand.

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OFFSHORE RIGS
Transformation is on the Horizon

The offshore drilling rig market is showing remarkable signs of recovery despite having faced severe headwinds. Throw the "green rig" revolution and further consolidation into the mix, and the next few years could be a period of real transformation for the industry.

By Teresa Wilkie and Hans Jacob Bassoe

Rewind to July 2020, oil and gas companies were cancelling rig contracts left, right and center. Many campaigns that were not cancelled were facing massive delays due to Covid-related travel restrictions or other logistical issues. Meanwhile, the oil price was on its knees, hitting the lowest point of just under $20 per barrel for Brent Crude, which meant demand for new drilling programs and rig award activity came to a screeching halt.

Offshore rig contract backlog was in the midst of a freefall, which according to the Esgian Rig Service, saw total backlog fall by 230 years, or 26%, between January and December 2020, while competitive utilization fell by 12% in the same period. This, of course, put further pressure on already subdued dayrates, meaning further massive losses for many rig owners, resulting in several major players filing for Chapter 11 bankruptcy.

That's a tough year considering the market was only just coming out of one (long) downturn, only to be met by a second. However, there have been several signs of recovery in the offshore drilling rig industry of late, leading to a marked rise in optimism for the future of the industry.

Contracting Doubles

With thanks to the higher and more stable oil price this year, tendering and contract awards are on the rise, with rig contract backlog finally showing signs of growth after over a year of losses. Esgian Rig Service shows that since January 2021 until mid-July, there have been 192 contracts or extensions awarded, to-

talling over 185 years of backlog added with an estimated value of over $7 billion. In comparison, this is around 50% more than was awarded during the same period of 2020, where there were 98 awards recorded, totalling just under 93 years of backlog added.

There has also been some upward movement in day rates as demand and competitive utilization rise faster in certain areas and segments of the market. An example of this is in the US Gulf of Mexico for 6th and 7th generation drillships with MPD capability, where supply has tightened so much that day rates have been reaching over $280,000 per day for use with MPD and $260,000 per day without it.

Though rates still have more room to rise as oversupply continues to plague the industry, it is a positive sign for drillers when comparing to the dayrate levels these rigs would have been fixed at last year (if fixed at all).

Utilization Moves Up

As can be seen in Figure 2, competitive jack-up utilization was sitting at 71% as of mid-July, and this figure is expected to continue rising to the 84-85% mark by Q3/Q4 2022.

Further demand recovery is expected in the jack-up segment, which will continue to be driven by National Oil Companies (NOCs) especially in areas such as the Middle East, India, Mexico and the Far East as these countries continue to focus efforts on increasing and maintaining domestic supply. On a smaller scale but still of importance, the North Sea, Southeast Asia, and West Africa will also provide jack-up demand.

Shallow-water utilization increases are expected to be more demand-driven rather than supply-driven over the next few years. Further attrition is expected in the jack-up segment over the coming years, though we believe most near-term retirements will happen within the uncompetitive fleet, which includes many units that have been cold stacked and unemployed for some time nor marketed for work. If more units from the competitive fleet were to be retired, this would be more helpful in terms of increasing competitive utilization and spurring on dayrates rises. Meanwhile, several newbuilds will finally be delivered over the next 18 months as some NOCs aim to bring in newer tonnage to replace aging assets.

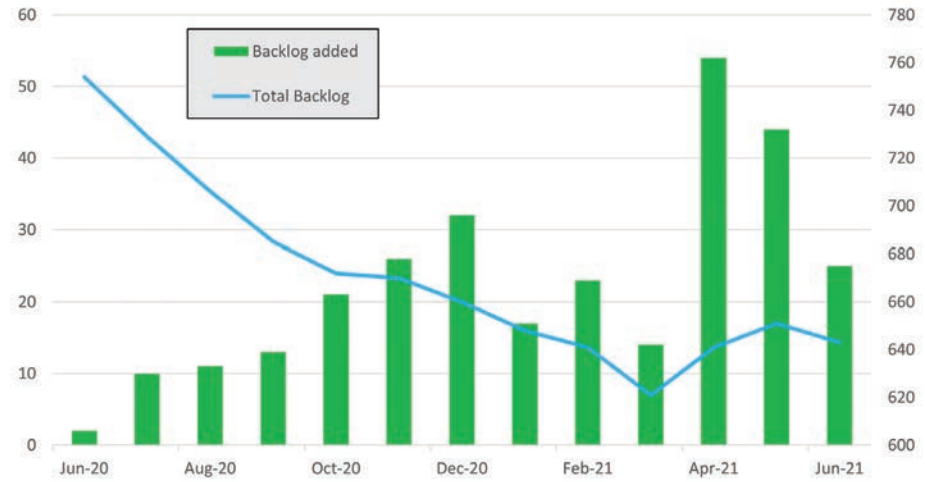


Figure 1: Rig contract backlog added & total backlog in years (June 2020 - June 2021).
Source: Esgian Rig Service (previously Bassoe Rig Analytics)

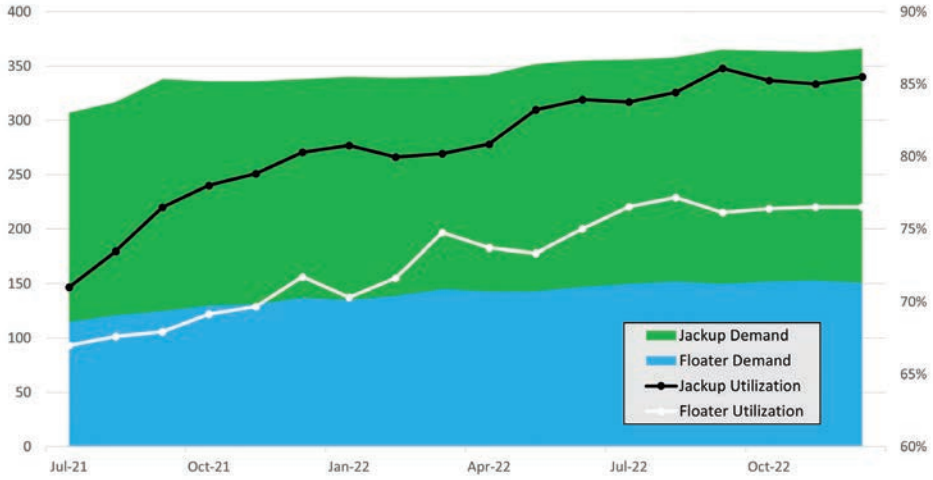


Figure 2: Jackup and floater demand and utilization forecast (July 2021 - December 2022).
Source: Esgian Rig Service

Slower Floating Recovery

Meanwhile, in the floating rig segment, competitive utilization is anticipated to grow from 67% (as of mid-July 2021) to around 78% by late 2022, somewhat lagging behind the jackup segment. Utilization recovery witnessed so far is partially down to increasing demand, but Esgian believes that the lower competitive supply, following a lot of cold stacking and retirements over the last year, has done a lot to kick-start those increases.

A lot of demand is coming from South America, where Petrobras is finally beginning to increase its rig count after many years of decreases, plus other independent operators are planning their

own development or exploration campaigns off Brazil, too.

Meanwhile, we are also seeing increasing numbers of floaters moving into Guyana and Suriname. Outside of South America, independent operators will lead most of demand in areas such as the North Sea as well as the US Gulf of Mexico, West Africa, the Far East, and Southeast Asia.

Like the shallow-water side, Esgian believes there is further attrition planned and needed in the floating rig segment, which of course may be amplified by consolidation within the rig owner segment and potentially by the green transition.

Similarly, we expect that near term, a lot of attrition will come from the cold-stacked fleet rather than those rigs that are currently competitive, however, this will still help the market recovery longer term. There are only a handful of newbuilds planned for delivery over the next 18 months, despite there currently being 18 drillships and six semisubs under construction.

Consolidation Kick-Started

Several drilling contractors have now exited Chapter 11 proceedings with fresh balance sheets, and the consolidation season appears to have kicked off with two of these companies – Pacific Drilling and Noble – merging.

Large offshore drillers have previously proven keen on consolidating during times of optimism (as depicted in the historical M&A tree shown in Figure 3). As the long-awaited recovery appears to have begun and with the first transaction out of the way, more deals are expected imminently.

Since 2018, Esgian's records show that 154 rigs have been recycled or sold for conversion outside of the drilling market, while only 62 newbuilds have been delivered and therefore, total supply is decreasing.

However, the industry continues to suffer from oversupply and fragmentation, with almost 750 rigs currently spread over 100 owners. Further amalgamations would reduce the number of owners while increasing attrition as companies often look to "right-size" their fleets post-acquisition.

Also, after years of turmoil, most offshore drillers have reduced their overall operating costs. This, combined with the likely cost synergies realized after a merger or acquisition (Noble Corporation expects to achieve annual pre-tax cost synergies of at least $30 million from the acquisition of Pacific Drilling), may allow companies to better position themselves during negotiations, especially for longer-term work at dayrates more in tune with the capital invested.

As oil prices have increased to pre-covid levels and demand has picked up, asset values also seem to have bottomed out and are increasing slightly, too.

According to Esgian Rig Service, the entire offshore drilling rig fleet is currently valued at $43.9 billion, which, although it is an almost 3% drop against July 2020's figure of $45.2 billion, is an increase of nearly 4% on December 2020's value of $42.4 billion. This leads Esgian to believe that the time for consolidation is now.

The "Green Rig" Revolution

According to Esgian Rig Service, over the past year, the total fleet of jackups, semisubmersibles, and drillships generated approximately 10.7 million tonnes of CO2. So, we know that a lot of CO2 is being emitted from offshore rigs, but what's being done about it?

Over the past few years, there has been a growing trend of owners retrofitting their rigs with emission-reducing or fuel-saving systems in a bid to help not just their clients lower their emissions but also to help them meet their own sustainability targets as the energy transition gains pace.

As can be seen in Figure 4, there are six rig owners/managers that have been most active so far in this area, with common system upgrades including the likes of hybrid-power, DP closed bus operations, energy emissions efficiency software, selective catalytic reductions systems. Seadrill also announced that its West Saturn drillship will be installed with a hydrogen and methanol injection system (along with other upgrades) prior to commencing a long-term campaign offshore Brazil.

Most of these systems have only been used on rigs for a short time and are in their infancy; therefore, results are still coming in, but in terms of hybrid power and closed bus solutions, targeted reductions are commonly around the 10-25% mark in terms of fuel and CO2 emissions. As can be seen in Figure 4, the North Sea is leading the way, especially in Norway and the Netherlands, where there are either incentives or strict regulations that are driving demand for low-emission rigs. However, the US Gulf of Mexico is an area of growth due to Transocean's roll-out of its patented hybrid power systems on several of its drillships working in the region.

Though there are currently four under-construction floaters recorded by Esgian Rig Service with such emission-reducing measures, due to high costs associated with building new rigs and with the current oversupply problem, it is likely that more delivered units will be retrofitted in the future rather than newbuild orders being placed for "green" rigs.

Energy Transition: Threat or Opportunity?

With utilization, supply, consolidation, and dayrates seemingly headed in

the right direction for rig owners, the next big challenge for the industry is now how to respond to the energy transition. Oil and gas companies are emitting tons of GHG and will experience continued pressure not only from governments and regulatory bodies to lower their emissions.

With the International Energy Agency's (IEA) recent report arguing that investors should not fund new oil, gas, and coal projects if we should reach net-zero emissions by mid-century, the future of this industry seems uncertain. However, most operators will not divest all their assets, as hydrocarbons are expected to continue to play an important role in the energy transition and may be used to help fund alternative energy projects.

Rather, Esgian expects that these oil and gas companies will diversify their energy portfolios and look to continue drilling, but in more sustainable ways. Therefore, rather than being a problem, the energy transition could provide an opportunity for offshore drillers to gain a competitive edge if they chose to invest in asset upgrades and new technologies to help reduce harmful emissions from drilling campaigns.

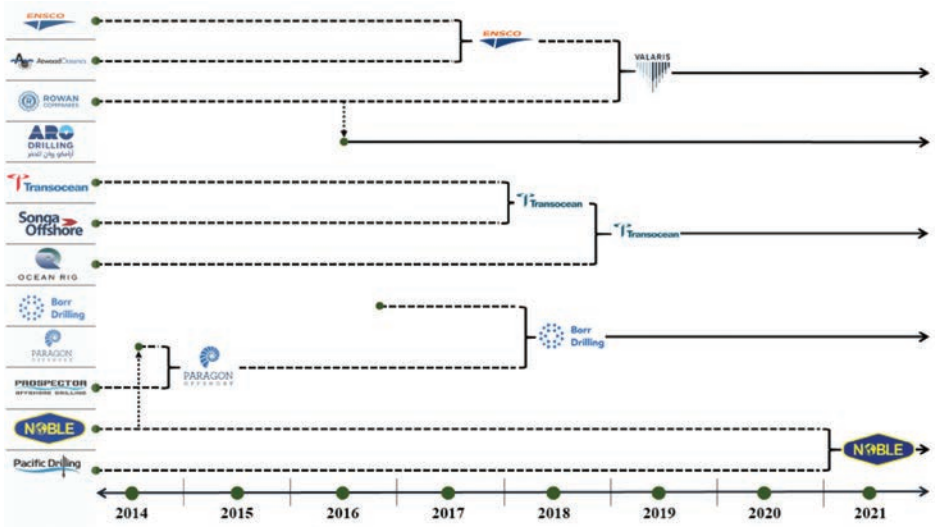


Figure 3: Offshore rig owner consolidation so far.
Source: Esgian Rig Service

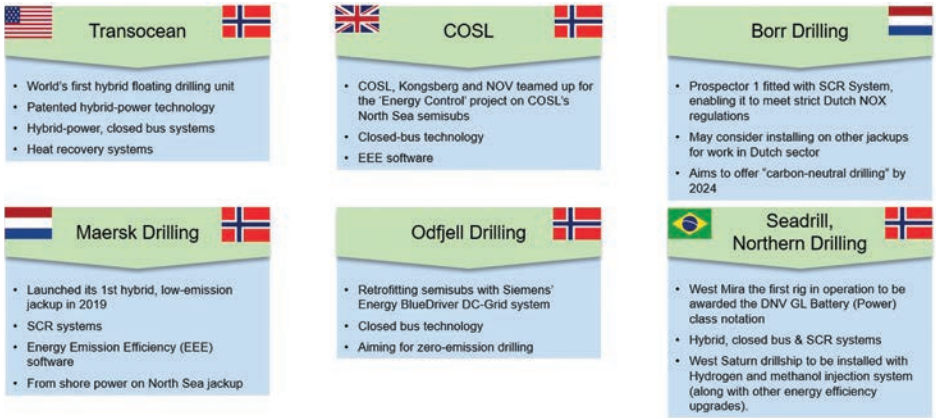


Figure 4: Some of the emission-reducing technology & efforts being implemented by offshore rig owners (flags indicate countries where these rigs will be put to work).
Source: Esgian Rig Service

In the floating rig segment, competitive utilization is anticipated to grow from 67% (as of mid-July 2021) to around 78% by late 2022, somewhat lagging behind the jackup segment.

SUBSEA UK AND THE CREATION OF THE "GLOBAL UNDERWATER HUB"

*Subsea UK is embarking on a new adventure as **The Global Underwater Hub**, a new organization with already nearly $18 million in funding. 'The Hub' aims to leverage the UK's strong maritime heritage, as well as its underwater expertise that transcends offshore defense and research. Subsea UK has been around nearly 20 years, set up to champion the UK subsea industry. It was fortuitous timing, as that $2.7B CapEx industry in oil and gas grew to more than $12B by 2013. **Neil Gordon**, Chief Executive at Subsea UK, discusses the path ahead.*

By Greg Trauthwein

While Subsea UK was formed in 2003 to champion the UK subsea industry, its predecessor was an organization in the Northeast of Scotland around Aberdeen called The Scottish Subsea Technology Group. "That was a number of companies (30 or so) that used to come together and talk about technology because there wasn't a forum to talk about the challenges and opportunities," said Gordon. When the small group realized the potential of linking others across the country, both the UK and Scottish governments became involved, and subsequently born Subsea UK was born.

Today Subsea UK is an organization of 300 members with an aim to grow the subsea business domestically and globally.

Path to the Top

While Neil Gordon is the recognized public face of Subsea UK, his early years suggested a career in his family business, not the subsea sector. And then he met Oceaneering, where he was able to meld his love of business, sports and diving. "I got hooked in the industry and off I went to do my training in commercial diving," said Gordon.

Over the years he worked in a host of different organizations that gave him a "grounding to understand how the subsea industry works, both offshore and onshore," with insights on communicating to these different group.

Just prior to taking the top spot at Subsea UK, Gordon was running The National Hyperbarics center, which looked at testing, training, and trials of subsea equipment and processes, which again helped Gordon to broaden his knowledge of the subsea sector as a whole. "There was also a lot of training and testing of equipment like subsea control modules," said Gordon. "That was an interesting period to understand what goes on in that subsea world, because there's a whole plethora of technological infrastructure happening beneath the waves."

A Challenging Environment

The challenges inherent in the subsea sector are well known and recorded by those who live it daily. Working in and under one of the most difficult environments on the planet is the entrance, punctuated by severe business peaks and troughs, particularly in the offshore oil and gas sector, that make long range planning and success difficult.

"The oil and gas industry harnessed and developed subsea technology, accelerating the industry massively. But some of the biggest challenges are the highs and lows of the oil price," said Gordon. But necessity is the mother of invention, as the

OETV

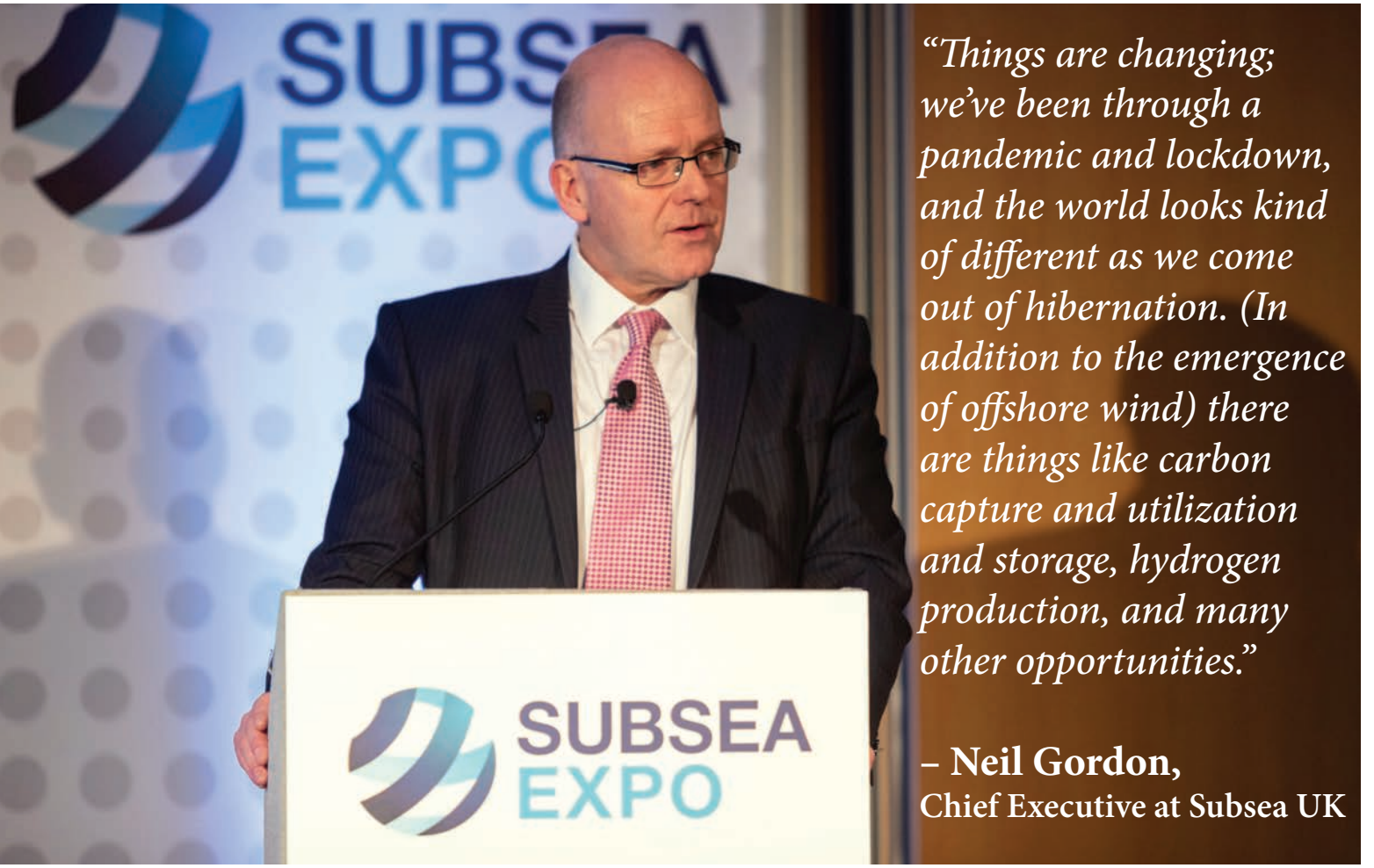
Watch the interview @
bit.ly/3kFupEF

The **Global Underwater Hub (GUH)** will be an intelligence led and strategically focused organization helping companies to understand new markets and identify opportunities by delivering in four key areas:

- **Collaboration & Innovation:** *Creating a multi-sector underwater industry.*
- **Capability and Skills:** *Developing skills and companies to drive competitive advantage.*
- **Accelerate & Scale-up:** *Supporting the growth of new and existing companies.*
- **International market development:** *Increase exports and attract new inward investment.*

Oceaneering

Subsea UK



"Things are changing; we've been through a pandemic and lockdown, and the world looks kind of different as we come out of hibernation. (In addition to the emergence of offshore wind) there are things like carbon capture and utilization and storage, hydrogen production, and many other opportunities."

– Neil Gordon,
Chief Executive at Subsea UK

challenges create opportunities as operators take a microscope to their operating costs, particularly looking at the balance between capital-intensive topside versus subsea developments.

"Look at subsea developments, for example, and in the North Sea, where there were a lot of subsea tiebacks to existing infrastructure," subsea technologies that have enabled assets that were perhaps designed for only 20 years to have their life extended well past 40 years.

Tapping the $3 Trillion Blue Economy

The opportunity now – and hence the creation of The Global Underwater Hub – is to leverage all of this accrued subsea expertise, much of it born in the traditional offshore oil and gas environment, and find new 'homes' for it in alternate and emerging offshore industries, from defense to aquaculture to the burgeoning offshore wind market, particularly with the need to chart, understand and build on the seafloor, as well as the more recent emergence and promising future of 'floating wind' that share many similarities to offshore oil and gas.

In motion for a few years, drawing on the resources of Subsea UK and additional entities in Scotland and the UK, The Global Underwater Hub is aiming to harness all that the subsea industry has to offer and leverage it toward future opportunities. "So the challenge was, a few years back, we looked at Subsea UK, which had done a great job up until then, but the future was starting to look slightly different," said Gordon. 'Slightly different' includes the impact of COVID. "Things are changing; we've been through a pandemic and lockdown, and the world looks kind of different as we come out of hibernation. (In addition to the emergence of offshore wind) there are things like carbon capture and utilization and storage, hydrogen production, and many other opportunities."

Cumulatively it is perhaps best described as taking a bigger piece of the 'blue economy' which encompasses all aspects to do with the ocean, driven by the recent Organization for Economic Cooperation and Development (OECD) report that projects the blue economy is set to grow to about $3 trillion by 2030. "Now that's a massive growth," said Gordon, noting that $1T of that pie are sectors where Subsea UK has already or has targeted to work.

OSBIT

"We know countries such as Norway, Japan, Canada and the U.S. are all investing in the ocean economies," said Gordon, in discussing the push to develop The Global Underwater Hub, which in its essence is creating value for the UK and Scottish economies. "We are a world leader, but we want to make sure that we can maintain that leadership. So let's get some real focus about the blue economy. How do we create the jobs? How do we develop the technology? How do we encourage exports?" Gordon and his colleagues see The Global Underwater Hub is the answer to those questions and more.

Logistically the organization will have three locations: one in Scotland, one in North England and one in South of England, creating "a backbone, a hub and spoke model," said Gordon. "Anyone around the country can access and connect to help them grow their business."

Gordon is particularly clear to point out that The Global Underwater Hub is not an 'Innovation Center.' "It's not an innovation center, because there are lots of innovation centers around," he said. "What we need to do with those innovation centers is make sure that they know where the opportunities are and how to commercialize those opportunities."

The GUH will be an intelligence led and strategically focused organization helping companies to understand new markets and identify opportunities by delivering in four key areas:

- **Collaboration & Innovation:** ***Creating a multi-sector underwater industry .***
- **Capability and Skills:** ***Developing skills and companies to drive competitive advantage.***
- **Accelerate & Scale-up:** ***Supporting the growth of new and existing companies.***
- **International market development:** ***Increase exports and attract new inward investment.***

"The main things that the hub will be able to deliver is help companies identify where are the opportunities and help them navigate, find and win that business," said Gordon. "We've got energy transition, net zero oil and gas, offshore wind [to name a few]. It's for us to try and help articulate the opportunities and help companies make those strategic decisions where they invest in, where they want to do business."

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2021 THE YEAR WHEN OFFSHORE TAKES OFF IN THE UNITED STATES

As of end-June 2021, there were at least 40 offshore wind projects in the planning stage representing an $135.8B CAPEX and $4.2B annual OPEX opportunity that are forecast to be developed within this and early in the next decade.

By Philip Lewis IMA/WER

The U.S. offshore wind sector is rapidly accelerating after years of false starts. At least 40 offshore wind projects are forecast to be developed within this decade. Ports, fabricators, component manufacturers, vessel operators, engineering firms and lenders will benefit from the $135.8B CAPEX, $4.2B annual OPEX, and $18.4B DECEX opportunity.

Despite being the second largest global market for onshore wind, the U.S. is today a minor player in offshore wind in comparison to the European and Asian offshore wind markets. Two operational projects for a total 42MW of installed capacity were installed in the U.S. at the end of 2020 versus a global offshore installed base of 32GW.

The year 2021 will deliver a step change in offshore wind activity in the U.S. as the journey accelerates to develop the 40.8GW project pipeline.

These are the findings shared in a recent report on the U.S. offshore wind market in this decade by World Energy Reports (WER).

The 80-page report examines the business conditions likely to drive offshore wind project development in the U.S. within this decade, forecasts the number, CAPEX, OPEX and timing of projects, and provides a roadmap to accessing these market opportunities.

DEVELOPMENTS IN US OFFSHORE WIND

WER's forecast represents a much higher level of activity than was anticipated six months ago.

Since April 2021, the White House has set a development target of 30GW of offshore wind by 2030 and 110GW by 2050, a major project in federal waters has been approved for construction (Vineyard 1), six projects in federal waters are under final review, 2.6GW of project capacity has secured state procurements and 11.6GW of new federal leasing activity in the northeast and California is underway.

Final investment decisions are expected for 19 projects over the next 18 months. Most of the projects will be larger wind farms in the federal waters of the northeast and Mid-Atlantic. The forecast also includes a demonstration project in the Great Lakes and four floating wind demonstration projects – two each in the Atlantic and the Pacific.

A 40.6MW PROJECT FORECAST

As of March 2021, there are 44 projects in planning. Close to 1GW of projects have been approved and a final investment decision is imminent. An additional 13.7GW of capacity is forecast to reach FID within the next 18 months. This capacity is mainly made up of bottom-fixed offshore wind farms in the Atlantic – however, our forecast also includes one Great Lakes demonstrator and four floating wind pilots, two on the Atlantic Coast and two offshore California.

In the mid-term, there is a further 9GW of Atlantic OCS projects in early development. WER anticipates an FID on these projects in 18-36 months.

Longer-term, the balance 7GW of existing Atlantic offshore wind capacity is forecast to reach FID in 36-60 months.

Close to 12GW of FIDs will be made towards the end of this decade, coming from at least eight New York Bight bottom-fixed projects and multiple floating wind projects coming from the future Morro Bay 399 and Humboldt leasing activity. These projects will mainly see offshore construction in the early 2030's.

A $135.8B CAPEX AND ANNUAL $4.2B OPPORTUNITY

WER's bottom-up forecast model breaks the $135.8B of CAPEX into component spend, forecasting close to $100B to be spent on material supply, manufacturing and/or fabrication of turbines, cables, foundation structures and other equipment.

WER anticipates around $22B will be spent on installation and commissioning activities. The Jones Act supports U.S. built, owned and operated vessels. This means that foreign flag installation vessels will not be able to shuttle components from U.S. ports to the construction site, as is the practice in the developed European and East Asian markets. There is limited Jones Act compliant turbine, foundation, and cable installation capacity. This can lead to project delays or increased costs as developers compete for scarce foreign flag tonnage and comparatively high-priced Jones Act new buildings, or select less efficient/cost competitive combinations of foreign flag installation vessels and domestic feeder vessels.

As with offshore oil and gas projects, a significant amount of lifetime project cost in an offshore windfarm is represented by routine planned operations and maintenance. For an offshore windfarm this is typically 40-45% of the lifetime cost. WER's forecast identifies around $4.2B of annual recurring OPEX once the identified projects are commissioned.

Wind farm operators will set routine inspection and maintenance schedules, chartering in long-term vessel support for the activities. The tonnage will be mostly Jones Act Vessels. Certain vessel categories can be modified/redeployed for the existing Jones Act fleet. Other requirements call for new buildings.

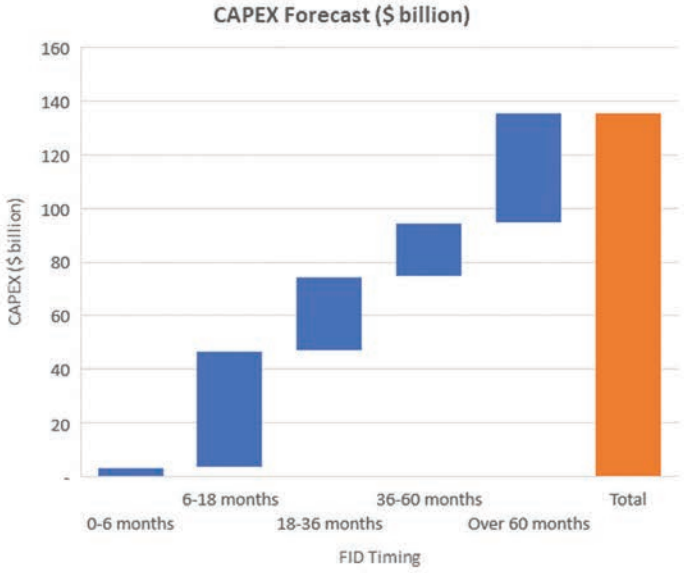
Details off all the projects in the forecast are provided in the report.

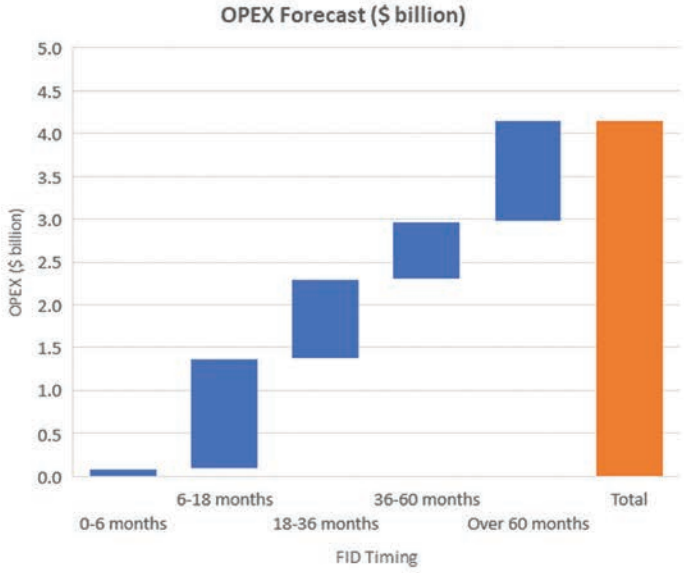
Summary Forecast for US Offshore Wind Projects

Summary forecast ($ billion)	GW	CAPEX	OPEX/yr	DECEX
0-6 months	0.8	3.1	0.1	0.4
6-18 months	12.7	43.6	1.3	5.7
18-36 months	9.1	27.8	0.9	4.1
36-60 months	6.6	20.2	0.7	3.0
Over 60 months	11.6	41.1	1.2	5.2
Total	**40.8**	**135.8**	**4.2**	**18.4**

WER Database

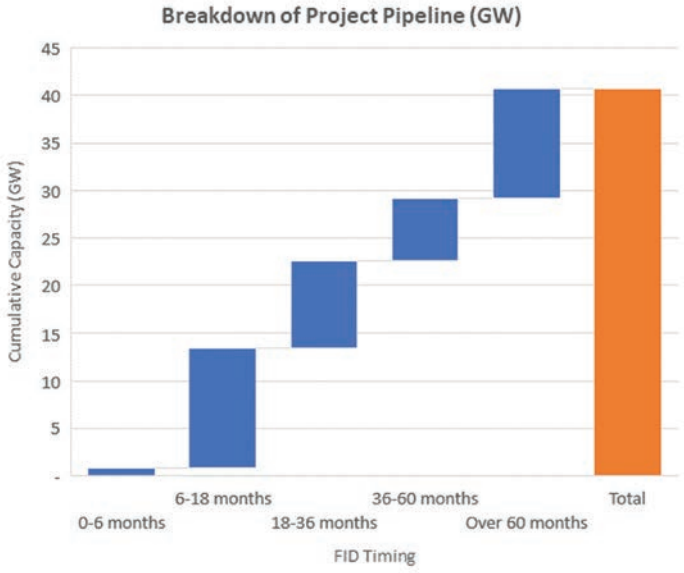
CAPEX and OPEX Forecast





WER Database

US Offshore Wind Forecast



WER Database

For more information about the report visit ***www.worldenergyreports.com*** or contact Rob Howard at +1 561 732 4368 or Philip Lewis at +44 203-966-2492

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INTERNATIONAL WIND TURBINE AND FOUNDATION INSTALLATION VESSEL MARKET

As of end-June 2021, more than 100 turbine and foundation installation and maintenance vessels will be required for offshore wind projects planned over this decade.

By Philip Lewis IMA/WER

More than 100 turbine and foundation installation and maintenance vessels will be required for offshore wind projects planned over this decade. Almost all of the current fleet of international wind turbine installation vessels will be technically redundant as installation vessels by 2025 as a consequence of the rapidly growing wind turbine sizes, greater water depths and increase in foundation size. Demand will be satisfied by more than 60 newly constructed or upgraded vessels – presenting a $14B opportunity for engineering firms, shipbuilders and conversion yards, equipment suppliers, service providers and those who finance marine assets.

Foundation installation requirements are also rapidly changing. Market requirements are now shifting to purpose-built wind foundation installation vessels capable of handling the largest monopile foundations. More specialized vessels will be required for this purpose.

As well as uncertainties posed by the rapidly evolving technological terrain, installation vessel owners are also having to navigate their way through evolving local content requirements in Taiwan, Japan, the U.S. and elsewhere.

China is a relatively closed and busy offshore wind market with its own demand drivers. Chinese WTIVs are unlikely to operate outside of China. In fact, it is more likely to see smaller installation vessels redeployed to the Chinese market, especially as they become less technically suited to international demand.

These are the findings in a new report *International Wind Turbine and Foundation Installation Vessel Market* recently completed by World Energy Reports.

The 70+ page report provides a guide to understanding the drivers that will shape requirements in this growing, globalizing and technically evolving industry. The report examines the structure of the installation industry, profiles the underlying market drivers, forecasts wind installation activity through 2030 and identifies installation vessel technical requirements to meet future demand.

Summary Forecast for Global Wind Turbine Foundation Installation Vessel Orders

Summary Forecast ($bn)	Vessels	CAPEX ($ billion)
WTIV	49	11.8
Wind Foundation Installation Vessel	12	2.4
Total	61	14.2

Source: WER Database

INTRODUCING OFFSHORE WIND TURBINE AND FOUNDATION INSTALLATION VESSELS

Until now installation requirements have been largely satisfied by WTIVs and heavy lift vessels designed for the oil & gas and port/salvage market. Market requirements are now shifting to larger capacity WTIVs and purpose-built wind foundation installation vessels capable of handling the largest monopile foundations.

A WTIV is a self-propelled self-elevating jack-up with a crane capacity of 600 tonnes or greater for lifting a WTG set in 5-6 lifts. WTIVs perform a range of functions as part of the

WTIV Activities and Attributes

Scope	Activity/ Demand Driver	Key vessel attributes
WTG T&I	WTG transportation from marshalling ports to offshore construction locations and installation of WTG sets is the main demand driver for WTIVs. A complete WTG set comprises of the tower, nacelle and blades. Lead-time ~2-3 years. Medium term contracts (months).	**Higher lifting mode:** Crane hook outreach and height above deck for lifting WTG components without damaging fragile blades and nacelle. **Stability:** Provided by the jacking system to reduce marine related movement. **Carrying capacity:** Judged by the VDL (variable deck load) and free deck area.
WTF T&I	Transportation of foundations (mainly monopiles) from manufacturing facility or marshalling port to site and installation of WTF's. Demand driven by WTGs and occurs ~1/2 to 1 year before WTG installation . Lead-time ~2-3 years. Medium term contracts (months).	**Heavy lift mode:** Crane with a hook height to install monopiles and jackets. **Carrying capacity:** Judged by the VDL (variable deck load) and free deck area.
WTG O&M	Scheduled and unscheduled maintenance and repair services. Includes blade repair and major component replacement. Shorter lead times. As the industry matures, with a greater number of WTGs offshore, O&M support demand will increase.	**Crane capacity.** Crane hook outreach and height above deck for lifting WTG components without damaging fragile blades and nacelle. **Availability:** O&M campaigns have helped WTIV owners maximize fleet utilizations and reduce idle time between construction jobs.
Decommissioning	Decommissioning at the end of the 20 to 30-year turbine life.	**Crane capacity:** Crane hook height and capacity.

Image credit: Fred Olsen Wind Carriers (top image), SIF (bottom image)

Wind Foundation Installation Vessel Activities and Attributes

Image credits: OHT

Scope	Activity/ Demand Driver	Key vessel attributes
WTF T&I	Transportation of foundations from manufacturing facility or marshalling port to site and installation of WTF's. Demand driven by WTGs and occurs ~1/2 to 1 year before WTG installation. Lead-time ~2-3 years. Medium term contracts (months)	**Heavy lift mode:** Crane with a hook height to install monopiles and jackets. **Carrying capacity:** Judged by the deck load and free deck area.
WTG T&I	DP3 WFIV vessels are seen as having a capability to install WTGs, especially in areas of poorer soil conditions for jack-up operations (such as Taiwan).	**Higher lifting mode:** Crane hook outreach and height above deck for lifting WTG components without damaging fragile blades and nacelle. **Station keeping:** Provided by DP3 dynamic positioning capabilities.
Decommissioning	Decommissioning at the end of the 20 to 30-year turbine life.	**Crane capacity:** Crane hook height and capacity.

offshore wind farm supply chain:

A new generation foundation installation vessel is a self-propelled DP2/3 vessel with a large deck space for carrying foundations from the manufacturer's facility direct to site and with a crane capacity of 3,000 tonnes or greater.

OFFSHORE WIND OVERVIEW

From the first eleven 450kW wind turbines at the 5MW Vindeby windfarm, commissioned in 1991 in Denmark, offshore wind has grown to reach over 32GW of cumulative installed capacity by the end of 2020 provided by 18 countries. Almost all capacity is bottom-fixed – except for some floating wind pilot arrays.

Northwest Europe and China accounted for 99% of installed capacity at the end of 2020.

The UK was the single biggest market, accounting for 32% of global capacity by at the end of 2020. Germany was the second largest market with 24% of capacity. This activity has supported the development of a significant industrial base for wind farm component manufacture installation capabilities. Europe and the UK has taken three decades to industrialize the offshore wind supply chain. The 1990s and early 2000s where characterized by comparatively small demonstration projects aimed at testing offshore wind technology. Commercial scale wind farms only started to appear at the start of the last decade. Wind farm development in emerging non-European markets (Taiwan, Japan, the U.S.) has been supported by European manufacturing capacity and installation vessels.

China has witnessed a surge in offshore wind activity since 2015, grid connecting 22GW of capacity by the end of 2020. The foundation of the current offshore wind boom is subsidies available for projects approved before the end of 2018 and grid connected by end 2021. Much of China's initial wind farm activity can be classed as intertidal, in very shallow water falling within 10km offshore. More recently wind farms have moved outside of the tidal zone into offshore waters. China is a relatively closed and busy offshore wind market with its own demand drivers.

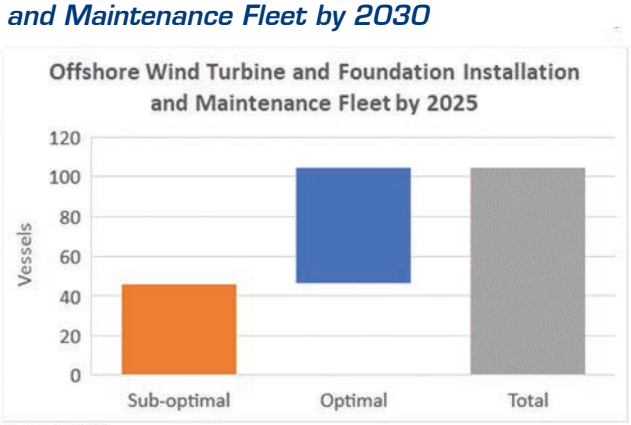
For a wind turbine and foundation installation perspective, we see three relatively distinct markets driving demand:

- **International:** This segment is considered largely open for all international assets. Over time, certain markets like Taiwan, Japan, the U.S., and South Korea will see an increased supply of locally flagged and owned assets at which time these markets will become increasingly locally content driven. Bottom-fixed solutions (up to 60-70m) will drive growth. Floating wind segment will develop through this decade in most of these markets, both for deeper water (over 60m water depth) or in shallow water poor soil conditions – possibly for the Baltics and Taiwan.
- **China:** A discrete installation market, that may take assets from the international supply but is unlikely to contribute to the international supply side in the foreseeable future. Initially an intertidal market, China is developing as a bottom-fixed market.
- **Vietnam:** a largely intertidal market not requiring modern purpose built WTIVs/WTVFs.

In the mid- to long-term, we are tracking offshore wind projects in 38 countries. Our Base Case forecast identifies around 235GW of installed capacity by 2030, around 96% of which will be bottom fixed. This activity will drive the installation of over 9,300 wind turbines and foundation in the

Summary of Market Size, Local Content Preference and Development Type

Offshore Wind Turbine and Installation and Maintenance Fleet by 2030



Source: WER

international market through 2030 and over 8,000 in China.

The international and Chinese market will be installing different turbines and foundations. The international market will be mainly supplied by three leading OEMs – Siemens Gamesa Renewable Energy, GE and Vestas. The largest wind turbines installed today are the 8-10MW turbines. 12-14MW turbines will dominate mid-decade activity and 15MW+ turbines will be deployed at scale from 2027. The Chinese market will move away from 4-6.5MW turbines to 10MW and over by the middle of the decade.

UNDERLYING TECHNICAL DRIVERS

The speed of wind turbines output evolution has been rapid – larger wind turbines deliver higher outputs and higher capacity factors which leads to project cost reductions. As the size of wind turbines grows, so too must the size of WTIVs.

Larger wind turbines output results in heavier and larger components (nacelle and hub, blades, and towers). The heavier components drive heavier foundations to support the increased wind turbines loads. The longer carbon fiber blades that all larger rotor diameter wind turbines have drive higher lifting heights.

Foundations will generally be installed in the year before turbine installation. The steel monopile has been the predominant bottom-fixed foundation solution in the international market to date. It is expected that the monopile will continue to be deployed in large numbers of international projects in the future. We anticipate that monopiles and jackets will account for over 95% of bottom fixed foundations through 2030. Larger wind turbines and deeper waters are resulting in very large monopiles, most of which cannot be installed by today's WTIV fleet.

WIND FARM CONSTRUCTION AND MAINTENANCE VESSEL FLEET

We forecast a global fleet of around 105 wind farm construction and maintenance vessels by 2025. Close to 60 WTIVs and foundation installation vessels will provide the backbone of the wind farm turbine and foundation installation capabilities by the middle of the decade. Although being suitable to perform wind farm maintenance duties, our forecast indicates that the majority will focus primarily on construction work.

An additional 45+ vessel, grouped as sub-optimal for installation activities, will support some construction work, particularly in China, as well as servicing important O&M demand.

The figures exclude some 125 oil & gas and port/salvage heavy lift vessels, some of which have been used to support offshore wind projects in the past and will occasionally provide solutions on specific project challenges in the future.

A $14B CAPEX OPPORTUNITY

World Energy Reports expects that more than 35 optimal WTIVs and foundation vessels will be required to meet international turbine and foundation installation demand through 2030 amounting to over $10 billion of CAPEX. The Chinese market demand will be met with around 25 additional WTIVs and foundation vessels for close to $4 billion of CAPEX. Details off the forecast are provided in the report.

For more information: ***www.worldenergyreports.com*** or contact Rob Howard at +1 561 732 4368 / howard@marinelink.com or Philip Lewis at +44 203-966-2492

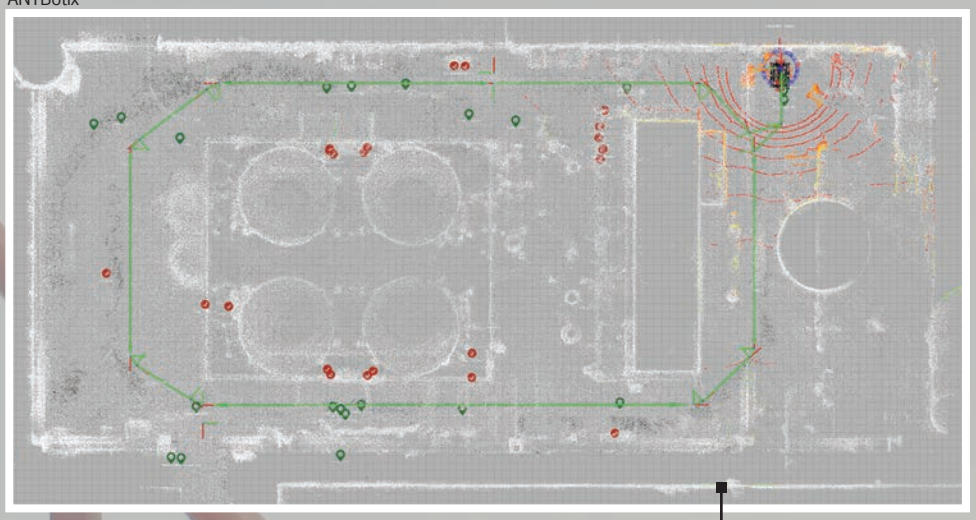
MEET YOUR NEW

OFFSHORE ROBOTIC CO-WORKERS:

Charles, Eddie, ANYMal & Spot

ANYBotix

ANYBotix



The mission user interface for ANYmal, used on the Petronas trial.

ANYBotix' **ANYmal** C legged robot took its first steps offshore on Petronas' Dulang C platform, Malaysia.

Within the last year, **a series of significant steps have been made in the world of offshore robotics:** *a number of legged and tracked robots made their first steps onto and around offshore facilities in Malaysia, the Netherlands, Norway and the US. For operators, it's a big leap to have these things on facilities. For technology developers, it's a big step towards future potential adoption offshore.*

By Elaine Maslin

In August last year (2020), Total Netherlands claimed a first offshore autonomous mission for an ATEX robot. The Taurob vehicle was used in the condensate recovery area of the bridge-linked K5 Central Complex offshore gas production facility. Its tasks included autonomous missions and external corrosion and painting inspection, as part of evaluating use cases for these systems.

In September last year, Petronas took an ANYBotix ANYmal C quadruped robot to its Dulang B facility 200 km offshore Malaysia. Locomotion and autonomous navigation were tested, as well as general visual inspection, thermal imaging, audio recording and battery charging, over a three-floor water injection module due to the robot not being EX certified yet.

Then, in the three months October through December last year, BP trialed a Boston Dynamics Spot quadruped robot on the Mad Dog platform in the U.S. Gulf of Mexico to replicate the work personnel would do in walking the platform looking for anomalies.

The same month, a version of Spot was taken onto Aker BP's Skarv FPSO to trial its mobility as well as communications between it, software services firm Cognite's Cognite Data Fusion platform and Aker BP, with remote control of the robot from a home office onshore. Spot has also been trialed at Woodside's onshore facilities.

Robots are seen to offer a number of opportunities, from reducing the exposure of personnel to harsh or dangerous environments and or reduce emissions by having lower footprint assets to being able to operate in places that might otherwise not be possible.

"Robots for us are an opportunity, a tool for a new business opportunity, for areas we might not be able to go otherwise," says Eric Bartoli, head of remote operations and robotics – R&D, TotalEnergies. TotalEnergies has been working on robotics for some time. Its goal is to be able to support normally unattended facilities, that would be unattended for a one-year long period at a time, says Bartoli. To do that, facilities need to be more reliable, and electrification plays a big role there. But there will still be a need for some form of 'eyes' on site, and even intervention capability, which is where robots come in.

TotalEnergies' first step was the Argos (Autonomous Robots for Gas and Oil Sites) challenge from 2014-2017, developing the "first ATEX autonomous ground robot". Since 2018, it has been part of the Offshore Ground Robotics Industrial Pilot (OGRIP), an OGTC-supported project, which has developed Taurob's Argos-winning robot further, creating the now commercialized Taurob Inspector; a tracked vehicle able to travel around a platform to collect various data (video, infrared, sound, remote gas detection, etc.).

August last year was the first time a Taurob Inspector was taken offshore, for a one-week trial on the K5 facility in Netherlands. Taking robots to work sites offshore is a critical learning step, says Bartoli. For example, while on K5, it became obvious a robot there would need to be able to open doors to get around, due to wind shields on the facility. Being able to move on different floorings has also been a lesson – multiple, in fact. The first trials at an onshore test site with grated floors saw the vehicle's tracks destroyed within three weeks, says Bartoli. These were improved to be able to work on the grated floors. However, new sandpaper-like anti-slip flooring installed in the test facility at Lacq has again shown higher level of wearing for tracks. Without testing, robot manufacturers don't know about these issues that are specific to offshore oil and gas assets, says Bartoli.

It's just as important to prove reliability, he says. Which is why, in November (2020), two Taurob Inspectors (named Charles and Edward) were handed over to TotalEnergies for a 12-month trial at Shetland Gas Plant, where only Total staff are

Boston Dynamic's Spot quadruped robot posing during its trials on bp's Mad Dog facility in the US Gulf of Mexico.

BP

operating them. There, they're doing rounds autonomously in a MEG (gas dehydration) treatment unit. This is a big step, says Matthias Biegl, co-founder at Taurob. "Using robots in an operational environment with us not being there, handing over to the operators, is a big stepping-stone and that was a milestone for us and for ground robots in oil and gas," he says. It's also a virtuous feedback loop says Bartoli, helping TotalEnergies to learn how to use the robot and how it will fit in operationally, as well as how to improve the robot. It also supports building acceptance of using robotics in operations; both within their peers, i.e. other operators, as well as staff on the ground, as it were.

However, the Taurob Inspector is just the start. The next step is to introduce manipulation capability, first for simple tasks, like opening or closing valves, says Bartoli. Testing on the components for this capability has started with a first prototype expected in Q2 next year. A second track is adding more dexterity, he says, for performing simple maintenance tasks, such as changing a filter cartridge. Work on defining the specifications for this is ongoing.

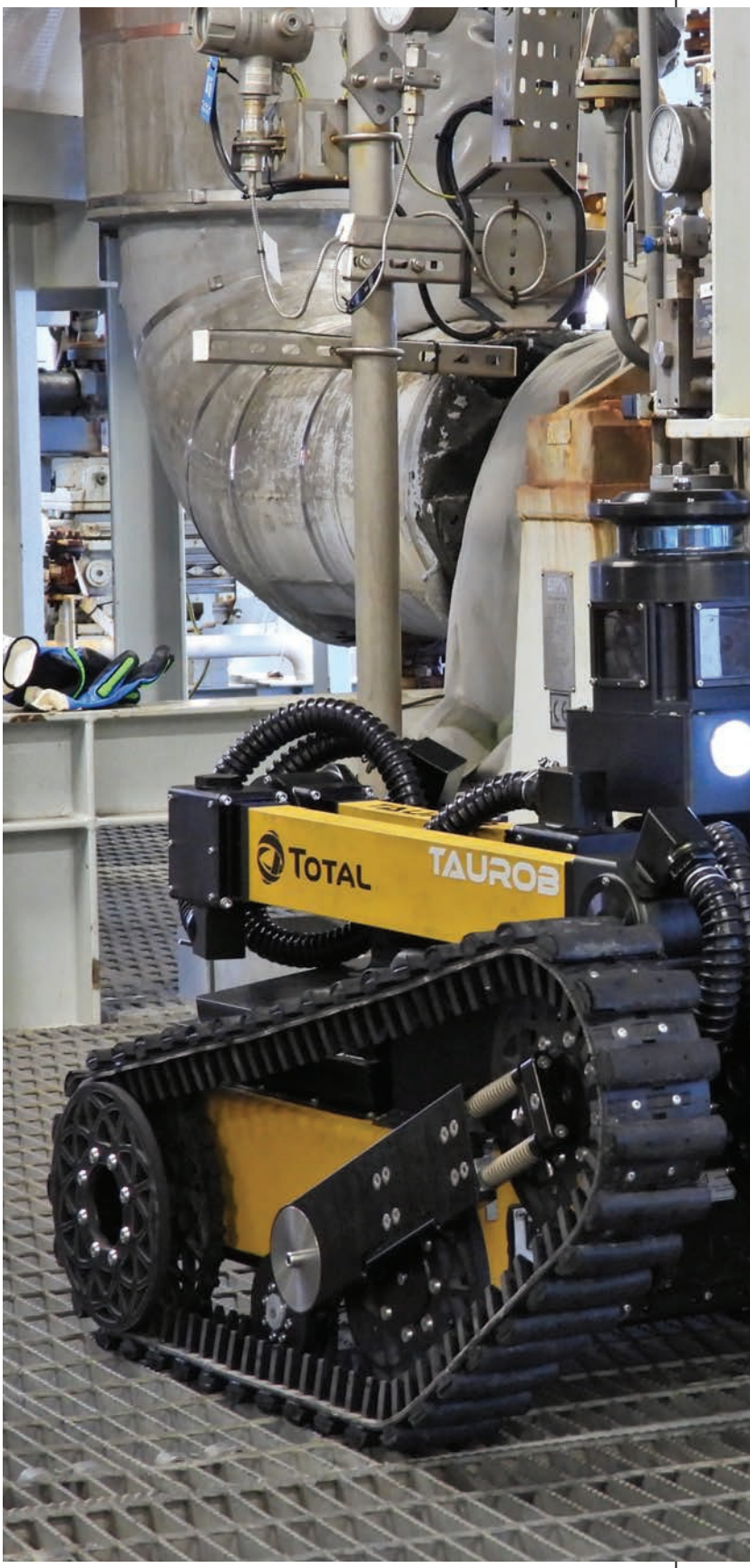
For this next development, TotalEnergies is part of a joint industry project (JIP) using the OGRIP chassis to create an ATEX and IECEx certified offshore work class robot (OWCR), with partners Equinor, Total-owned battery maker SAFT and robot maker Taurob. This will include interchangeable light and heavy-duty arms, unsupervised autonomy and universal interfaces for mission-dependent attachments such as gas sensors.

And this is key. TotalEnergies doesn't want specialised robots for specific tasks. Instead it wants to have interchangeable tooling or sensors, similar to how ROVs swap out tooling, such as the manipulator or a gas detector, with standardised interfaces so that different vendor robots and tooling can be interchanged, enabling greater uptake within the industry, says Bartoli.

Crucially, it will also involve the introduction of the first ATEX/IECEx lithium-ion battery in the energy range 500 to 1000 Wh, that are being developed by SAFT. Currently, nitrogen blankets are needed around lithium-ion batteries to make them ATEX safe, says Andy Bell, Project Manager at OGTC, a technology accelerator, or older batteries have to be used with poorer charging rates and lifecycles. The new batteries will also be able to operate harsher environmental conditions, including temperature ranging between -30°C to +60°C.

Petronas

For Iskandar Mahmood, Manager (Robotic), Petronas, "The motivation for having industrial inspection robots is to reduce HSE risk by minimizing offshore work force deployment, reduced OPEX, due to reduced offshore workforce logistics, and improved data taking and storage and automatic report generation," he told a SPRINT Robotics seminar earlier this year.

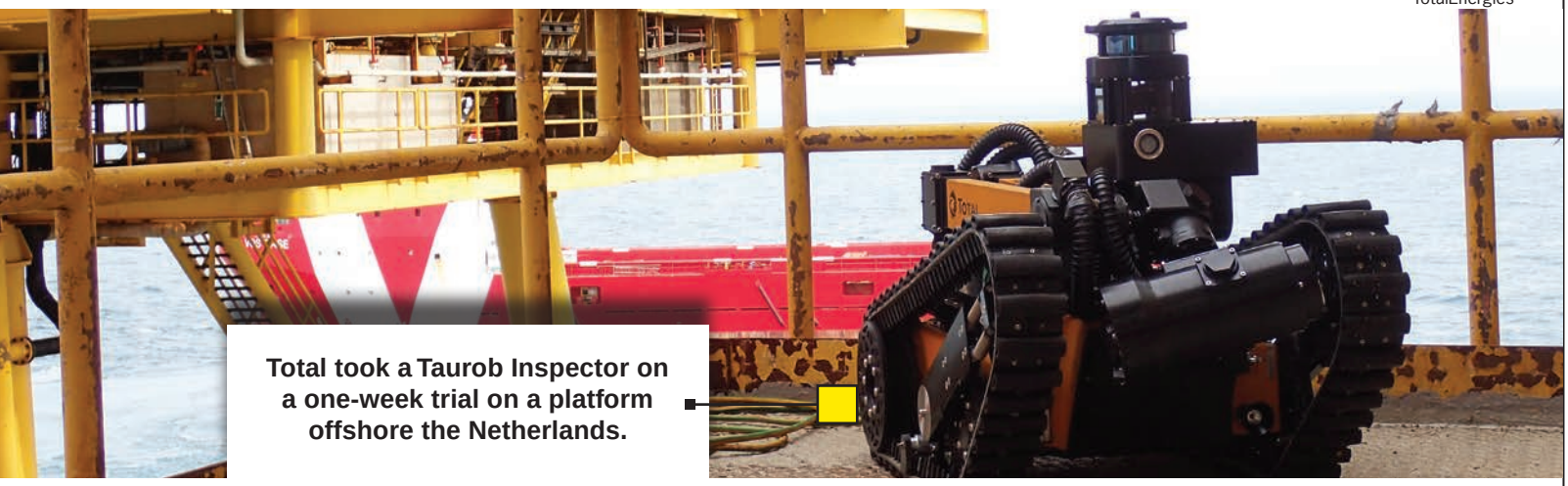


Charles & Eddie

Two Taurob Inspectors, Charles and Eddie, are on a 12-month trial at Shetland Gas Plant in Scotland.

TotalEnergies

TotalEnergies



Total took a Taurob Inspector on a one-week trial on a platform offshore the Netherlands.

Following onshore testing at the Institut Teknologi Petroleum Petronas (Instep)'s Upstream Downstream Training Plant in Malaysia, Petronas took its ANYmal C offshore for three weeks testing on a hydrocarbon free platform as the robot is IP67 rated (water and dust-proof), but not EX-rated. "We made use of the sensors onboard to perform a general visual inspection and read analogue and digital gauges, do thermal imaging and record audio emitting from a pump and battery recharging," he said. The platform was also mapped over four floors, with navigation via pre-programmed way points, including traveling up 36 narrow steps with a 45-degree incline. "It was always windy, the wind speed was about 17 knots but it didn't affect the stability of ANYmal. We went up to third floor, performed three inspection points and then came down again and we tested this a few times and it was a success."

Walking up stairs is no mean feat. To get here, the offshore industry is leveraging decades of work, not least by the likes of Boston Dynamics, an MIT spin-out now famous for its videos of robots either falling down or, today, performing synchronized dance routines. It's now owned by Hyundai (indicating their definite move into the commercial realm). Balance for a quadruped means having to continuously send commands maybe 400 times a second, based on an array of sensors constantly telling the software to adapt, says Maurice Fallon, Associate Professor in Engineering Science, at Oxford Robotics Institute. A lot of actions are now highly simulated before being put into action on a robot, taking into account forces that will be involved and the algorithm design. Some of the sensors robots used have also advanced, such as depth cameras. Eight years ago, robots relied on stereo cameras. Now they have 4-5 depth cameras to help them understand their environment, as well as torque-based balance algorithms and decision making – whether to step on a certain terrain or not.

Boston Dynamic's Spot is commercially available for $75,000, and has been used for social distancing in Singapore and in the U.S. by state police, says Fallon. "A primary use case is probably in industrial inspection," says Fallon, such as offshore, remote or nuclear facilities, that otherwise mean putting someone in harm's way.

But there's also still more work to do for the offshore industry, in addition to developing ATEX batteries and manipulation capabilities. For Petronas, the next steps are further pilots at a fabrication yard, a regasification terminal and CPP with ANYmal C. But from 2022, it wants to then trial ANYmal CX, which will be an ATEX certified ANYmal. This year Equinor will also take a robot offshore.

Meanwhile, following its Mad Dog trials, bp has said it plans to look more into ways robots could 'see' things humans can't, using multispectral and hyperspectral imaging. "The idea is there for a robot to be able to see things a human eye can't see, such as methane emissions," says Adam Ballard, bp facilities technology manager.

As well as solving the battery and manipulation challenges, there are other tasks to solve. One challenge is that existing infrastructure hasn't been built with robots in mind. Building environments that are prepared for robots would make some of their life easier, especially for maintenance tasks. That includes having reliable communications infrastructure, enabling connectivity with the robot and the human in the loop supervision or control that will be essentially initially. While the robots have computing on board, access to the cloud and cloud applications is an important topic, says Biegl. "If we're operating 200 km offshore, we need low latency to make it work," says Bell, "especially while the autonomy is being built – and it's not quite there yet, he says.

"I think the building blocks are there," adds Bell. "A lot of companies are out there developing solutions that need to be used in anger. But there's no real testing center, so it's difficult

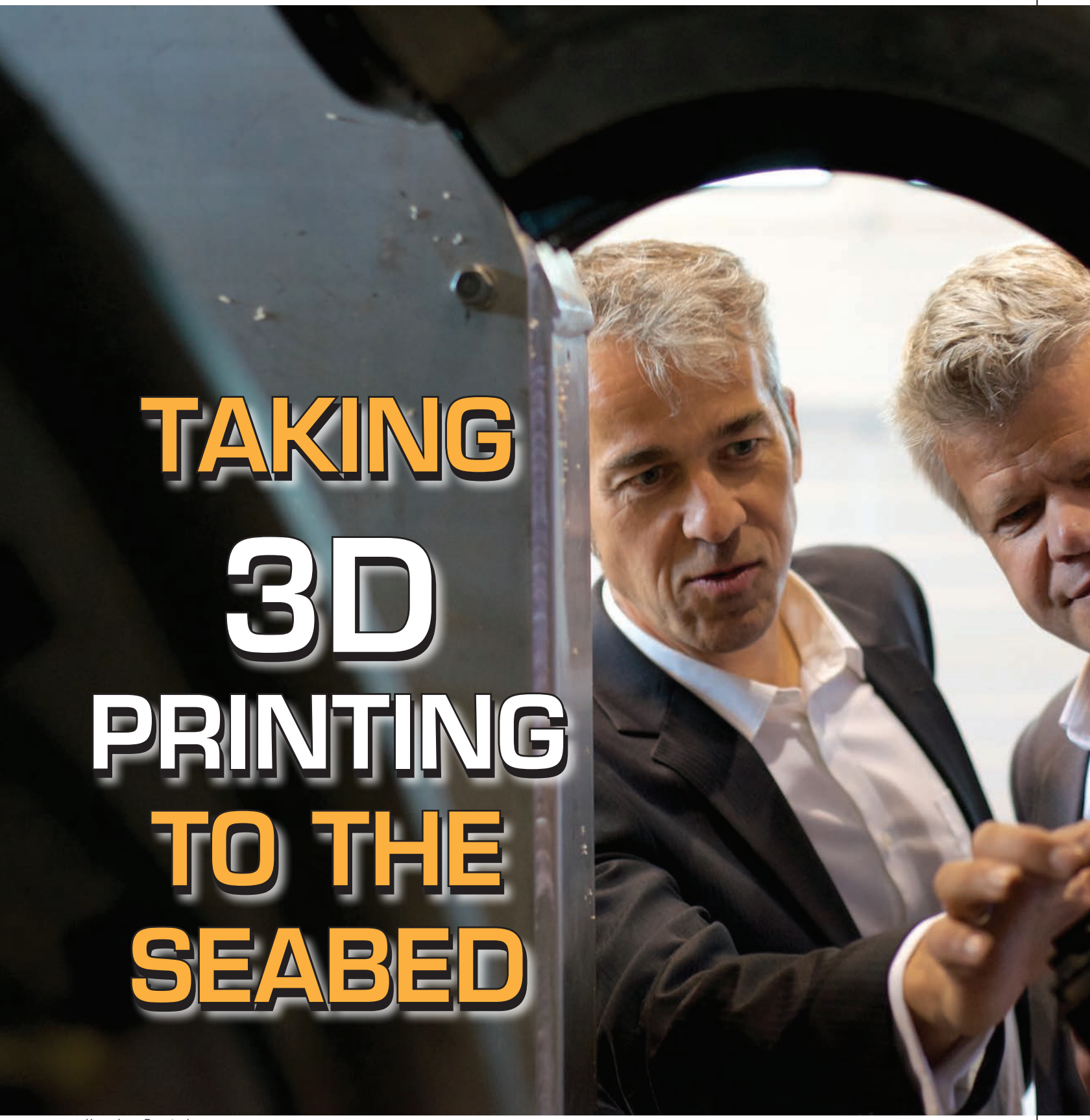
to do extensive testing to have comfort and believe the robot can do the job. The majority of developers are not from an oil and gas background, they don't understand it and the harsh environment, so there are going to be gaps and there are some lessons learned for developers when they are on site."

Even when high reliability is demonstrated, "To go from there to unmanned operations is another order of magnitude," says Fallon. And then there's also being able to show that these machines add value. "Operators need to see value in using these machines because deployment of new technologies always bear risks," says Biegl. "Like Total and Equinor, you need to have a vision as an operator to see this as the future and dive into it and engage financially. These machines are complex and you need skin in the game. Adoption also needs education within these corporations, especially for the people who will work with these robots."

Fact file

Taurob Inspector is now commercialized and will be manufactured to scale in France and hopefully deployed around the world with partner Dietsman. It's a tracked vehicle with cameras, Lidar, smart algorithms to detect a valve or pump gauges to see if they're operating in the right parameters or to do a general visual inspection of corrosion. It also has microphones so it can get a base frequency of a value and then hear if it's operating out of that frequency. It will also have thermal imaging in it for gas releases, weeps and seeps.

ANYmal is a quadruped with an open API based on ROS industry standards to integrate robots and is able to operate for 90 minutes and recharge in 100. It has various sensors, including Lidar, a visual camera with 20X optical zoom, for images and video at 4k resolution. It has a thermal camera, ultrasonic microphone for acoustic measurements and LED spotlight. The sensor pack can be extended with up to 16kg additional payload. With its Lidar it can track structural changes in the environment. ANYmal says it can connect though Wifi, 4G LTE but doesn't need continuous connectivity because of the sensors and intelligence onboard. In 2018, an ANYmal was taken offshore the Netherlands for a one-week trial aboard an offshore work transformer platform.



TAKING 3D PRINTING TO THE SEABED

Kongsberg Ferrotech

Kongsberg Ferrotech technical manager Torgeir Bræin and CEO Christopher Carlsen.

Underwater pipeline repair is an unavoidable and also fairly intensive activity within the offshore industry. There's a lot of pipeline on the seabed, some of it is old and/or subject to corrosive substances and even damage by anchor or trawler gear. Until now, its repair is largely through installing clamps over specific defects or cutting out and then welding in new sections, when there are multiple defects or a more extensive issue, ***reports Elaine Maslin.***

Norwegian company Kongsberg Ferrotech has come up with an entirely new solution. The company has developed a self-propelled robotic system for performing close inspection and in-situ composite and soon also 3D printed repairs, to rectify defects, restoring integrity and prevent integrity loss. The company calls it 'taking the workshop to the defect' and it's targeting subsea pipelines and cables.

The company was founded in 2014 in Norway's Kongsberg region – a strong subsea hub, despite its distance from the sea. CEO Christopher Carlsen comes from FMC Technologies (now part of TechnipFMC), while technical manager Torgeir Bræin was at Equinor and FMC Technologies before that. They're joined by Lois de la Torre, an entrepreneur who comes with background from coating and pipeline repair industry.

The company's first target is composite repairs. "Composite repairs are now well-known topside, but there have been relatively few subsea applications," says Carlsen. "We think that's mainly due to the difficulty in applying it in a controlled and repeatable way (subsea)." To solve this challenge, over more than five years, the company has built the Nautilus subsea habitat; a self-propelled pipeline inspection and repair system delivering DNV qualified composite repairs even for through-wall defects.

"Nautilus is the first ever robotic solution for inspection, repair and maintenance of subsea pipelines," says Carlsen. It's a robotic inspection and repair system that lands over a pipeline defect (already identified and located through internal pigging), then creates a dry controlled habitat in which it can then further inspect the defect, delineate how it needs to be repaired, then prepare the pipeline for repair and then perform the repair.

"A single robot can cater for a range of diameters – you can build a repair clamp, in-situ using polymers and carbon fiber, also cutting out lead times," says Carlsen. "And it can be deployed from a vessel of opportunity." To give an idea of its scale, the robot for 8-16 in. pipelines weighs about 4 tons and measures about 3m x 2m x 3m.

It's similar to habitats that have been built for carrying out welding on subsea pipelines, except it's designed to repair rather than replace defects. It's also self-propelled, us-

Kongsberg Ferrotech's Nautilus subsea pipeline repair habitat.

Kongsberg Ferrotech

ing ROV thrusters and guiding aids so that it doesn't need the support of an ROV or diver to move it into position. It's been designed to be completely self-contained, including waste material, so all materials produced during the process, such as pipe coating that's been removed to carry out the repair, are contained and returned to the surface. Throughout, the entire process is monitored by cameras, says Carlsen, so the client can witness it from start to finish. Repairs can cover a range of defects from small pits to through-wall defects, because of the flexibility afforded by applying composite materials, with curing of the polymer using potable water, the firm says.

An in-water test composite repair test using the system was completed in Trondheim Fjord in Norway last year (2020), with a prototype supported initially by an ROV. The technology will be ready to be deployed on commercial applications and operations in Q3 2021, Carlsen says. Kongsberg Ferrotech is initially targeting Southeast Asia where it says there's a relatively large amount of wet gas production where internal corrosion is a common issue. PTTEP of Thailand has been our partner through the development of the Nautlus, and will also be the pilot client for introducing the service in the region, says Carlsen.

In tandem with commercializing the composite repair system, it has been working on adding 3D printing to Nautilus' capabilities and has recently joined forces with Equinor, SINTEF and Gassco, with Norwegian National Research Council funding and support from part-owner-incubator Kongsberg Innovation to make this happen. Just like the composite repairs, the process would be done inside the Nautilus platform using additive manufacturing techniques to rebuild damaged metal structures in-situ. "It's like building the equivalent of a steel clamp directly on to the pipeline with off-the-shelf mate-

Normal welding usually involves welding together two pieces of pipe or structures. With AM, you add material to build strength or geometry, that's the elegance. There is huge potential applying AM and that way of thinking, instead of replacing something, repair it and add lifetime and money. It's more sustainable.

Brede Lærum,
Head of 3D printing at Equinor, which is a partner on the first use case for additive manufacturing (AM)

rials and without the waiting time associated with acquiring a clamp," says Carlsen.

"For a high-pressure application with long lifetime requirements or extending the design life the ideal solution is to make a repair or functional upgrade with the exact same material you have on the flowline," says Bræin. "With 3D printing you can do that and build up, layer by layer, with different metals, aligned with existing design codes." As well as creating a repair, Kongsberg Ferrotech has developed technology to create a digital twin of the pipe section, replicating it and the repair, to allow for simulations to be run to ensure that it repair will work. The operator then also has an exact record of their pipeline, its dimensions and how much fiber or welding was done, says Bræin. The firm says the goal ranges from preventive maintenance, to prevent a defect from getting worse, through to full wall loss and significant corrosion repairs.

Brede Lærum, head of 3D printing at Equinor, which is a partner on the first use case for additive manufacturing (AM), says that 3D printing is more or less a robotic welding process, but the difference is how you apply it. "Normal welding usually involves welding together two pieces of pipe or structures," he says. "With AM, you add material to build strength or geometry, that's the elegance. You can build something or add material – to a new pipe or structure or an old structure where damage or corrosion or underwater mechanisms have caused damage. We see both topside and subsea, there is huge potential applying AM and that way of thinking, instead of replacing something, repair it and add lifetime and money. It's more sustainable."

The potential is almost limitless, he says. "The limit lies in ourselves to imagine what's possible. This new way of working offers great opportunity. Robotic repair solutions will be an important part of our future." That will include more and more floating wind turbines, he says, where damage such as cable coating will need to be addressed.

For its first user case with Equinor and Gassco, wire arc additive manufacturing is one of the technologies that could be suitable for AM, says Bræin. The goal is to have this ready to be deployed, with the procedures and design parameters in 2022. After that, the company will then add new processes and solutions, depending on customer requirements. A future development could also be printing new parts onto pipelines that weren't there originally, this could be to support a tie-in or even decommissioning, adds Bræin.

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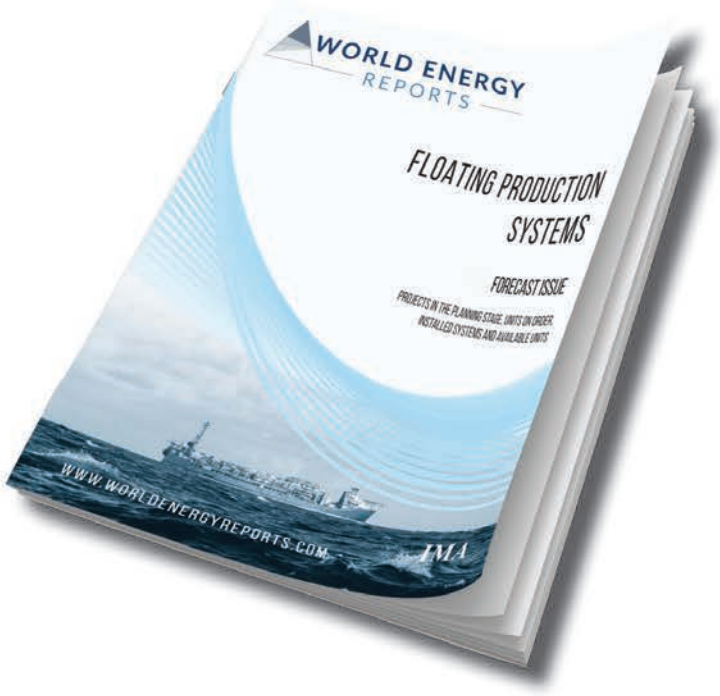

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Optimize OPEX, Minimize Carbon Footprint

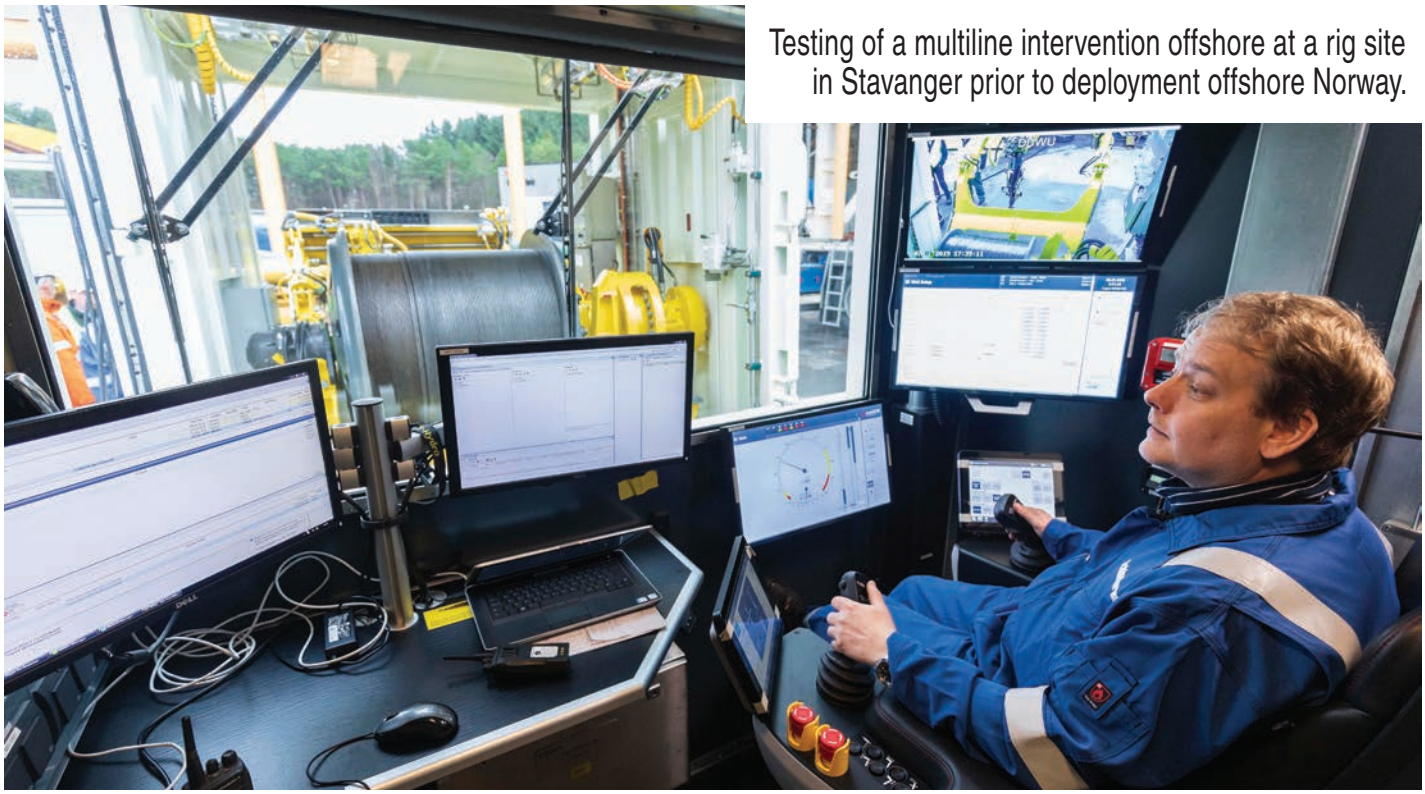
Aker BP

By Wallace Pescarini, President – Offshore Atlantic, Schlumberger

As the world begins to emerge from under the fog of a global pandemic, signs of opportunity are visible as oil and gas demand is expected to increase throughout the second half of the year. This is particularly true for international markets, where confidence in second-half outlook has strengthened based on international rig count trends and CAPEX signals. More specifically for the offshore market, indicators point to an acceleration of activity internationally and a multi-year upcycle that may extend through 2024 or 2025, including optimism for growth in deepwater activity in many of the most advantaged prolific offshore basins in the world.

While there are positive signs afoot, for the near- to medium-term there will continue to be significant focus on generating free cash flow and maximizing return on existing assets. In addition, the industry is being increasingly challenged with lowering the incremental carbon intensity of barrels produced. For the offshore market, a strategic and proactive approach to asset life extension fundamentally addresses these challenges. By approaching asset life extension proactively, we can identify new opportunities to maximize production and return on OPEX. Granted, this is not easily achieved given the historical mindset to the offshore market. The term intervention has typically held a negative connotation, in part due to the remediation nature and low historical execution success ratios. We must significantly shift our mindset — we should see proactive intervention as a means to securing optimally consistent performance.

While this fundamental mindset shift is significant, the groundwork to embrace this change has long since been laid out. By leveraging digital innovation — for our workflows, data and operations — and adopting a more open and collaborative approach — across the value chain, and amongst all players — we are performing in a manner that is safer, more consistent and environmentally sustainable than ever before.



Testing of a multiline intervention offshore at a rig site in Stavanger prior to deployment offshore Norway.

Schlumberger

Changing the Intervention Perception

For today's offshore fields, when production targets are being met, all is deemed operationally satisfactory. Over time, production declines for various reasons, most often as a result of well integrity and reservoir-related production issues. Intervention — perceived as a drastic and costly measure — typically only occurs when these issues are severe enough to significantly impact production. By only remediating post-failure or after significant production declines, the result is value erosion, deferred production and unplanned cost for remediation. These are expensive assets, and field implementation is timely and costly.

With effective intervention, we know that we can improve production at a reduced cost per barrel without having to deploy new infrastructure. Depending on the type of offshore intervention, historical studies tell us that production increases of as much as 16% can be achieved. Intervention also enables us to lower the carbon footprint associated with barrels produced. By avoiding the installation of new drilling infrastructure to optimize production, we effectively lower the carbon footprint of barrels produced.

Mindset Shift

While the efficacy of proactive intervention as a means to extend the life of existing assets is proven, factors such as risk, complexity and cost continue to impact our ability to fully embrace this strategy.

In today's environment, many are still operating with an "asset mindset" approach, wherein the possibility of damaging the formation of an actively producing well in an attempt to increase production is too risky. This mindset is counterintuitive. Intervention should be seen as being analogous to vehicle maintenance. Checking and replacing fluids periodically as part of proactive maintenance is the ideal way to ensure not just operation, but also optimal performance with longevity. Conversely, not checking and replacing fluids can cause smaller problems, which, if not addressed eventually intensify, often resulting in more severe issues and higher repair costs compared to routine maintenance. Through an evergreen or proactive approach, we can similarly ensure offshore assets produce at an optimal level more consistently.

There are also various complexities associated with offshore intervention. In most cases, a service provider is only called upon for intervention with minimal prior engagement or involvement — the bulk of planning and opportunity screening (which wells and with what procedures) is an exercise that operators conduct mostly behind closed doors. This relegates the service provider selection to a primarily procurement-driven process. However, through early engagement and collaboration, there's a huge opportunity to optimize outcomes. For example, through early engagement and collaboration across multiple domains, we can develop a prescriptive plan and screening process to identify the best can-

The Well Intervention and Stimulation Alliance was established by Schlumberger, Aker BP and Stimwell Services in 2019.

didates for interventions, and the best procedures for those candidates. With this approach we can also improve upon the overall procurement process. Today, the procurement process typically results in fulfilling a pre-defined work plan based on the contractual systems. Rather, the procurement process should seek to align the full ecosystem of suppliers and service providers — regardless of company or service provider — along the value chain to ensure a comprehensive approach is devised to optimize outcomes.

Another typical drawback of offshore intervention activity is that most operators deem the cost to be prohibitive. Because repurposing a rig for intervention can be extremely complex and costly, vessel-based solutions are emerging as both operationally viable and economically advantaged. However, a model in which an intervention vessel is scheduled for three or four jobs in a six-month period may be financially unsustainable. With a proactive approach driven by early engagement and collaboration amongst multiple players — including multiple operators — we can ensure greater reliability, viability, accessibility and predictability, all of which helps to drive down overall costs without compromising the outcome.

In the offshore North Sea, we have a recent example in which early engagement and collaboration enabled an operator to restore production through a unique combination of surveillance and intervention techniques deployed on wireline. The operator selected a cluster of candidate wells for intervention, with the main objective of securing an increase in production. Collaboration and early engagement facilitated the development of a novel approach, technical and commercial alignment helped to facilitate the project's outcome, and access to domain expertise was established amongst the subsurface teams. A combination of logging tools — a well production logging system and a multifunction spectroscopy service — was used to identify under-performing hydrocarbon intervals, bypassed pay zones and water shutoff opportunities. Subsequent remediation techniques using slickline and powered wireline intervention technologies were applied, resulting in production optimization while also reducing watercut. As a result, the operator was able to increase production by 1,200 bbl/day on four wells, while also reducing water production by approximately 15,000 bbl/day.

Digital is Key

In recent years we have seen significant leaps in digital innovation. These leaps are now enabling the next step in performance optimization. Applications such as intervention can enable even small increases in production performance or recovery factor, yet even a minor increase can yield a significant increase in value generation. Digital is enabling the industry to amplify the results of interventions, while also increasing probability. The focal point of a digital strategy is facilitated via a digital platform, which is built upon three core areas: workflows, data and operations.

From a workflow perspective, we are working with customers to transition their technical workflows from the desktop to the cloud, where artificial intelligence is proven to enhance

workflow integration and collaboration. Through digital enablement we can develop workflows that enable the identification of prime candidate wells and intervention programs in a fraction of the time, and with a higher degree of certainty and reliability.

All of this, of course, is driven by data. We now have the ability to consume historical, unstructured production data, in addition to real-time downhole and surface data. This data is used to increase the probability of intervention outcomes. E&P data ecosystems now provide us with the ability to integrate this information, including data from other systems — maintenance, tools, logistics, etc., all of which becomes integral to the development of a prescriptive intervention program.

Operations provides us with a unique opportunity to deploy asset and field digital solutions. Through a combination of intelligent and connected hardware and an edge computing platform, complemented by a cloud-based E&P data environment, we can significantly impact operations, including via remote operations or automation. For example, we can utilize data acquired from digitally connected sensors as part of an evergreen intervention selection process. With edge computing we deliver domain-specific workflows to automate repetitive or even dangerous operations. Automation is a key progressive step towards autonomous operations, which is where digital enablement will eventually take our industry. We are already seeing returns through automation, and, especially in the last year, with remote operations.

Openness

While digital enablement can have a transformative impact on intervention operations, it's important to realize that every organization's digital transformation journey is unique. Openness is thus a key enabler of success. Access to cloud environments, data sharing and collaboration, etc., all present unique challenges for energy operators. It's for this reason that Schlumberger has developed a number of strategic partnerships with key players like Microsoft, Amazon Web Services and IBM, all of which are designed to ensure operators have borderless access to digital solutions. Recognizing again that data is the key to unlocking digital transformation, we have also worked closely with the OSDU Forum to establish OSDU as the industry data standard, which we believe is an essential step towards liberating data at scale for AI applications and to enable multivendor interoperable workflows.

Openness also extends to expertise and capabilities, and developing strategic partnerships to complement this approach. This is why we launched the Subsea Services Alliance with Helix. This alliance forms an advanced subsea well construction, intervention and decommissioning portfolio, including marine support, well services, project management, and subsea well access and control. The alliance commands vessels that can handle well commissioning, intervention, artificial lift and abandonment services. The objective of the Subsea Services Alliance is to provide integrated operational designs that enable operators to maximize project safety, while also ensuring, with more streamlined interfaces, simpler and more cost-effective solutions for subsea well intervention.

Another example is the Well Intervention and Stimulation Alliance, which we established with Aker BP and Stimwell Services in 2019. This alliance endeavors to transform conventional intervention operations with clear targets of boosting hydrocarbon production on new and existing assets on the Norwegian Continental Shelf. Following a full year of operation, the Alliance had executed 80 well intervention and stimulation operations, and enabled a delivery in excess of 30,000 bbls/day incremental production by protecting, recovering or adding production through existing well stock and new well deliveries.

Changing Landscape

As the evolution of the energy landscape hastens, and with the pervasive challenges of delivering low incremental-carbon energy while maximizing free cash flow and return on existing assets, it is incumbent upon us as an industry to be more agile, if not more disruptive. For the offshore market, maximizing the value of existing assets provides us with a fundamental approach to addressing our near- and mid-term challenges, but to do so we must also embrace a new perspective. By approaching asset life extension proactively, we can identify new opportunities to maximize return on OPEX. Core to this mindset shift is leveraging digital innovation — for our workflows, data and operations — and adopting a more open and collaborative approach — across the value chain, and amongst all players. In doing so, we will successfully manage to continue delivering affordable energy to the world, all the while operating more safely, more consistently and in a more environmentally sustainable way.

We must also maintain a close eye on the long-term future. While still in production today, many of today's assets will have a second life that can help us to prepare for tomorrow. By enhancing late-life incremental returns, we can finance future plug & abandonment and decommissioning. These assets may also be repurposed for carbon offset solutions (such as carbon capture and sequestration or hydrogen). Essentially, asset life extension is as much about maximizing value today, as it is about preparing for tomorrow.

OTC & Offshore Innovaton

From Sarajevo with L(ament)ove.

As the world has been shut down in stages due to COVID for the past 18 months, the same can't be said for innovators in the offshore energy sector, many of whom will be honored in Houston August 16-19, 2021, with an **OTC Spotlight on New Technology Award.**

By Bartolomej Tomic, Managing Editor

If you read *Offshore Engineer* regularly, OTC needs no introduction. Better yet, if you're reading it right now, you are probably in Houston at OTC, as this is where the July/August edition of *Offshore Engineer* (barring any unforeseen circumstances) is being distributed.

At its peak in 2014, OTC drew more than 100,000 attendees from more than 100 countries, and while I've yet to attend personally, I've wanted to. For a journalist whose beat is offshore energy, this is like attending the Champions League finals. Despite covering the international offshore energy industry since 2010 and visiting other industry events in Houston and globally, OTC and yours truly have yet to meet face-to-face.

I came close in early 2020, when I joined *Offshore Engineer*and my new firm's editor & associate publisher, Greg Trauthwein, called and said "pack your bags for Houton."

But then, COVID 19.

In March 2020, the U.S. Embassy in Sarajevo – where I'm based – suspended visa applications and canceled my scheduled appointment. 'There is still time,' I thought, 'this will blow over in a few weeks and I'll make it to the OTC, learn about exciting tech advancements and share it with our readers extensively.' But it wasn't to be.

Just two days after my visa appointment was canceled, OTC organizers pushed to the third quarter of 2020, and eventually, as you know, cancelled the 2020 event

Fast forward to 2021 and OTC, traditionally held in May, has been moved to August 16-19. Hopefully, you're reading these lines from the NRG Park.

For me, this year too will, unfortunately, be another year where I'll miss OTC, but I'm keeping my fingers crossed for 2022, and the chance to learn more on the technology developments, and to meet the people behind the tech face-to-face, over a beer (or two)!

The *OE* crew will be in Houston this year, so stop by booth #2726 to pitch your story threads to Greg and the *OE* team. For myself, I'll borrow the outro line from seemingly everyone on YouTube: "I'll catch you guys in the next one!"

But before I go, there's something else you need to know (this is actually what you need to know, really!)

For each edition of the event, winners of the prestigious **OTC Spotlight on New Technology Award** are announced. This year is no different, with 14 technologies from 13 companies around the world selected, including five companies receiving small business recognition. Read all about the winners on the next four pages.

Dril-Quip, Inc., producer of Dril-Quip BADGeR Connector

The Dril-Quip BADGeR Specialty Casing Connector dramatically reduces HSE risks and improves well economics.

It features an automatic hands-free anti-rotation device that enables remote make-up, removing rig personnel from the red zone and eliminating the need for hand tools.

It effectively lowers the risk of injuries and hardware damage caused by dropped objects and missing components while reducing operating expenses. The BADGeR Connector makes up in 15 seconds with no service techs and no special tools compared to conventional casing connectors, which require two service techs and hand tools to install. The savings in time can equate to as much as $100,000 depending on rig rate and the number of casing strings.

Proven by testing, the Badger connector has the highest capacities, the lowest stress-amplification factor, and longest fatigue life in the industry. It features an innovative metal-to-metal, gas-tight seal to ensure reliable, environmentally responsible performance, Dril-Quip says.

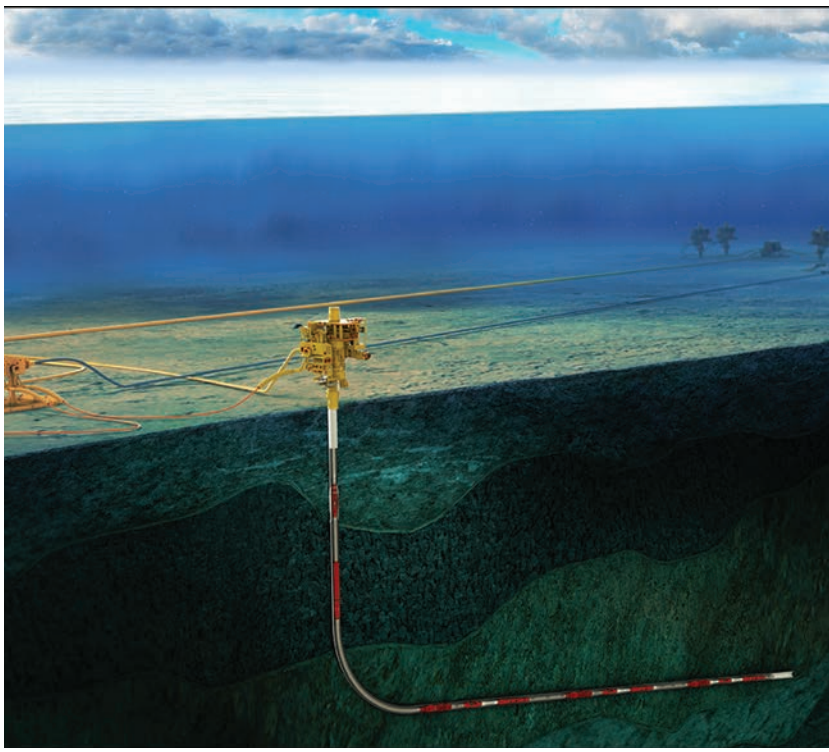
Halliburton and TechnipFMC, producer of Odassea Subsea Fiber Optic Solution

The Odassea Subsea Fiber Optic Solution integrates hardware and digital systems to strengthen capabilities in offshore reservoir monitoring and production optimization. Halliburton provides the fiber optic sensing technology and analysis for reservoir diagnostics. TechnipFMC provides the optical connectivity from the topside to the completions.

Through this collaboration, operators can accelerate full-field subsea fiber optic sensing, design, and execution. ExxonMobil selected the Odassea solution for its Payara development project in Guyana. The award followed the completion of front-end engineering and design studies and qualifications. The Payara development, located 200 kilometers offshore Guyana in 1,800 meters water depth, is the third development within the Stabroek block with current discovered recoverable resources estimated at around 9 billion oil-equivalent barrels.

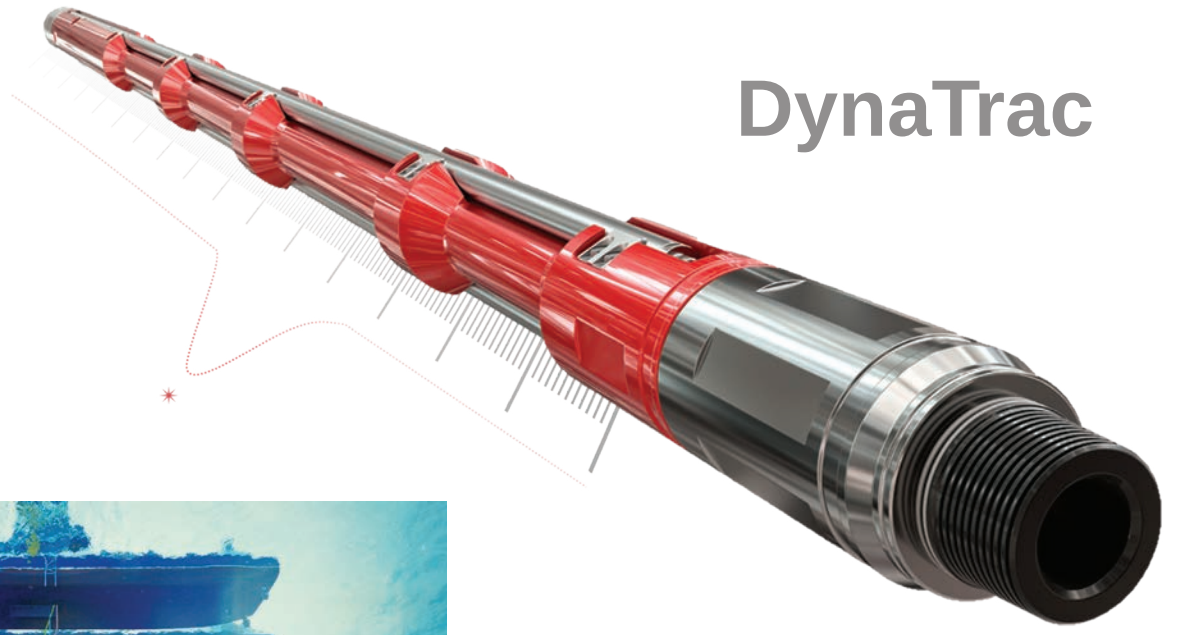
TechnipFMC and Halliburton are delivering Odassea solutions to multiple other subsea projects at all stages, from conceptual design to execution.

BADGeR



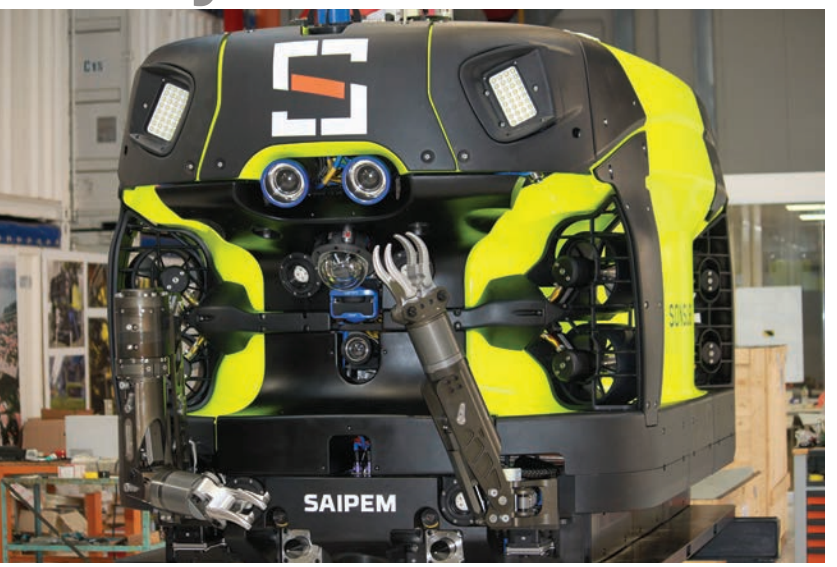
Odassea

DynaTrac



Merlin

Hydrone–R



Halliburton, producer of DynaTrac Real-time Wireless Depth Correlation System

The DynaTrac system enables operators to accurately position packers, perforating guns and the bottom-hole assembly (BHA) without running wireline or moving the work string. The system takes static measurements to determine the position of the BHA before and after setting the retrievable packer. Operators can measure depth at any time while tracking changes in position to improve operational efficiency. Through on-demand measurement of tool position, the technology reduces health, safety, and environmental risks associated with performing wireline operations.

Additionally, operators can configure the system to perform automatic position measurements to track BHA movement over time, which increases the accuracy and reliability of reservoir analysis. The technology reduces downhole uncertainty and improves reservoir insight while saving valuable rig-time.

Oil States Industries, producer of Merlin Deepsea Mineral Riser System

The Merlin Deepsea Mineral Riser System is a robust, fast, hands-free riser system with remote monitoring that enables recovery of deepsea minerals used in electric vehicle batteries and supports the energy transition. Oil States with partners has become an integrator of complete mineral collection systems from harvester to vessel. In an industry first, the Merlin Deepsea Riser System was recently design-reviewed by ABS. The system is designed to collect polymetallic nodules 6,000 meters below the surface of the Pacific.

Saipem, producer of Hydrone-R Drone

Hydrone–R is an Underwater Intervention Drone (UID), capable of performing both inspection and intervention missions and conceived to offer Life-of-Field Services focused on guaranteeing safety and productivity of Offshore Energy fields while minimizing operational costs. It is also the first-ever modular subsea resident intervention platform, integrated within the subsea field for dives up to 12 months.

In 2019, Hydrone-R was chosen by Equinor to be the first UID commercially deployed in the Njord Field Development, offshore Norway, understood to be the first ever worldwide service contract for subsea resident drones signed in the Offshore Energy Industry. The innovative value resides in:

- *vessel-free IMR,*
- *larger and more frequent data from the field,*
- *faster on-site intervention in case of any anomaly,*
- *more than 90% of CO2 emission reduction compared to conventional ROV IMR services,*
- *new field design criteria and architectures are unlocked*

Schlumberger, producer of DrillPlan coherent well construction planning solution

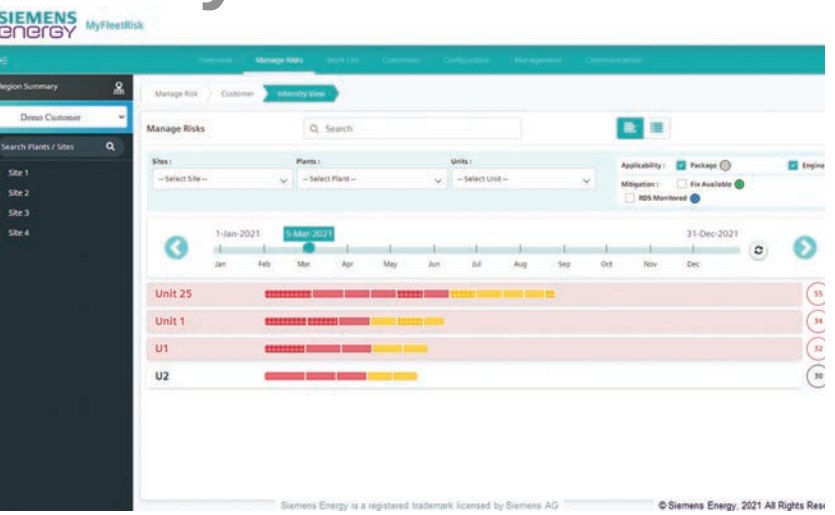
Schlumberger's DrillPlan coherent well construction planning solution is a cloud-based application that accelerates the delivery of an efficient and optimal drilling program. The solution provides a digital collaborative space that enables the discovery and consumption of offset knowledge and cross-domain engineering workflows in one place.

Data is liberated from siloed repositories to enrich the context of data-driven insights to achieve continuous improvement. Automated design and validation workflows accelerate the delivery of an efficient and optimal drilling program with a few clicks. The solution can also be connected to vendor neutral databases or applications, using application program interfaces (APIs) and open-source code, to create bespoke solutions that help operators achieve greater levels of flexibility, automation, innovation and high-powered computation.

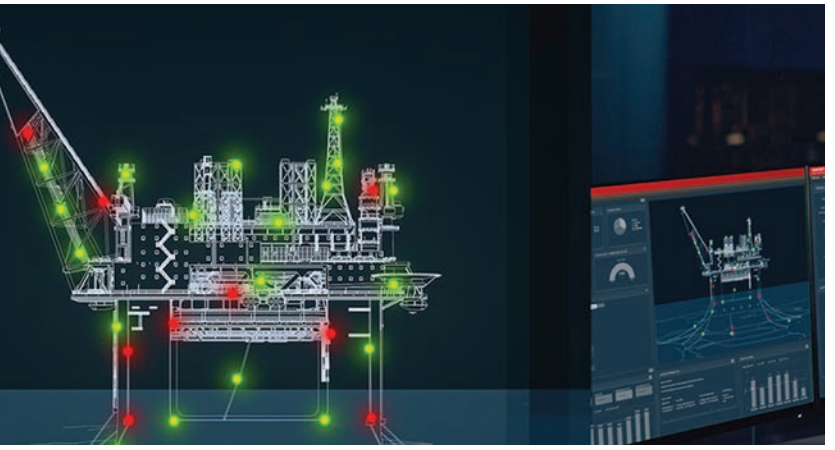
Since 2019, the DrillPlan solution has helped operators, including several NOCs and IOCs, plan more than 7,000 wells.

APM4O&G

MyFleetRisk



Subsea 7 NESP



Siemens Energy, producer of APM4O&G and MyFleetRisk

Siemens Energy won two awards for APM4O&G and MyFleetRisk solutions.

APM4O&G delivers a diagnostic and decision-support solution for oil and gas equipment, enabling a step-change in how offshore operators manage their assets. By continuously comparing real-time equipment operational data against models and running automated diagnostics, operators can forecast performance, pre-empt failures, and conduct reliability-centered maintenance.

MyFleetRisk is a data-driven, collaborative risk management platform that leverages real-world engineering expertise to quantify and visualize risk profiles of Siemens Energy's oil and gas customers' gas turbine fleets. Its transparent delivery of risk and criticality information empowers offshore operators with actionable insights without the need for connectivity in a challenging environment.

Subsea 7 and autonomous Subsea 7 subsidiary Xodus Group, producer of Subsea 7 NESP – Nano Engineered Sensor Platform

Subsea 7 Nano Engineered Sensor Platform (Subsea 7 NESP), developed in collaboration with Xodus, is a transformative solution that can continuously monitor fatigue and corrosion offshore, reducing OPEX in these areas.

The wireless nano-technology sensor can be deployed efficiently and easily across any operating asset. Subsea 7 NESP, which requires no power supply or batteries, offers a scalable, cost-effective, zero maintenance solution to extend asset life and improve uptime.

The NESP technology fully integrates with Xodus' Asset Management & Integrity Network (XAMIN) tool, which allows the company's experts, infrastructure owners and operators to capture design, installation, testing, operating, inspection, and decommissioning information within a single system. This additional capability leads to a further increase in efficiency, ensures regulatory compliance, and helps optimize the performance of assets.

Below are the winners of the OTC 2021 Spotlight Small Business Awards. Find more about these awards on the OTC website **https://2021.otcnet.org/**:

- HYTORC, producer of HYTORC J-Washer
- INGU, producer of Pipers 2.8
- OLIDEN TECHNOLOGY, producer of LithoFusion Azimuthal Density and Porosity LWD Tool
- Rocsole Ltd., producer of Deposition In-Line Inspection (DILI)
- TECHNI, producer of PACT

AMERICAN OFFSHORE ENERGY DRIVES HUMAN PROGRESS

By National Ocean Industries Association President Erik Milito

The offshore energy industry is leading a remarkable energy transition. From the Gulf of Mexico providing among the lowest carbon barrels of the oil producing regions to new wind projects along the Atlantic coast to emerging carbon reduction technologies, such as hydrogen development and carbon capture and storage, the offshore energy sector is driving the energy innovation and technological progress essential to fueling the world and lifting society with supplies of sustainable energy.

NOIA fights for the continued success of U.S. offshore oil, natural gas, and wind development and production. Continued American offshore energy production paves the way towards enhanced national security, high-paying and accessible jobs, capital investment and spending in every state, and lower air emissions, a smaller physical environmental footprint and more efficient water use and management.

NOIA works tirelessly to ensure that Washington, D.C. policymakers understand – and embrace – the vast benefits of American offshore energy production.

In the Gulf of Mexico, a symphony of U.S. offshore production involves more than 345,000 men and women across all 50 states, provides a GDP impact of $28.6 billion and generates more than $5.4 billion in government revenues.

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The offshore oil and gas industry provides opportunity throughout every corner of the U.S. From the oil and gas companies that make up the fabric of countless Gulf Coast communities to buoy experts in Maine to software companies in Florida to concrete specialists in Hawaii, every U.S. state has businesses and employees linked to the offshore industry.

Not only is there is a legal obligation to continue Gulf of Mexico leasing, but there are a multitude of important benefits including reduced greenhouse gas emissions. The U.S. Gulf of Mexico region is recognized as providing among the lowest carbon barrels of the various producing regions because of the scale and tremendous level of investment and innovation inherent in offshore operations. The women and me of the energy industry, representing a diverse supply chain of companies both small and large, commit themselves to continuous improvement in ever-reducing emissions from operations. In fact, the Obama Administration review of the 2017-2022 Five Year Plan for offshore oil and gas leasing determined GHG emissions would be higher without these lease sales because energy production would be outsourced to foreign countries with greater emissions intensity and resulting in a higher carbon footprint.

U.S. government efforts should serve to prevent substitution of sustainable and responsible U.S. offshore production with barrels from high emitting foreign sources with weak environmental oversight, such as Russia, China, or Iran.

Capitalizing on an American environmental and emissions

success story means that American will be able to depend on reliable and affordable homegrown energy that is produced in a way that protects the environment and strives to help meet the goals of the Paris Accord on climate change. However, the incredible energy, economic, and emission performance of the Gulf of Mexico cannot continue without a regular, predictable, and legally mandated schedule of lease sales, along with the ability to develop these leases. It is more important than ever, in our post-pandemic world, that we take proactive steps to increase critical oil and gas supplies domestically so that we can help avert potential inflationary risks and rising energy prices, which disproportionately impacts those who can afford it the least – low-income communities.

There has been more progress of late in the offshore wind sector. The Biden Administration is promulgating new offshore wind lease sales offshore New York, New Jersey, California, and Virginia. Considering that than 80% of Americans live within just a couple of hours from our nation's coasts, this is welcome news for millions of energy consumers.

All told, states have established more than 29 GW of offshore wind procurement targets to date. More than 9.1 GW of offshore wind is expected to come online by 2026. Tremendous investments are needed to move these offshore wind projects to completion. Current demand alone will require $70 billion or more in investment by 2030. All told, more than 83,000 good paying jobs could be created by the end of the decade.

Offshore wind jobs are not found solely in the states adjacent to wind lease areas. Offshore wind jobs are found throughout the U.S., including along the Gulf Coast. The same fleet of heavy vessel operators, welders, fabricators, subsea construction firms and other businesses that built the Gulf of Mexico oil and gas are going to be needed to lend their experience and expertise to build out offshore wind.

But holding new lease sales is only one step in seizing the generational offshore wind opportunity. Continued new lease opportunities need to be supported by an all-of-government approach that links permitting, leasing, and regulatory priorities.

The Biden Administration is considering changes to bedrock environmental conservation laws, including the National Environmental Policy Act (NEPA) and the Migratory Bird Treaty Act (MBTA), which could have a massive impact on how offshore wind projects are able to proceed.

In the past, overly strict enforcement of NEPA and MBTA have impeded critical infrastructure projects, including wind energy development. Unfounded litigation is one of the fastest ways to deter financing and progress for vital projects. Rules that protect otherwise lawful and permitted activities combined with the robust mitigation measures that offshore wind deploys can enhance environmental stewardship and economic and energy growth.Offshore energy companies – from every sector and segment – are finding solutions to Environmental, Social & Governance (ESG) issues and to the climate challenge. The NOIA ESG Network and the recently adopted NOIA climate change position and principles have been thoroughly embraced by the full diversity of NOIA membership.

We are helping to solve energy and climate problems by scaling and deploying real-world solutions. Whether it is the build-out of new offshore wind projects, developing CO2 storage facilities, finding new ways to produce hydrogen, or optimizing technology, logistics, and operations to reduce the carbon footprint, the offshore energy industry is at the forefront of energy solutions and emission reductions. Across the board, our members are committed to innovation, best practices, and deployment of advanced technologies that are central to addressing the climate challenge.

The promise of American energy remains constant. We are a foundation of homegrown energy, jobs, economic opportunity, billions of dollars of government revenue, and environmental and climate change solutions. The benefits of American offshore energy production lift every American, regardless of party.

As the world returns to normalcy, the need for safely and reliably produced oil and natural gas and wind energy has never been greater. The benefits of American offshore energy lift every American, regardless of party. NOIA is working tirelessly to ensure that our elected officials recognize the vast benefits of our industry, so the promise of American offshore energy remains bright.

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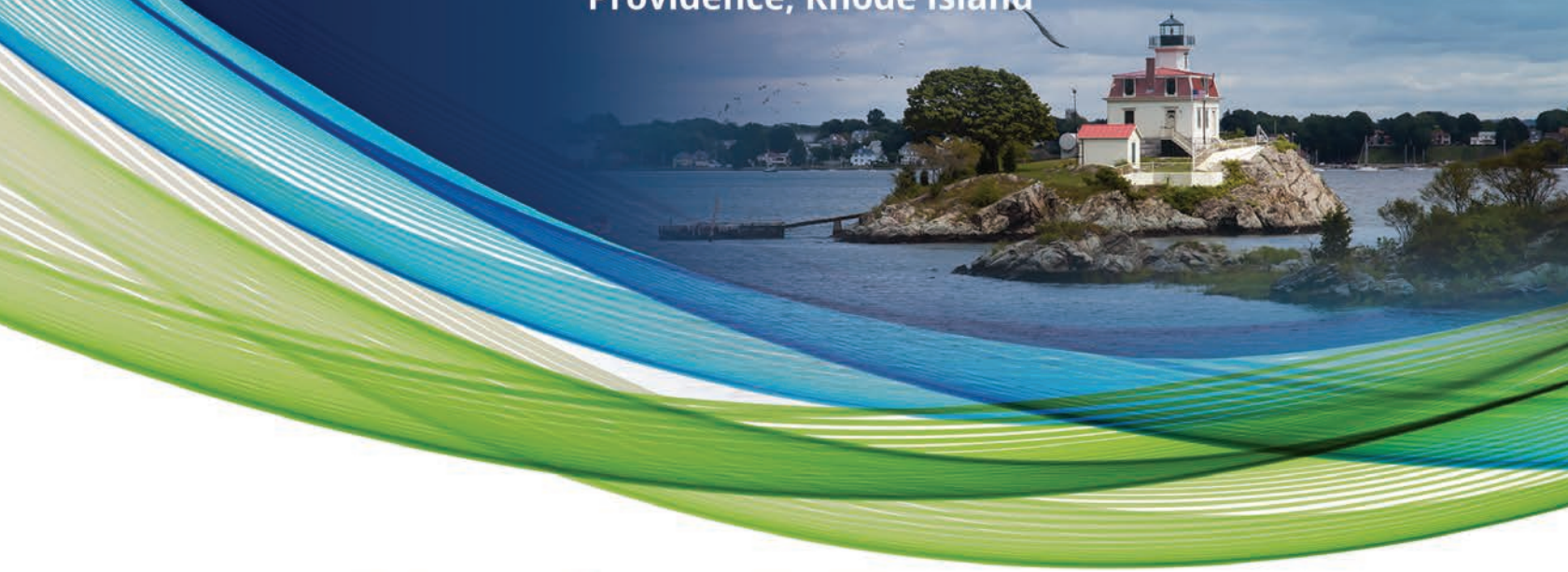

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