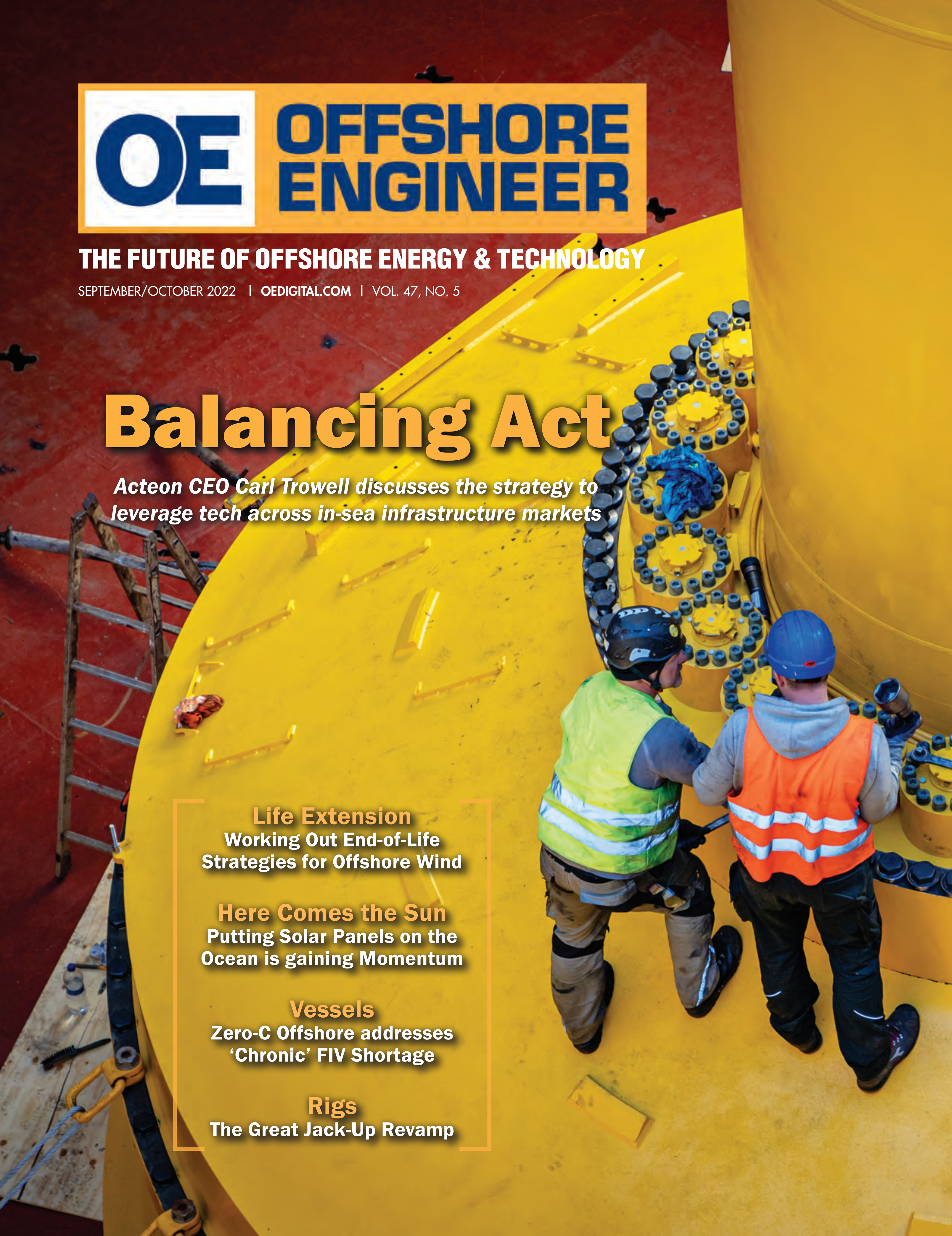
OE OFFSHORE ENGINEER

THE FUTURE OF OFFSHORE ENERGY & TECHNOLOGY

SEPTEMBER/OCTOBER 2022 | OEDIGITAL.COM | VOL. 47, NO. 5



Balancing Act

Acteon CEO Carl Trowell discusses the strategy to leverage tech across in-sea infrastructure markets

Life Extension
Working Out End-of-Life Strategies for Offshore Wind

Here Comes the Sun
Putting Solar Panels on the Ocean is gaining Momentum

Vessels
Zero-C Offshore addresses 'Chronic' FIV Shortage

Rigs
The Great Jack-Up Revamp

SEPTEMBER/OCTOBER 2022
WWW.OEDIGITAL.COM
VOL. 47 / NO. 5

FEATURES

Photo courtesy Acteon

The Balancing Act

Striking a balance between traditional offshore oil and gas and renewable markets is neither straight nor clear. Carl Trowell, CEO, Acteon Group discusses his company's strategy to capitalize on what he sees as resurgence offshore oil and gas investment premised on energy security concerns, plus a "mega-cycle" of investment in offshore wind energy in the long term.

By Greg Trauthwein

ON THE COVER: **Menck, an Acteon brand, has led pile driving technology and services for oil and gas, wind and civil engineering projects.** Photo from Acteon

Copyright daryakomarova/AdobeStock

Image courtesy Zero-C Offshore

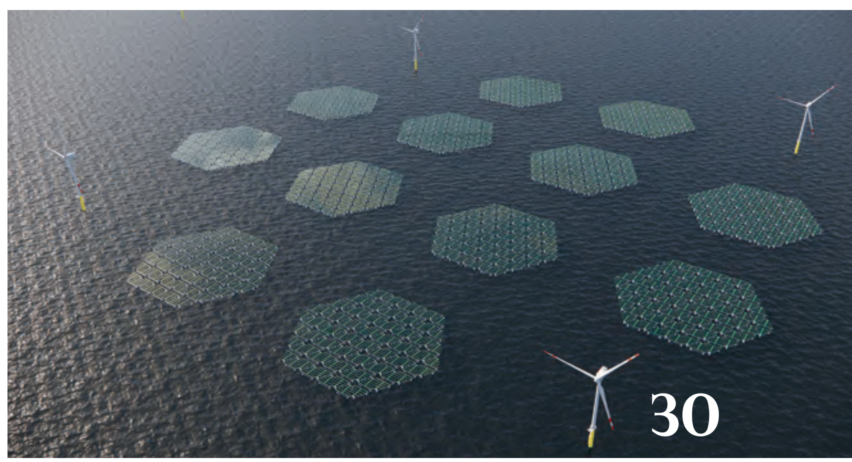


Image courtesy SolarDuck

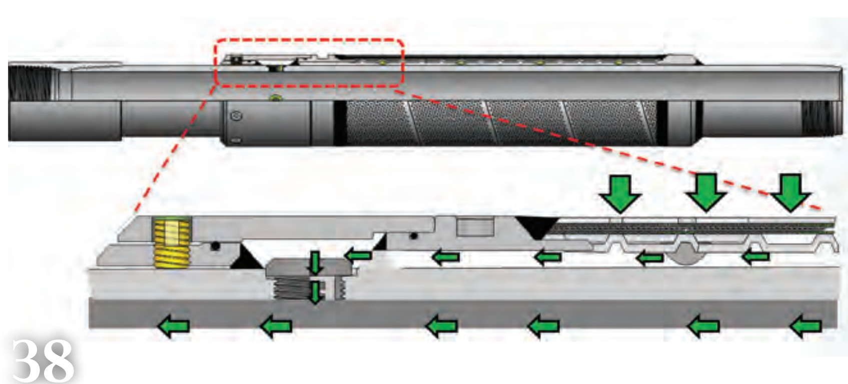


Image courtesy Tendeka

OE OFFSHORE ENGINEER
THE FUTURE OF OFFSHORE ENERGY & TECHNOLOGY.

www.OEDigital.com
Vol. 47 *No. 5*
ISSN 0305-876x
USPS# 017-058

118 East 25th Street,
New York, NY 10010
tel: (212) 477-6700
fax: (212) 254-6271

OFFSHORE ENGINEER (ISSN 0305-876X) is published bi-monthly (6 times per year) by AtComedia, Inc. 118 East 25th St., 2nd Floor, New York, NY 10010-1062. Periodicals postage paid at New York, NY and additional mailing offices.

POSTMASTER: Send All UAA to CFS. NON-POSTAL AND MILITARY FACILITIES send address corrections to Offshore Engineer 850 Montauk Hwy, #867 Bayport, NY 11705

SUBSCRIPTION
To subscribe please visit:
www.OEDigital.com

Email:
oecirc@offshore-engineer.com

Web:
www.OEDigital.com
t: (212) 477-6700
f: (212) 254-6271

BY THE NUMBERS

RIGS

Worldwide

Rig Type	*Available*	*Contracted*	*Total*	*Utilization*
Drillship	8	69	77	90%
Jackup	196	287	483	59%
Semisub	26	51	77	66%

Africa

Rig Type	*Available*	*Contracted*	*Total*	*Utilization*
Drillship	1	12	13	92%
Jackup	17	14	31	45%
Semisub		2	2	100%

Asia

Rig Type	*Available*	*Contracted*	*Total*	*Utilization*
Drillship	3	7	10	70%
Jackup	82	81	163	50%
Semisub	13	10	23	43%

Europe

Rig Type	*Available*	*Contracted*	*Total*	*Utilization*
Drillship	1	6	7	86%
Jackup	9	35	44	80%
Semisub	6	20	26	77%

Latin America & the Caribbean

Rig Type	*Available*	*Contracted*	*Total*	*Utilization*
Drillship	3	23	26	88%
Jackup	3	3	6	50%
Semisub	3	9	11	82%

Middle East

Rig Type	*Available*	*Contracted*	*Total*	*Utilization*
Jackup	50	116	166	70%
Drillship		1	1	100%

North America

Rig Type	*Available*	*Contracted*	*Total*	*Utilization*
Drillship		20	20	100%
Jackup	27	28	55	51%
Semisub	1	5	6	83%

Oceania

Rig Type	*Available*	*Contracted*	*Total*	*Utilization*
Drillship				
Jackup		3	3	100%
Semisub	1	4	5	80%

Russia & Caspian

Rig Type	*Available*	*Contracted*	*Total*	*Utilization*
Jackup	7	3	10	30%
Semisub	2	1	3	33%

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 October 2022
Source: Wood Mackenzie Offshore Rig Tracker

DISCOVERIES & RESERVES

Offshore New Discoveries

Water Depth	***2017***	***2018***	***2019***	***2020***	***2021***	***2022***
Deepwater	15	16	20	13	13	10
Shallow water	77	56	85	42	55	19
Ultra-deepwater	12	18	18	9	7	11
Grand Total	**104**	**90**	**123**	**64**	**75**	**40**

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	571	47,162	22,735
Shallow water	3,258	423,276	143,124
Ultra-deepwater	333	43,225	27,759
Grand Total	**4,162**	**513,662**	**193,618**

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

Region	***Number of fields***	***Remaining reserves gas mboe***	***Remaining reserves liquids mbl***
Africa	577	19,639	13,079
Asia	839	16,420	7,544
Europe	750	12,379	12,554
Latin America and the Caribbean	192	6,595	42,168
Middle East	133	76,822	147,420
North America	479	2,951	14,108
Oceania	89	12,359	1,298
Russia and the Caspian	61	17,385	14,280
Grand Total	**3,120**	**164,550**	**252,450**

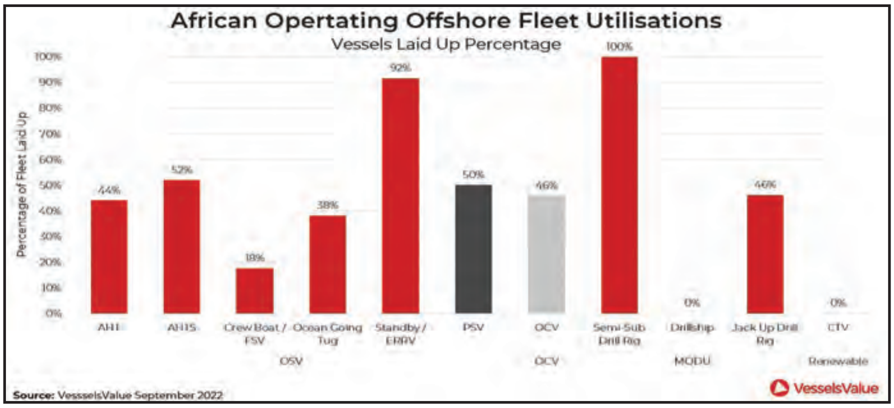
Onstream and under development.

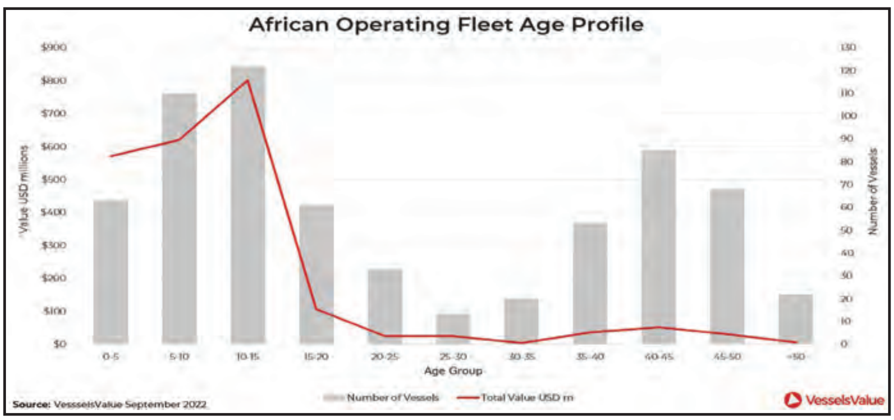
The portion of commercially recoverable 2P reserves yet to be recovered from the reservoir.

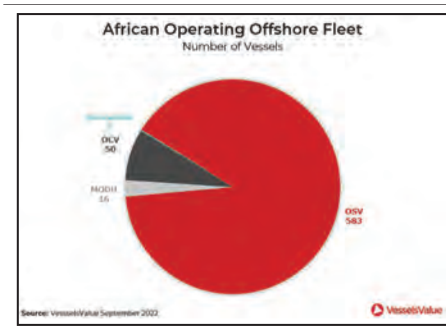
Source: Wood Mackenzie Lens Direct

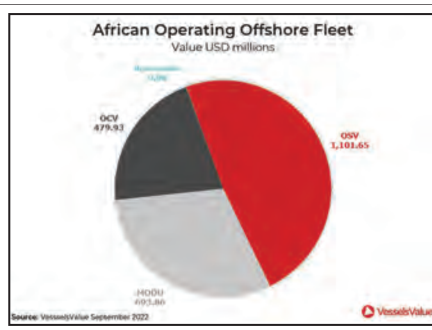
SECTOR IN FOCUS
AFRICA

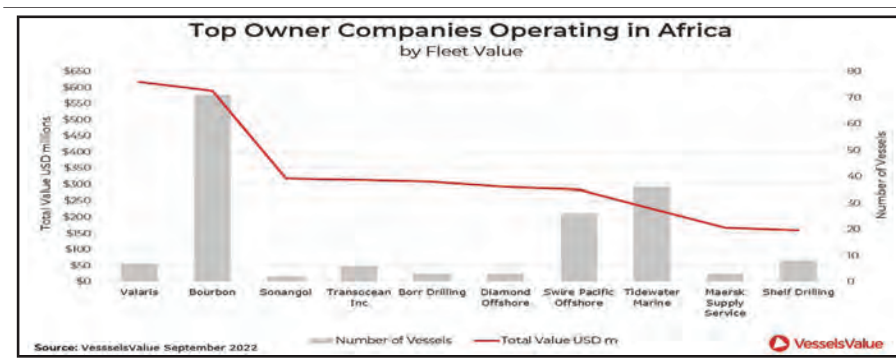
Data & Statistics powered by VesselsValue











OE OFFSHORE ENGINEER
THE FUTURE OF OFFSHORE ENERGY & TECHNOLOGY.

New York
118 E. 25th St., New York, NY 10010
tel: (212) 477-6700; fax: (212) 254-6271

SEPTEMBER/OCTOBER 2022
WWW.OEDIGITAL.COM
VOL. 47 / NO. 5

OE WRITERS


Haun


Maslin


Konopczynski


McCaul


Lewis


Papavizas


Moradi


Tomic

Pamela Cordova is Senior Rig Analyst, S&P Global Commodity Insights.

Jingheng Hau is Tendeka's country manager, China. He joined Tendeka in 2015 and has worked in the oil and gas industry for nearly 20 years.

Eric Haun, former managing editor of *Offshore Engineer*, is the editor of *Marine News.* He has covered the global maritime, offshore and subsea sectors since 2013.

Michael Konopczynski is a director of subsurface engineering at Tendeka in Houston. He holds a BSc (1981) in mechanical engineering from the University of Toronto. He is a member of the Association of Professional Engineers and Geoscientists of Alberta (APEGA) and SPE.

Philip Lewis is Director Research at Intelatus Global Partners. He has extensive market analysis and strategic planning experience in the global energy, maritime and offshore oil and gas sectors. Intelatus Global Partners has been formed from the merger of International Maritime Associates and World Energy Reports.

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.

Mojtaba Moradi is a principal reservoir engineer at Tendeka in Aberdeen. He holds a PhD (2016) in petroleum engineering from Heriot-Watt University. He is a member of the European Association of Geoscientists and Engineers (EAGE), and SPE.

Constantine (Charlie) Papavizas is a partner in the international law firm of Winston & Strawn LLP resident in Washington, D.C. and is the chair of its maritime practice group.

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.

STRIKING A BALANCE

Balancing Act is the apt description of our interview with Acteon CEO Carl Trowell, who oversees a family of brands, many of which are closely associated with the offshore oil and gas sector. Like many executives in the sector, Trowell is engaged in a balancing act of sorts, serving traditional oil and gas customers while eying opportunities to tweak and leverage existing technologies for new and emerging markets. In assessing the tools in his toolbelt, Trowel reckons that Acteon is an in-sea infrastructure company, rather than tied to any one industry, and he is unabashedly bullish on the opportunities he sees ahead. "There's going to be more infrastructure going into the sea in the next decade from offshore wind than went in throughout the whole lifetime of oil and gas. If you just look at the number of units, the number of installations, and you start moving to floating wind, it's going to be off the scale ... we're at the beginning of what will be a mega cycle of investment."

Balancing Act is also an apt description for *Offshore Engineer* and the family of electronic and social media brands under our guise. While we, like you, have been watching and living the digital evolution, the advent of COVID took this evolution and turned it into a revolution, putting digital on a steroid-infused fast track.

I've been in the publishing business for 30+ years, starting when the internet and email weren't really 'a thing' in our business lives. To this day I still consider myself a paper guy, as it remains my preferred media to consume information. However, the reality is far from that: yes, I still get the *Wall Street Journal* delivered on my driveway, primarily because it's one of my black lab's jobs of the day to fetch and get the reward. But the reality is I read *WSJ* on my app while I'm still in bed and the dog's snoring!

With this edition *Offshore Engineer*, the magazine, is going all-digital, offering our global and mobile readership more ways to receive information. In reality, this is only a slight tweak in the overall package, as via **OEDigital.com**, **AOGDigital.com**, our various eNews and our social channels, the majority of our contact on a daily basis with you is coming digitally. Counting our websites, eMagazines, eNews, mobile apps and social networks we have a cumulative global audience approaching half a million (492,475 to be exact). Through a relentless effort online by Managing Editor **Bato Tomic**, we have more than 51,000 followers alone on our Offshore Engineer LinkedIn page.

While the change is natural, the one thing that does not change is the commitment of the Offshore Engineer staff to deliver to you the same great content, how you want, where you want it, 24/7/365.

Gregory R. Trauthwein
Editor & Publisher
trauthwein@offshore-engineer.com
m: +1-516.810.7405

JONES ACT *CIRCA 1563*

A common misconception regarding the U.S. domestic trading restriction known as the "Jones Act" is that it appeared out of nowhere in 1920. Nothing could be further from the truth. Jones Act seeds were planted by Queen Elizabeth I in 1563.

By Charlie Papavizas, Partner, Chair, Maritime Practice, Winston & Strawn LLP

England's first maritime trading law – known as a "navigation act" – is generally regarded to be a 1381 act adopted by King Richard II, son of Edward the Black Prince. The avowed purpose was "to increase the Navy of England, which is now greatly diminished." That law was known in the American Colonies centuries later. John Adams, for example, wrote to Thomas Jefferson in 1785 urging individual states to adopt similar laws.

The law also had a mercantile purpose in that it prohibited the export of gold and silver. It was determined that such exports would lead to the "Destruction of the same Realm, which God prohibit."

The 1381 law restricted much of English foreign trade to "Ships of King's Liegance." A problem was that there was no "out" if no such ships were available, and a "technical correction" had to be adopted in 1382 which provided that English vessels only had to be used if they were to "be found able and sufficient." Another law in 1390 set limits on what rates English vessels could charge limiting those rates to "reasonable Gains" to prevent price gouging.

These navigation restrictions were expanded, contracted, and otherwise modified over time until they were abruptly repealed in the first year of the reign of Queen Elizabeth I in 1558. The reason given was that other countries had retaliated with their own navigation restrictions such that there had "growen greate displeasure between the forreyne Prynces and the Kinges of this Realm."

The need to protect English shipping for Navy purposes, however, resurfaced and England reversed course in 1563 in the fifth year of Queen Elizabeth's reign. England continued to regulate its maritime trade thereafter culminating in the most famous navigation acts adopted in 1650, 1660, and 1661 primarily to combat Dutch maritime ascendancy and to tie English colonies tightly to the mother country. The 1660 Act was later referred to as the "Sea Magna Charta" or "Charta Maritima" and remained English policy until the middle of the 19th century.

Among other things, those acts required certain enumerated goods to be shipped to England in English vessels from English colonies, even if their destination was elsewhere, which was a requirement that aggravated the American colonies. These trade restrictions are referenced in the Declaration of Independence as one of the reasons to separate from England.

What is important for our present purposes is that the 1563 Elizabethan law also contained the first outright reservation of English domestic maritime trade to English vessels. Specifically, only English-owned vessels could transport "fish, victuals, wares or things" between English "ports of creeks" upon penalty of the forfeiture of the goods carried or the value thereof.

The first U.S. Congress in 1789 considered adopting a similar domestic trading formulation but determined instead to advantage U.S.-owned vessels by applying much higher duties (more than eight times higher) on foreign-owned vessels in U.S. domestic trade. The issue was not revisited until after the War of 1812 and more particularly after the U.S.-Britain Commercial Convention of 1815 which permitted the U.S. to adopt certain shipping restrictions without granting Britain a right to retaliate.

In 1817, the U.S. adopted its "Charta Maritima" copying many parts of the 1660 Navigation Act including language very similar to the Elizabethan 1563 domestic trade formulation. The 1817 Act was one of the last laws signed by Pres. James Madison before finishing his second term and it was something he had sought since he was a Congressman starting in 1789.

The critical difference between the U.S. version and the English versions was that the U.S. expressly invited other countries to open their trade to U.S.-flag vessels and in return the U.S. would reciprocate – in the foreign trade. The 1817 Act was a means to an end in the foreign trade – the English Navigation Act trade restrictions were the policy end regardless of what other countries did.

In the following years, country by country entered into reciprocal open maritime trade agreements with the U.S., and the 1817 foreign trade reservations to U.S.-owned vessels disappeared. There were many efforts after the Civil War up to and including in the Merchant Marine Act of 1920 to revive those restrictions – but that is a subject for another article. For the U.S. domestic maritime trade, the 1817 Act restricted to U.S. citizen-owned vessels the trade of "goods, wares, or merchandise" between U.S. "ports" upon penalty of forfeiture of the items transported. In other words, the 1817 Act domestic trade restriction was virtually the same as the 1563 Elizabethan restriction.

Notably, the 1817 Act restriction did not restrict U.S. domestic trade to U.S.-registered vessels often referred to as "U.S.-flag vessels." That change was not made until 1898. Other changes were made over time to this domestic trading restriction to expand its scope of other activities (like transporting passengers and engaging in dredging and towing), to other places (like newly acquired territories including Alaska, Hawaii, and Puerto Rico), and to close loopholes.

What Congress did in 1920 under the leadership of Sen. Wesley Livsey Jones was the latter, which was to close a loophole. The original 1817 Act was also restated to, among other things, apply the restriction between "points" in the United States rather than "ports" – but the 1817/1563 concept remained unchanged. So, the next time you read about the "Jones Act" and how it is either a great or terrible "100-year old law," you can remember that whatever it is, it is definitely *much* older than that.

© Lukasz Z/AdobeStock

The Great Jack-up Revamp

Middle East NOCs reshape the global jack-up market.

By Pamela Cordova, Sr. Rig Analyst, S&P Global Commodity Insights

Recently, numerous operators looking to charter jackups over the next three years have found themselves with greatly reduced available options and offered much higher day rates than expected: what has caused this sudden tightening of the jack-up market?

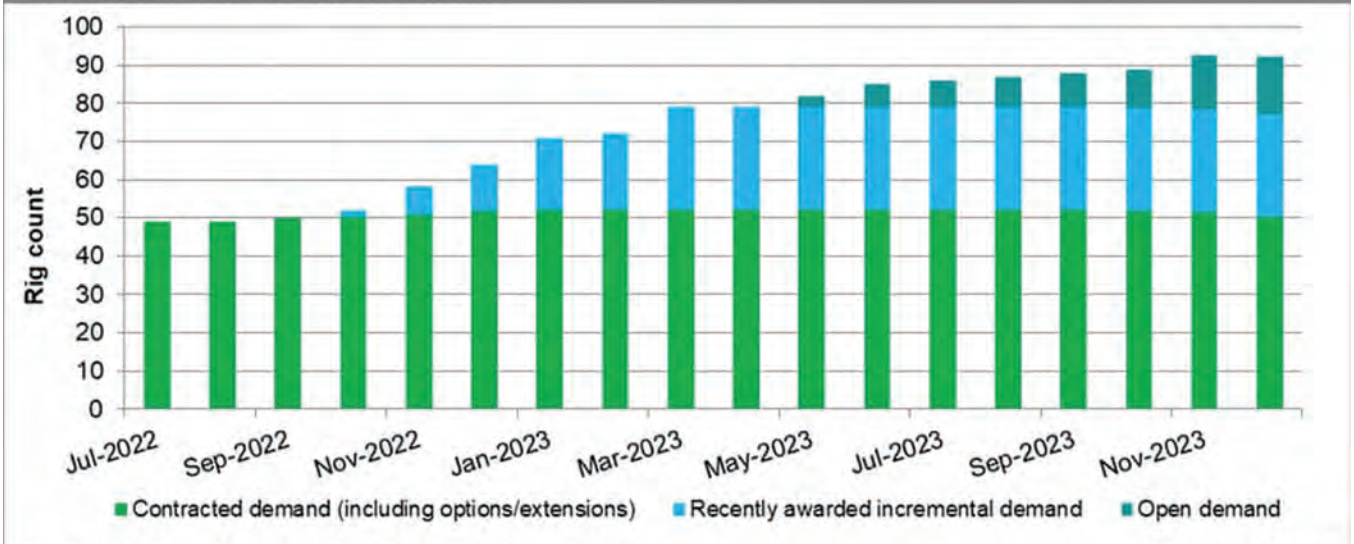
For the past five years until recent months, the distressed and oversupplied jack-up market had little prospect of seeing marketed utilization above 90%. Stranded jack-ups in shipyards and ports across the world had slim chances of picking up work. But this started to change in mid-2021 when Saudi Aramco announced plans to increase its jack-up fleet by 20 incremental units through multi-rig tenders. Then, in the first half of this year it announced plans to increase by up to 20 more rigs.

At present, the operator has plans to almost double its fleet, which in the past 10 years has averaged 45 jack-ups, to 92 contracted jackups by the end of 2023. The increase can be seen in Graph 1 below. Currently, the operator has 50 rigs under contract and at the time of writing will have 78 contracted by mid-2023. It is in the midst of contracting about 14 more.

In addition, the UAE has production targets to meet, so Abu Dhabi's ADNOC Drilling, is progressing its fleet expansion. It has purchased 13 units in the past two years and is in the process of purchasing additional units.

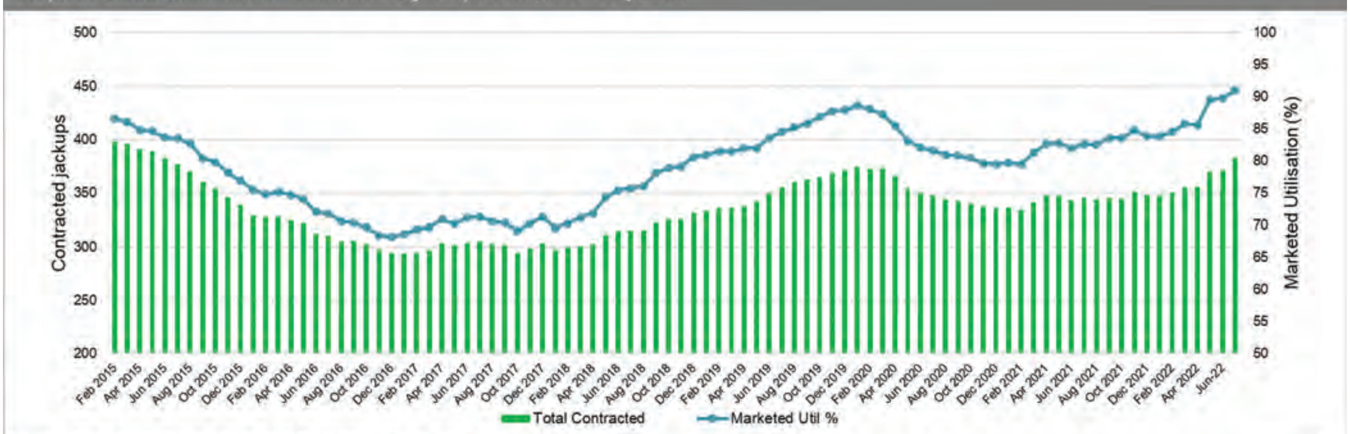
These two national oil companies alone are absorbing about 55 jack-ups (including those recently contracted but

Graph 1. Saudi Aramco's jackup demand



Source: Data taken from IHS Markit E&P content (Petrodata Rigs) © 2022 IHS Markit

Graph 2. Global marketed utilisation for IC jackups Jan 2015 - July 2022



Source: Data taken from IHS Markit E&P content (Petrodata Rigs) © 2022 S&P

which have not started work yet) as incremental demand from the marketed fleet – that is 12% of the global jack-up fleet, and 22% of the fleet capable of drilling between 350 ft and 400 ft. of water.

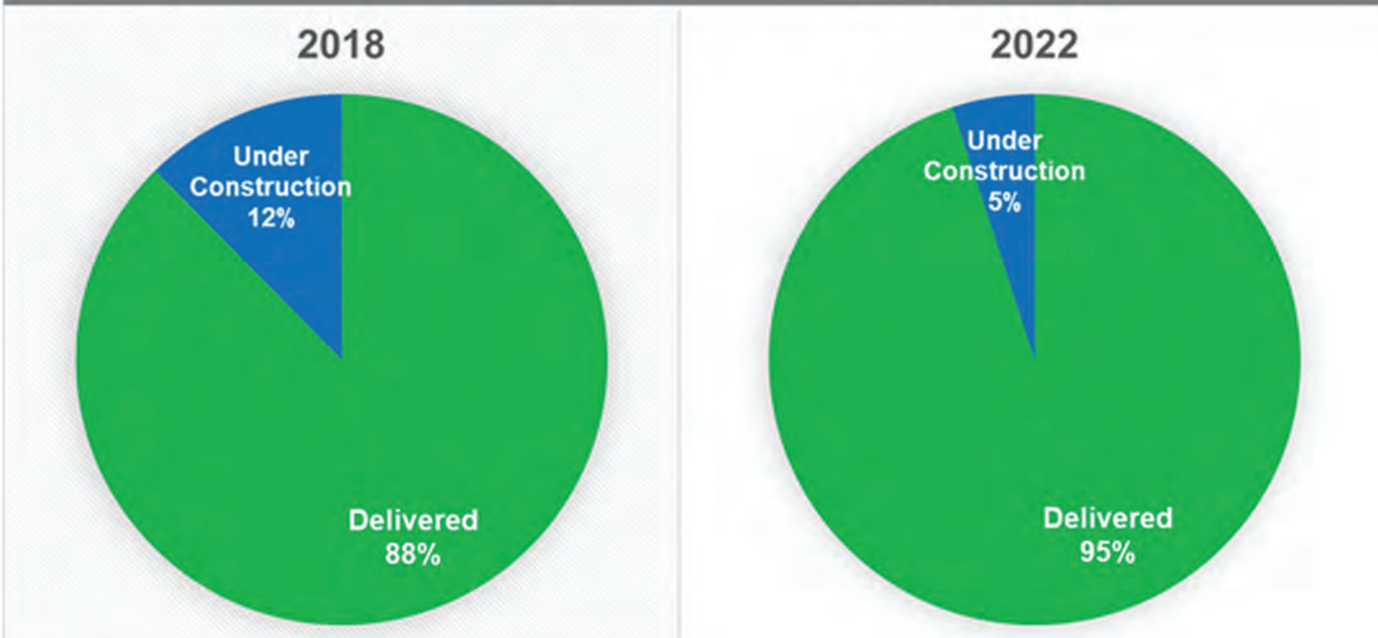
The contracting spree has resulted in at least 25 jack-ups scheduled to move into the Middle East from other regions. These are at least seven jack-ups from the Americas, 14 from Southeast Asia and at least four from China.

Another interesting development is the rise of Middle East drilling contractors. Between ADNOC Drilling and Advanced Energy Systems (ADES) they hold 70% of jack-up purchases in 2022. ADNOC Drilling its mostly owned by Abu Dhabi National Oil Company (ADNOC) and ADES is owned by the Public Investment Fund of the Kingdom of Saudi Arabia. In addition, Saudi Arabian drilling contractor Arabian Drilling recently bought two jack-ups from Mexico for contracts in Saudi Arabia.

As can be seen below in Graph 2, the above awards plus charters in other parts of the world have allowed marketed jack-up utilization to increase to a seven-year high of 90%. In the Middle East this is 93% and is expected to reach 100% of the marketed fleet by early 2023.

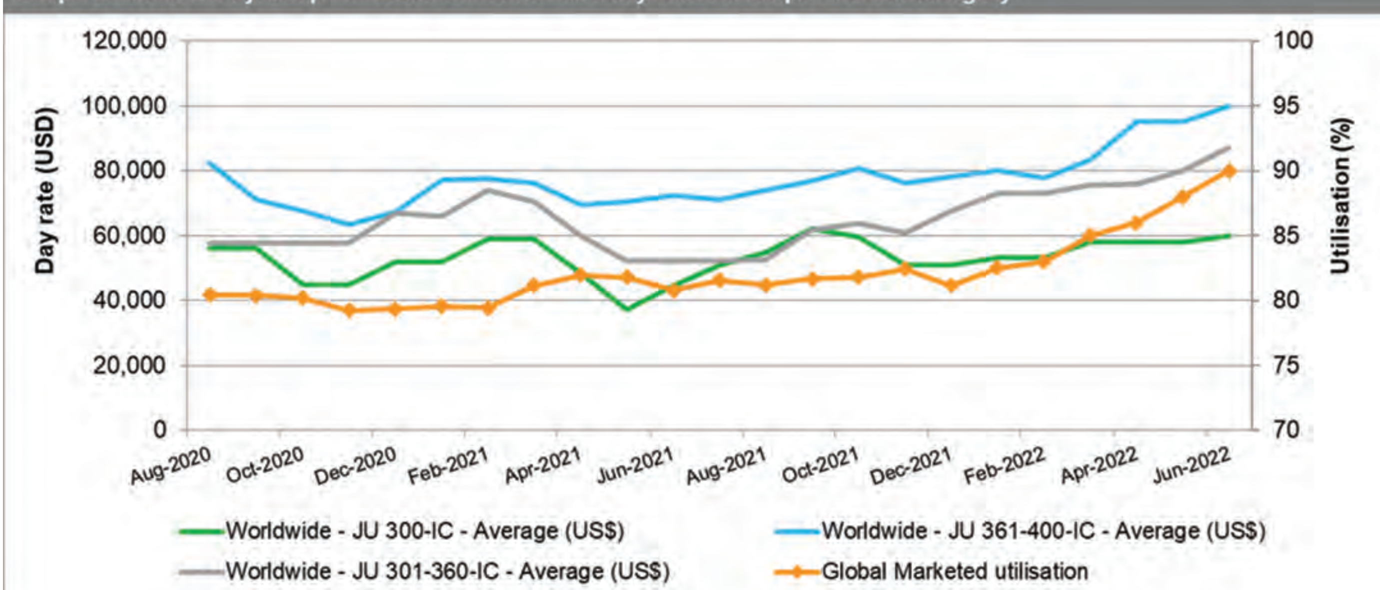
As a result, beyond Saudi Aramco, a few national oil companies with long term jack-up demand are starting to feel the effects of this scarcity as rig availability is not confirmed to them and prices are 30% to 50% higher than offers of one year ago. Some operators are in the midst of planning alternative ways to meet their rig demand, such

Graph 3. Percentage of jackup fleet under construction 2018 vs 2022

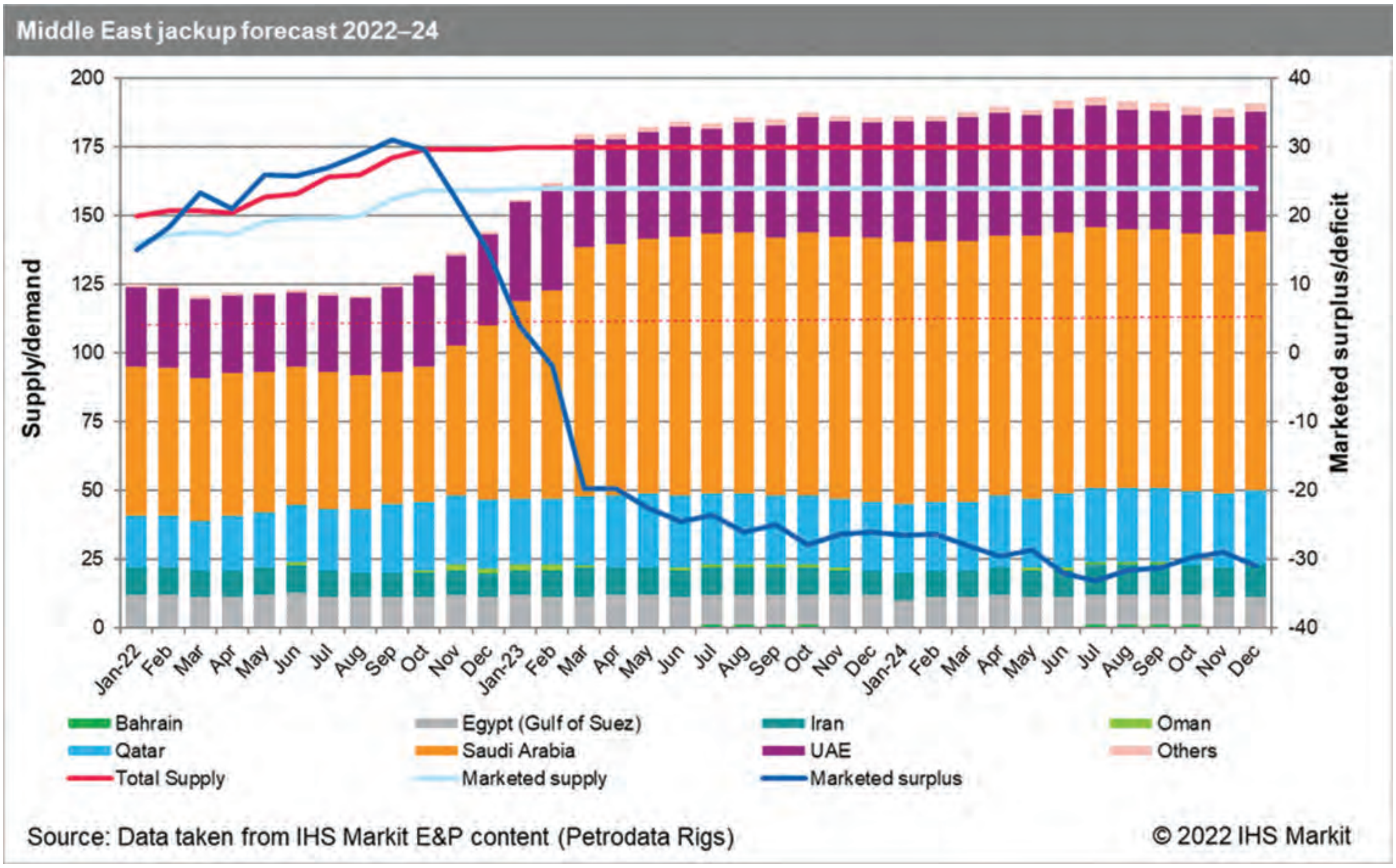


Source: Data taken from IHS Markit E&P content (Petrodata Rigs)

Graph 4. Worldwide jackup marketed utilisation and day rate trends per market category



Source: Source: Data taken from IHS Markit E&P content (Petrodata Rigs)



as buying whichever jack-ups are left from contractors in financial difficulties and even building new ones.

A few companies are known to have already commenced dialogue with shipyards regarding the possibility of ordering newbuilds to meet their long-term demand. Interestingly, the only shipyards left that would be willing to build rigs following the trauma of the last few years are in the Middle East, plus a small number in China. However, construction prices remain high due to inflated steel prices.

Others, like QatarEnergy are making sure they secure the existing fleet in the long term and have started to have discussions with providers on extending rig contracts beyond 2025.

Due to the increase in awards, 17 jack-ups which had been idle for a long time are now being reactivated - including 10 for Saudi Aramco. And the number of stranded newbuild jack-ups has also decreased dramatically: only 5% of the total jackup fleet is now under construction as can be seen in Graph 3, with only a handful of favored designs left. Twenty-six jack-ups remain under construction/undelivered, and of those, nine (34%) are contracted - mostly to Saudi Aramco. (Note: Data from July 2022).

All contracted units are of the popular models: the LeTourneau Class 116-C, Friede & Goldman JU-2000E, and KFELS B Class designs. There are only two remaining uncontracted rigs of the favored Keppel design. The rest of the newbuilds are unlikely to be taken for the time being.

Day Rates

In the past seven years, jack-up prices had come down to an average of $55,000-$75,000 per day for premium rigs in benign environments but improvement started in 2019, reaching above $80,000. However, that quickly fell back down to average levels during the pandemic downturn.

Now, as utilization is improving, day rates have moved up, across different jack-up market categories, but mainly for the premium category (JU 361-400 IC), as seen in Graph 4, where most fixtures have taken place. Average day rates for the premium category have surpassed $90,000 and most currently negotiated dates are above

$100,000 with the new Saudi Aramco tender expected to result in day rates from $110,000 to $130,000 with higher mobilization rates than before that could reach $45 million. Those rates haven't been seen since 2015.

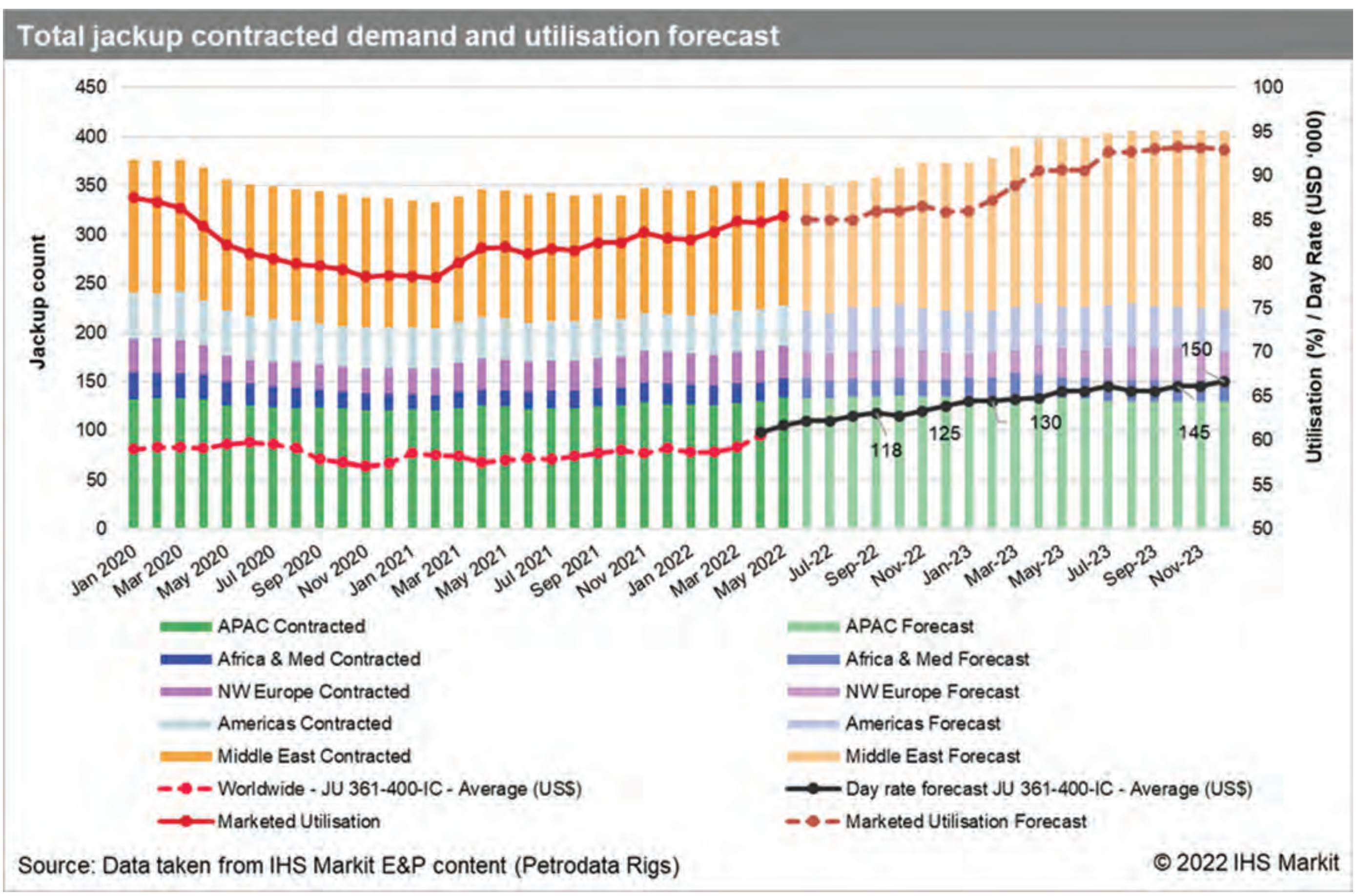
Outlook

Based on production targets and current visible demand, the Middle East will see the greatest increase in jack-up demand by far. The graph below shows the forecast demand and supply deficit for Middle East jack-ups per month. To meet the incremental demand the region will see at least 30 units mobilized into the region from elsewhere (including already scheduled rigs).

In the next 18 months, global marketed utilization is expected to remain above 90% and approach 95% by the end of 2023. We expect this will allow day rates to continue in a gradual upward trend that could average $150,000 by the end of 2023.

Concluding Remarks

This once distressed sector is coming back to life and moving towards a tight market in the next three to five years if the current demand remains. Rates will continue to increase, and perhaps opportunities will materialize to build more rigs possibly. This is becoming clearer with about 26% of contracted jack-ups being 30 years old and above, and many of them reaching the end of their lifecycle. Once this happens, there are not many rigs that can replace standard and shallow-draft units. Interesting times lie ahead.



© Arild/AdobeStock

Well Intervent

A new study by Petrologica.com and Axiom EMI shows the UK offers the best prospects for well intervention, plugging and abandonment over the next ten years. The joint report, *"Well Intervention Market – Available Technology and Prospective Market"* provides a 10-year market outlook for the UK, Norway and US Gulf of Mexico, as well as a review of the state of the art in well fatigue mitigation.

COVID-related labor shortages reduced well interventions by c. 50% in 2020 against 2017 levels in the UK. But with oil prices at a high point in the cycle, extending the life of existing assets is becoming increasingly cost effective. "Activity is likely to see a sharp uptick from 2023 onward and see 7% CAGR 2021-2030, with similar trends in both Norway and the US Gulf of Mexico", according to lead analyst for Petrologica, Leonardo Martini. "Both the latter markets have relatively high barriers to entry – Norway through Equinor's dominance, and the US through its well-diversified Jones Act-compliant fleet."

The well intervention space has been dominated by light intervention vessels over the past decade, but reconditioned semisubmersible rigs will regain market share in the future, according to the authors. "New developments in fatigue mitigation, including load relief, BOP tethering systems and more, are increasingly making a heavier rig-based solution feasible," says James Hall, lead analyst for Axiom EMI on the project. Reconditioned third and

tion in the UK

fourth generation MODUs are able to function as a "one-stop shop," covering both riser-less and riser-based interventions and lowering deployment time. Some operators have developed specialized rigs, such as Island's Innovator for well intervention and Well-Safe's Guardian for plugging and abandonment work. Utilizing the latest technology shorts well intervention lead time, reduces costs and minimizes environmental risks.

The report also shows that P&A activity will rise in the UK, Norway and US Gulf of Mexico. There are considerable inventories of subsea wells in all countries: over 1600 in US Gulf of Mexico, over 1900 offshore UK and over 2000 on the Norwegian continental shelf. Of these wells, just a quarter in the UK, a third in Norway and less than 50% in the US GoM are operational, leaving the vast majority as candidates for permanent abandonment if not re-entered in the future.

In the UK, current tax relief of 35% on decommissioning costs has seen subsea well P&A activity more than double year-on-year in 2022 with 55 wells expected to be decommissioned. Activity is likely to remain at or above this level for the next ten years.

Founded in 2003, Petrologica is a full-service energy consultancy that produces timely analysis on all things oil and gas. Axiom is a market intelligence start-up focused on the global offshore energy markets. For more information on both companies, and to sign up for a free weekly oil market briefing, visit petrologica.com and axiomemi.com

© jcg_oida/AdobeStock

EXTENDING LIFE in OFFSHORE WIND

Wind turbines, like any asset, have a finite life. Working out when end of life is and what can be done to extend it – or even to repower turbines, by replacement with newer, more powerful and efficient models – is now increasingly being looked at.

By Elaine Maslin

© Adwo/AdobeStock

Earlier this year, trade body Wind Europe said it expects more than 20 GW of onshore wind farms will be repowered in the next 10 years. But what of offshore wind?

With the first offshore wind farms starting to reach their initial design life, and some already being decommissioned (the world's first offshore wind farm, Vindeby, was commissioned in 1991 and decommissioned in 2017), it's a topic that is being looked at.

In the UK, the first commercial wind farm was North Hoyle, commissioned off the North Wales coast in 2003. It consists of 30, 2MW Vestas turbines on monopile foundations in about 12m water, about 8km from shore. Others soon followed, including Scroby Sands, commissioned in 2004 and consisting of 30, V80 turbines totalling 60MW.

"When they were being designed, the standard design

life was 20 years," says Huw Traylor, Principal Consultant and Business Manager, Offshore Technology Department, DNV. "More recently (for new wind farms), that's changed to 25 and we're seeing 30 years as a standard now," he says, reflecting licensing regimes, such as the UK's Round 4, which now offer 60-year licenses, up from 50, allowing for two full project life cycles (based on 30-year life span).

ASSET LIFE EXTENSION

However, as well as building new wind farms to last longer, operators are looking at how to squeeze more life out of their existing farms as they near the end of their 20-year life. Scroby, for example, was recently the subject of a DNV study to assess how much longer RWE could continue to squeeze energy out of it, beyond its 20-year expected life.

Through an assessment, looking at the design assumptions, such as soil stiffness, which impacts the frequency of the structure and fatigue cycles, and then actual data, actual frequency, to calculate loading from wind and waves, etc., as well as corrosion survey data, condition reports and SCADA data, an additional five years of life was added to the farm. That's 25% extra time to keeping earning cash.

DNV makes these assessments using its Bladed software, a simulation tool used to optimize turbines at every phase of its design, in this case using a time history analysis, with an aero-elastic model developed by DNV.

It's worthwhile work, says Traylor. It's harder to predict conditions offshore, compared with onshore, so designs can be conservative, which means they can have more life in them, he says. As-built conditions might be better than assumed; the operating conditions might be different. At Scroby, for example, the turbines had been well designed, the ground conditions were generally better than assumed, and it was found that updated ambient turbulence was found to be lower than the original design calculations.

WHAT ABOUT REPOWERING

It can also a more realistic option than repowering, he suggests. But asset owners are still mulling their options, says Traylor. "We were recently asked to look at what the best options are for an asset; sweat it until the operating costs of enhanced maintenance exceed the cost of keeping it running or take a refurbishment strategy for the blades and certain other parts to extend the life time. It's all about balancing the levelized cost of energy (LCOE)."

Repowering does have challenges, he says. For one, today's turbines are much, much larger than they were 20 years ago.

Indeed, repowering hasn't been tackled to any significant degree yet in offshore wind. Five 550 kW WindWorld turbines, installed in 1998, off the coast of the island of Gotland, Sweden were re-commissioned in 2018, after undergoing an extensive technological and mechanical upgrade by Momentum Gruppen. The project included the replacement of nacelles, blades and control systems using newly refurbished parts from five Vestas V47-600 kW. The towers, the foundations and the subsea cables all passed an extensive durability test. The result was that the turbine's lifetime was extended by 15 years and the expected yearly output was doubled from ca. 5,000 MWh to ca. 11,000 MWh.

Wind Europe has also pointed to the Windplan Groen project in the Netherlands where it says 98 turbines totaling 168 MW capacity are being replaced by 90 more powerful turbines with a total 500MW capacity. It has also said that Belgium was considering repowering one of its existing offshore wind capacity in order to significantly boost its 2030 target for wind at sea as part of Europe's efforts to become less dependent on Russian energy imports.

CHALLENGES

But fewer than 10% of end-of-life wind turbines (to date mostly onshore) are repowered and operators are discouraged by slow and complex permitting procedures and changing legislation, says Wind Europe.

Another challenge is around the size of newer equipment – turbines have grown massively since 2003, from 2MW units to 14MW and now 15MW units today. Monopiles built in the early 2000s – at <4m diameter – wouldn't be able to take these units that today require 15m diameter monopiles, says Traylor. What's more, the turbines would need different spacing to manage wake effects. That then runs into consenting issues – having to get a new consent for what's effectively a new design and new tip heights. For the earlier wind farms, such as Scroby, which are close to shore, increasing the tip height might not be so easy as they're so much more visible.

That's not stopping people looking at the idea. In order to use existing foundation structures for repowering, German institute Fraunhofer Institute for Wind Energy Systems is developing a foundation concept which involves the strengthening of existing monopiles to enable offshore wind turbines to be repowered, as part of the InGROW project.

A Dutch project, DecomTools, says repowering existing sites could help achieve ambitious wind energy targets in Europe. Refurbishment would also be better, environmentally, but life extension would be cheaper, it found. It also says the case for repowering offshore wind is complicated, with the harsher environments accelerating wear and tear, and corrosion and erosion of components (blades, foundations etc.).

Due to harsh conditions and high costs, frequent site visits to analyze the structural health are difficult while electrical infrastructure is difficult to change, without bearing high costs, says DecomTools, which aims to develop a sustainable end-of-life approach for offshore wind turbines, concluding in January 2023.

THE CASE FOR 20MW TURBINES

This could change in the future, however. In another study, DNV looked at what the maximum of a turbine could get to. "As the size of turbines has got bigger, the LCOE has got lower," says Traylor. "But the benefit starts to tail off at 20MW, which tends to suggest the increase in size will stop." At that point, manufacturers could start to optimize what they have got, which would then lend itself to repowering of those systems, he says. But that's still a long way off.

Until then, asset owners are focusing more on life extension, says Traylor. "Most of the big developers have got an approach or are putting an approach in place. A lot of the big developers are building extra life time into their structures in anticipation of going for longer lives and that's coming from the owners and lenders who have been asking if they can assume 35-year lives."

That includes better upfront analysis, such as soil condition assessment, which could give greater certainty around design life. This is being done by the Carbon Trust-led Pile Soil Analysis (PISA) project, which delivered a new design method, displacing the existing methodology which was based on oil and gas platform design methods, where piles are smaller diameter and longer.

TAKING A LIFE MANAGEMENT APPROACH

But there are also learnings offshore wind could take from oil and gas, particularly around maintaining offshore structures, tackling corrosion, designing structures for longer life and structural integrity management, says Traylor. "Oil and gas has developed structural integrity management expertise over 30-50 years and this knowledge could be adapted for offshore wind," he says. That could be more focused inspection and testing and using digital twins to continuously monitor the health of a structure. "We're right at the start of this approach at the moment in off-

© diyanadimitrova/AdobeStock

shore wind," he says, particularly for assessing the impact on the structure and the life left in it.

A life management approach would need a twin for every location, because each location is different, but also networked, so that load is spread throughout a wind farm, instead of leading turbines bearing the brunt. This is all about software, says John King, Wind Turbine Loads & Control business lead at DNV. "So it's very easy to change long term and you can bank on there being some improvements over the next 20 years."

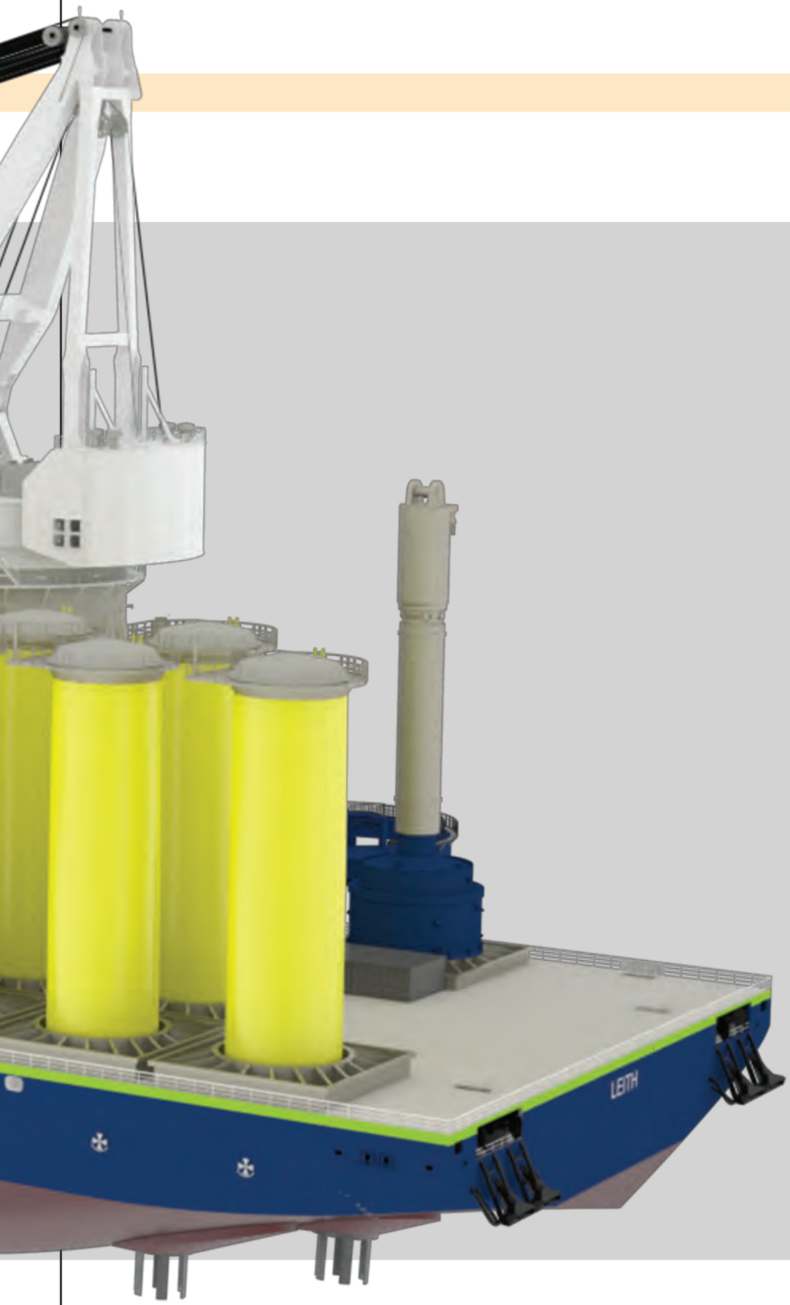
The benefits could be huge if engagement is early, which could even be before it's known what turbines will be used, says Traylor. Indeed, for some new build developments, owners are increasingly looking at how long they can manage their long-term investments for. Investors, especially, are interested in how long their investments could keep paying out – even before they invest and wind farms are built.

All images courtesy Zero-C Offshore

ZERO-C OFFSHORE:

A New UK Firm Aiming to Address a 'Chronic' FIV Shortage

By Eric Haun



The global offshore wind industry is staring down a potential shortage of foundation installation vessel capacity. A new UK company led by former offshore drilling executive Jon Oliver Bryce intends to help tackle this challenge as the industry's first pure play foundation installation vessel (FIV) firm.

The number of planned offshore wind projects globally is growing, spurred by green targets and a shift away from Russian oil and gas. This growth, alongside a shift toward the next generation of larger offshore wind turbines, is contributing to a shortage of foundation installation vessels that is "going from severe to chronic", said Jon Oliver Bryce, CEO of Zero-C Offshore Ltd. "There's a niche and misunderstood sector within this vessel space for the renewable industries. And it appears to me that everybody's missed this. It appears to me that there's going to be an enormous shortage of these vessels because nobody has figured this out yet."

The pipeline of offshore wind projects to be commissioned in the coming years is growing, and the urgency for these projects has intensified as many countries—especially those in Europe — seek to add new energy sources that are both green and non-Russian. Add to this big offshore wind plans in several Asian countries and the United States, and you'll find a very large pipeline of projects with only a handful of vessels currently capable of installing their foundations.

"If you look at what the UK has promised the world, it needs 50 gigawatts (GW) of offshore wind power by 2030. That means we need four FIVs working full time from now until 2030 to install all those projects. And that's just what the government wants. The commercial market will want more than that," Bryce said. "And it's a similar target in Holland, it's a similar target in Denmark,

it's a similar target in France, Norway, Poland, most of the Baltic states and Spain. Then you move around to Southeast Asia and into the States. There are not enough vessels. It's as simple as that."

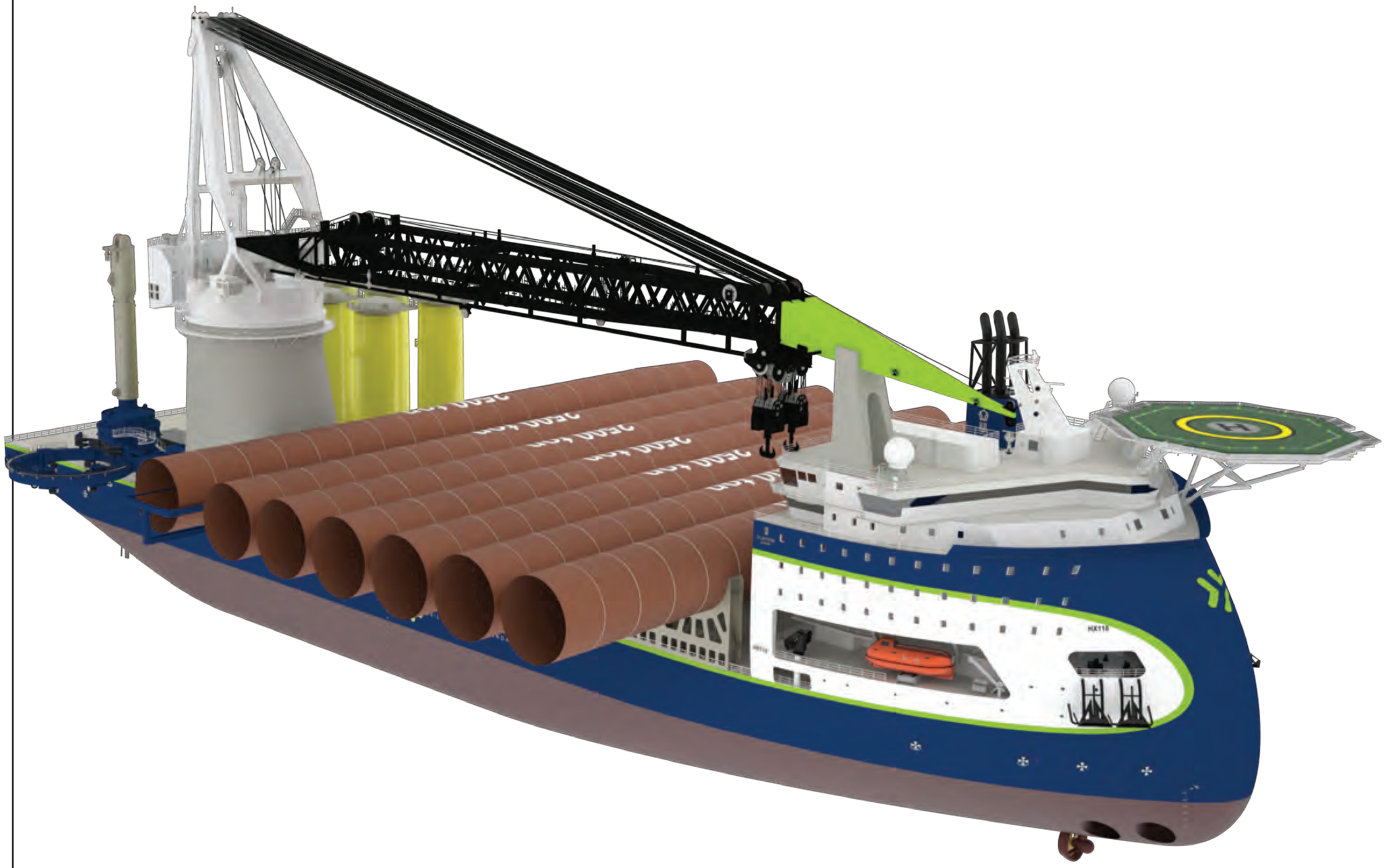
According to Bryce, the global fleet of vessels capable of installing the foundations for today's 10- and 12-megawatt (MW) turbines consists of eight vessels, only four of which were purpose-built. But that's not the "real issue" he said. "We've got a very limited supply now, but going forward, a lot of that supply won't be fit for the purpose."

While a greater number of projects will require even more vessels to install their foundations, the bigger problem is that the vessels presently available won't be able to handle the larger foundations of the future as turbines continue to scale up. In a relatively short period of time, the industry has advanced from 2 MW turbines to the 10-12 MW turbines being installed today. "But we're heading for 15, and we know we're going to get to 20 MW," Bryce said. "When we started, the foundations were 500 tons and they went to 1,000 tons. And now, a really big foundation, a big tube on a monopile, which supports the latest generation of offshore wind turbines, can be 3,000 tons. We are heading for 4,000 or 5,000 tons."

"Here comes your perfect storm. We're about to have an exponential increase in offshore wind park activity. At the same time, individual turbines have increased in size because of design and economics, and there are no vessels," Bryce said.

Zero-C is working to bring to market of a vessel of its own to help tackle this challenge. It has been working with Ulstein Design & Solutions BV in the Netherlands to design a vessel that Bryce calls "future-proof," capable of installing the fixed foundations for tomorrow's 20 MW tur-


ZERO-C OFFSHORE
BUILT ON GREEN FOUNDATIONS



bines. The ship-shaped dynamically positioned vessel will be about 230 meters long by about 60 meters wide, with accommodations for 160 people on board and equipped with a 6,000-ton Huisman crane.

Among other key characteristics, the vessel will be UK-flagged, it will be "mission flexible" with a number of layout options, it will be rated for high sea states (HS 3), and it will run on a cleaner burning fuel, likely dual fuel diesel with low-carbon green methanol to start.

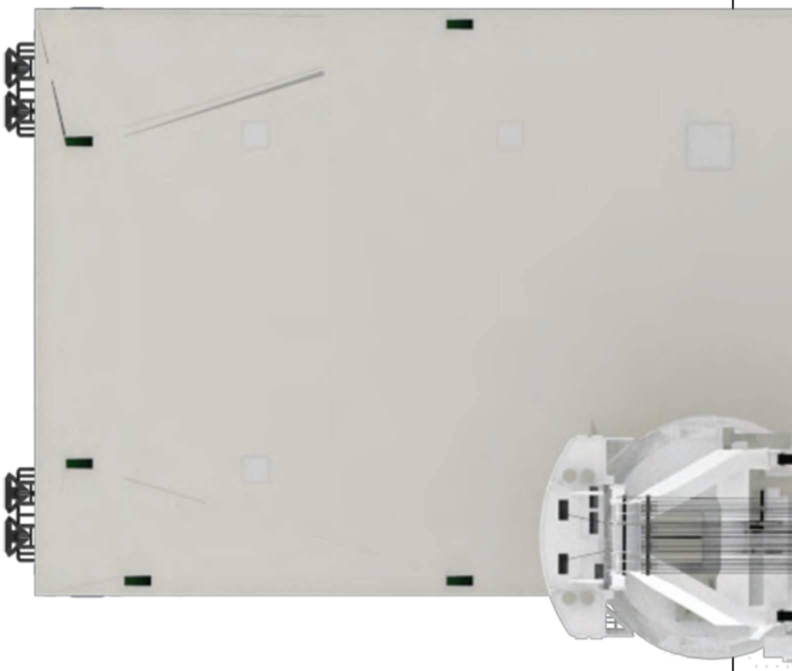
"[This] is very important to us," Bryce said. "The world's going green, but also IMO 2050 means that 50% of the world's vessels must be zero emissions by 2050. And we've got all kinds of other legislation coming in, European directives and some British Maritime Act, et cetera, saying we want zero emissions."

Bryce said Zero-C chose methanol after weighing a range of options and determining ammonia—the company's first fuel choice—carried too much risk as too new an option, and that engine advancements would not meet timeline targets. "We came to the conclusion that the engines probably wouldn't be ready [in time]. And also, when we were taking the company to market saying that's a brand new company, brand new management team, brand new concept, has a brand new fuel, we're probably spinning too many plates for investors," Bryce said. "We decided to park the ammonia, reluctantly. We can still design our vessels to call them ammonia-ready, which means in the future there's sufficient space and pipe work."

The result is a vessel that Bryce said is "literally the best pick, first choice in the entire world fleet of purpose-built [FIVs]. . . This vessel will be utilized 365 days a year, every year that it's in play. And the day rate squeeze is about to come, and it's going to be considerable because there's no supply."

Zero-C created the pre-concept design in-house before going to Ulstein for help with the concept design. Working with Clarksons Platou, Zero-C took the design to shipyards in China, Singapore, South Korea and the UK for price quotations. "We got some very, very competitive pricing from Asia. What comes next is we secure funding for the vessels and then we engage with Ulstein again for the basic design," Bryce said.

Zero-C has a memorandum of understanding (MOU) with Ocean Services—a Norwegian company formally called North Sea Rigs, with a lot of experience managing complex build projects in Asia—for construction project



management. "It's all about seamlessly delivering a complicated project and bringing in the best people and also a clever way of paying for this. It's about mitigating the risk and ensuring seamless delivery."

Bryce said Zero-C's potential customers fall into two categories: offshore wind developers and transport and installation (T&I) contractors. "We've had a lot of conversations with many of each. And we've gotten to the point when we have been talking about moving forward with commitments in writing," Bryce said. "They want to see us build, but we want to see them commit to us, help us to allow us to build. The issue at the moment is the equity market is just literally being wiped out since Q2."

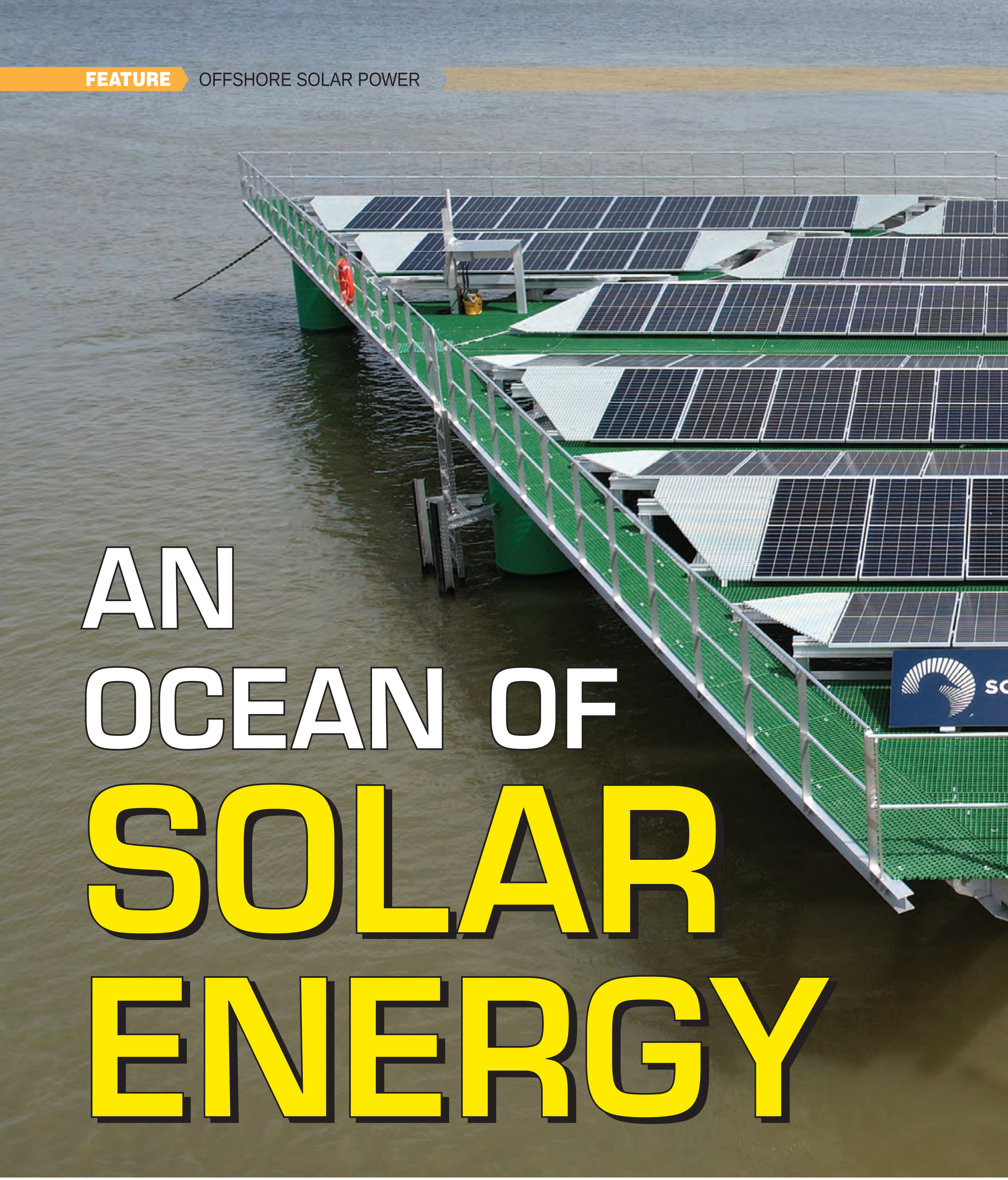
Bryce said Zero-C Offshore doesn't currently qualify for financial support from the Scottish government, but it has received assistance in other ways. "The Scottish government has said, 'Look, we will support you. We'll partner you with customer meetings. We'll come to the investor meetings. We will introduce you to our network. We will do everything we can, other than give you funding, until we can give you funding when you qualify.'"

The company has also been liaising with the British government for possible financial assistance. "They're much bigger than the Scottish government. And they've got bigger pockets, and they can do things in different ways," Bryce said. The company is in talks with the UK Infra-

structure Bank, which Bryce described as a new bank set up by the UK government to fund projects that are green, create jobs, and can't be conventionally funded due to some unusual circumstance. "There's no promises from them at the moment. We've certainly opened a line of communication and we'll see how it goes."

Zero-C has also been exploring other financial avenues, but Bryce said these have mostly closed off due to uncertainties created by the Ukraine conflict. "It's beyond frustrating that we can't get the capital markets to engage in this at the moment," he said. "We're guided by some big banks at the moment. We speak to three on an ongoing basis. Very, very supportive. But the reality is that IPO markets are pretty much closed at the moment. It doesn't matter what story you've got."

Bryce and Zero-C Offshore are pushing forward, keeping in sight the offshore wind industry's desperate need for FIVs. "I spoke to the chief financial officer of a very well-known Scandinavian investment bank at the start of this year, and I described [the FIV shortage]. He said he'd never seen such a chronic supply of bottleneck and looming in one industry," Bryce said. "When we're having our tricky moments trying to get this funded or trying conversations, I remember what he said. I was right, and he was right. And there will be a point when this whole sector burst into life. You heard it here first."



AN OCEAN OF SOLAR ENERGY

SolarDuck

An artist's impression of a larger scale deployment of SolarDuck systems.

Putting solar panels on the ocean may seem like a challenging idea, but it's increasingly explored.

By Elaine Maslin

Dutch research organization TNO recently wrote that, in 2050, 200 gigawatt peak (GWp) of solar power is expected to be generated in the Netherlands; 25 GWp of that will be on inland waters and 45 at sea.

Maybe that's a surprise? But floating solar isn't that new. According to Wood Mackenzie, there's about 8GW installed to date, mostly in Asia Pacific, with China (thought to have 70% of total capacity*), India and Indonesia leading.

A lot of that 8GW has been built in-land, e.g. on lakes or reservoirs. Dutch firm BayWa recently installed two farms, totaling 71MW on former sand extraction lakes in the Netherlands.

"Lack of availability of land that can be used for ground-mount solar has encouraged PV developers to look at alternate development technologies, giving rise to the demand for floating solar (FPV) installations," says Sagar Chopra, PV Research Analyst at Wood Mackenzie. "Costs associated with land lease, vegetation management, etc. can sometimes make FPV more favorable than ground-mount solar. The quick installation time is also an added driver for FPV project economics." With competition for agricultural land, there's also growing interest elsewhere, especially in Europe.

But not all areas have access to inland water or there could be restrictions on using these, says Chapra. So companies are looking offshore, which also offers hybridization opportunities with other renewables and unlimited expansion capability, he says.

Many have started in more benign waters. Vienna-based Swimsol claimed a world first "at sea" project in 2014, with a 15kW solar plant in the Maldives. But there are plenty of others taking steps offshore too.

TARGETING OFFSHORE

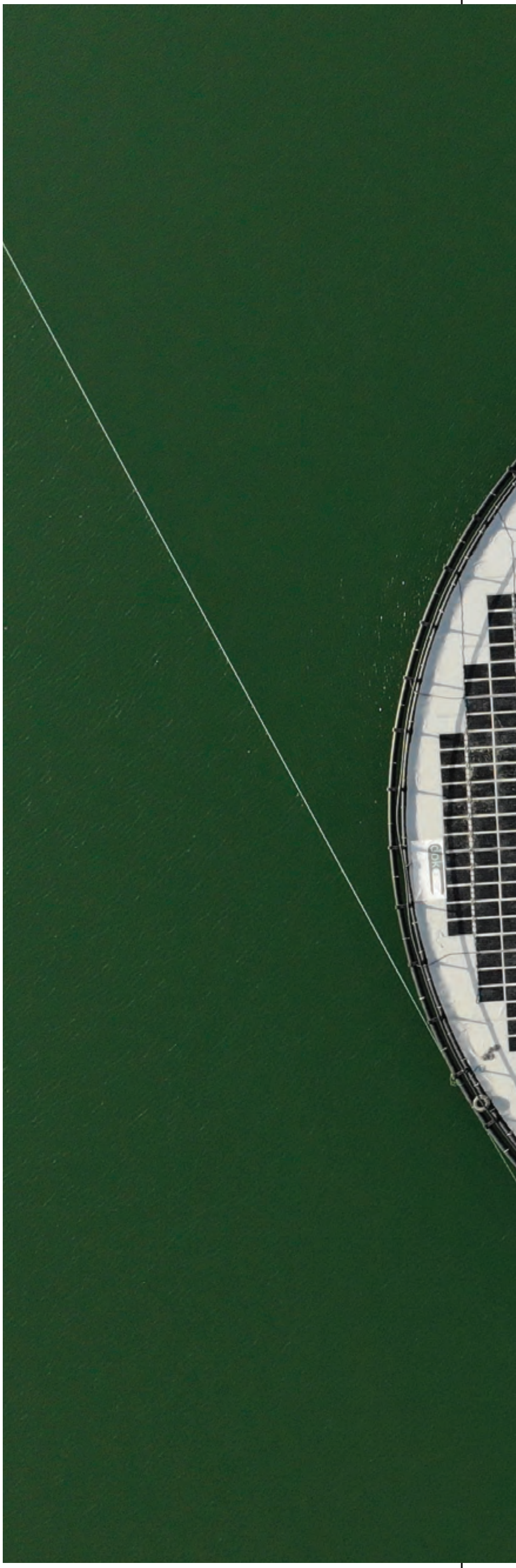
Norway's Ocean Sun has been building a track record in floating solar and is also targeting coastal waters. CEO Børge Bjørneklett founded the company in 2016 and they started their first pilot in Norway in 2017. Proximity to the user, land cost, transmission cable costs are all drivers to floating solar, he says.

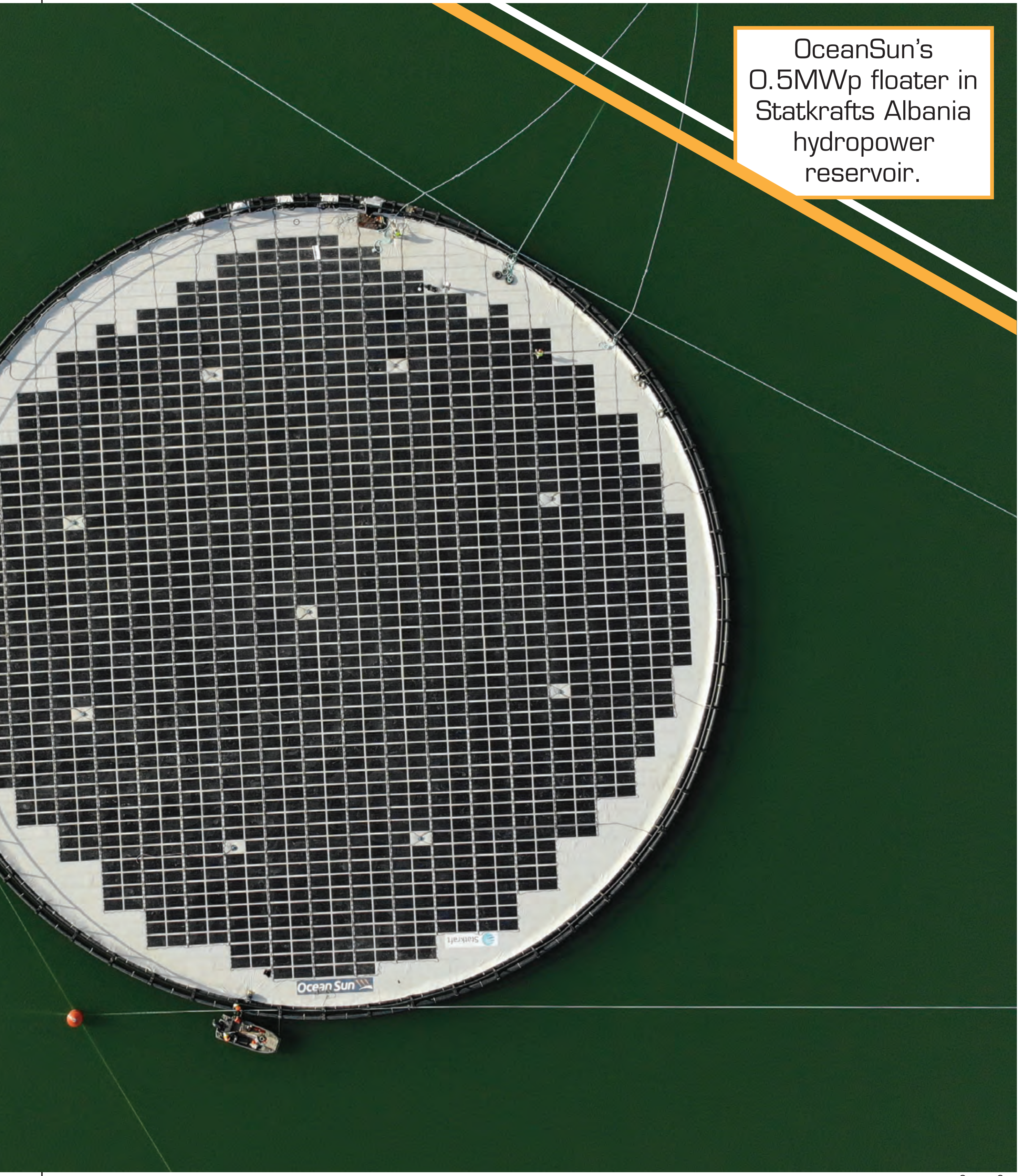
Ocean Sun's technology is based on placing panels on engineered textile membrane that sits directly on the sea surface, provides a large surface and behaves like a dampener, he says. It is held in place by a buoyant ring at the perimeter, that's moored to the seabed.

The membrane is the type that's used on top of large stadia or as roofing materials and contains e.g. biocides to prevent marine growth and UV stoppers to prevent UV degradation.

Using this method means it's easier to transport in 40ft containers and quick to install, compared with arrays of pontoons, which are more difficult to anchor and also suffer greater fatigue from the forces of the waves in the ocean, says Bjørneklett. Instead, being in direct contact with the sea helps cool the panels, giving higher voltage and improving yield. For every 1 deg C cooling there's approximately 0.4% efficiency gain, he says.

Ruggedized solar panels are used, comprising a "double glass sandwich" with an encapsulant that protects the solar cells inside. Each panel is up to about 2.5sq m with max power output of 600-700Wp (p = peak) each. A larger system, up to 75m diameter/>4,000sq m, can have 1,500 of them, and up to





OceanSun's 0.5MWp floater in Statkrafts Albania hydropower reservoir.

Ocean Sun

0.7 MW of installed power, depending on the panels. The maximum size of each ring is limited to what can fit in a 40ft container, for ease of logistics.

To handle waves, there's a freeboard, i.e. a flexible wall on the perimeter to take most of the spray from wave slamming, but they can take some salt water coming in and rain water and there are surface bilge pumps that automatically operate to remove it – or collect it for use, where required, says Bjørneklett.

SCALING UP

Since the 2019, it's been running a 230kW pilot in the Philippines, a country has experiences typhoons. This summer, Ocean Sun is expanding a single ring 0.5MWp ring that was initially installed on a hydropower reservoir run by Statkraft in Albania in 2021 to 2MW, by adding three more rings.

There have been challenges. The 0.5MWp Albanian plant suffered an accident caused by a tornado – conditions that had not been expected in that region. The design was since updated to better weather data and, following re-installation in April, has run successfully since, says Bjørneklett. In contrast, the design for the Philippines had been CFD tested to meet building codes there that include ability to withstand 275km wind speed – or a Category 4 typhoon, from the beginning

A lot else has also evolved, he says, including how to make improvements to make it easier from a supply chain perspective, i.e. being able to get the fabric made in the sizes needed. Things like this are important when moving to scale

What's worth noting is that solar panels tend to be tilted and that's for a reason: they work best when perpendicular to the sun. That means floating (mostly horizontal) installations closer to the equator will get more yield compared with Oslo, Norway, for example, at 60 deg north, says Bjørneklett. However, wind drag is a powerful force offshore and tilted panels acts like sails, , he says. But there's a pivot point for horizontal panels due to the gain from cooling. That's at about 45 degrees north, where you have more gain from cooling in comparison with traditional air-cooled panels with ideal angle to the sun, he says.

OceanSun has an agreement for a 1.2 MWp floating PV demonstrator near an island south of Singapore, comprising of two rings, with construction scheduled in Q3. It's also got an agreement with Keppel for a three-ring, 1.5 MWp floater near Jurong Island, Singapore, which is expected to be ready in 4Q 2023.

It's also signed a licensing deal with Chinese developer String Capital and Sunneng Technology for the construction of a 1 MWp FPV pilot nearshore Yantai, Shandong province, with construction due to start later this year. A second agreement with Sunneng and SPIC (State Power Investment Corporation), will see a 0.5MWp FPV pilot connected to a wind turbine built at Haiyang, also off Shandong. Following successful operation through typhoon season there, the rest of the wind turbines at Haiyang are also expected to be connected to 0.5MWp floaters, amounting to a total 20MWp project in 2023.

Over in Europe, Ocean Sun is working with Fred Olsen Renewables and other partners on an EU Horizon 2020 program. This is expected to see a 0.25MWp floating solar power plant built off Gran Canaria, to explore the outer limits of the technology in a rougher ocean environment.

SOLARDUCK

Formed more recently, SolarDuck has been making quick headway, including a collaboration agreement with utility RWE for a 0.5MWp pilot off Belgium.

The company is a spin out from Dutch shipbuilder Damen, which had previously dabbled in tidal energy with the BlueTEC platform. It's named after the solar duck curve, which describes how energy demand drops at peak solar output times and vice versa (in northern latitudes at least). Damen liked the idea of floating solar, but decided it was outside its core expertise, so let Koen Burgers, a business strategist at Damen, run with it, forming a company in 2019, which went independent in 2020, with Damen holding a stake.

Its concept is based on triangular, aluminium structures with grated flooring on which tilted panels are mounted. These would sit above the water surface (to keep water off the panels and limit issues such as algae formation) on three-column, semisubmersible bases. These can then be tessellated (more easily than squares and with more inherent flexibility) into giant hexagons producing 10MWp and upwards of solar power. To join the triangles into hexagons, SolarDuck has developed patented couplings that allow a certain amount of flex. The outer ring of the hexagon would be used for mooring points.

Hydropower dam – Ocean Sun's Luzon Island project in the Philippines. A 230 kWp ring, owned by SN-Aboitiz Power.

Ocean Sun

OceanSun's test system from 2018 at Lerøy Seafood on the west coast of Norway.

Ocean Sun

A KING EIDER DUCK

SolarDuck's first demo unit, "King Eider" (a type of duck), was built at a Damen shipyard in early 2021, towed to its site 55km away and has been operating on the River Waal in the Netherlands since then. The 65kwp unit is over 30m along each side, made up of four triangular platforms, built to withstand 3.5 significant wave height and 6.5m maximum wave height, and went through storm Eunice without a problem. SolarDuck says the platform received the world´s first certification for offshore floating solar by Bureau Veritas.

The next unit, "Merganser," another type of duck, is currently being built, as part of a partnership with German utility RWE for installation on the North Sea next year. This will be an optimized 0.5MW unit, designed for 7.5m significant wave height and 14m maximum wave height, and using much less aluminum, per kW, than the previous system, says Burgers.

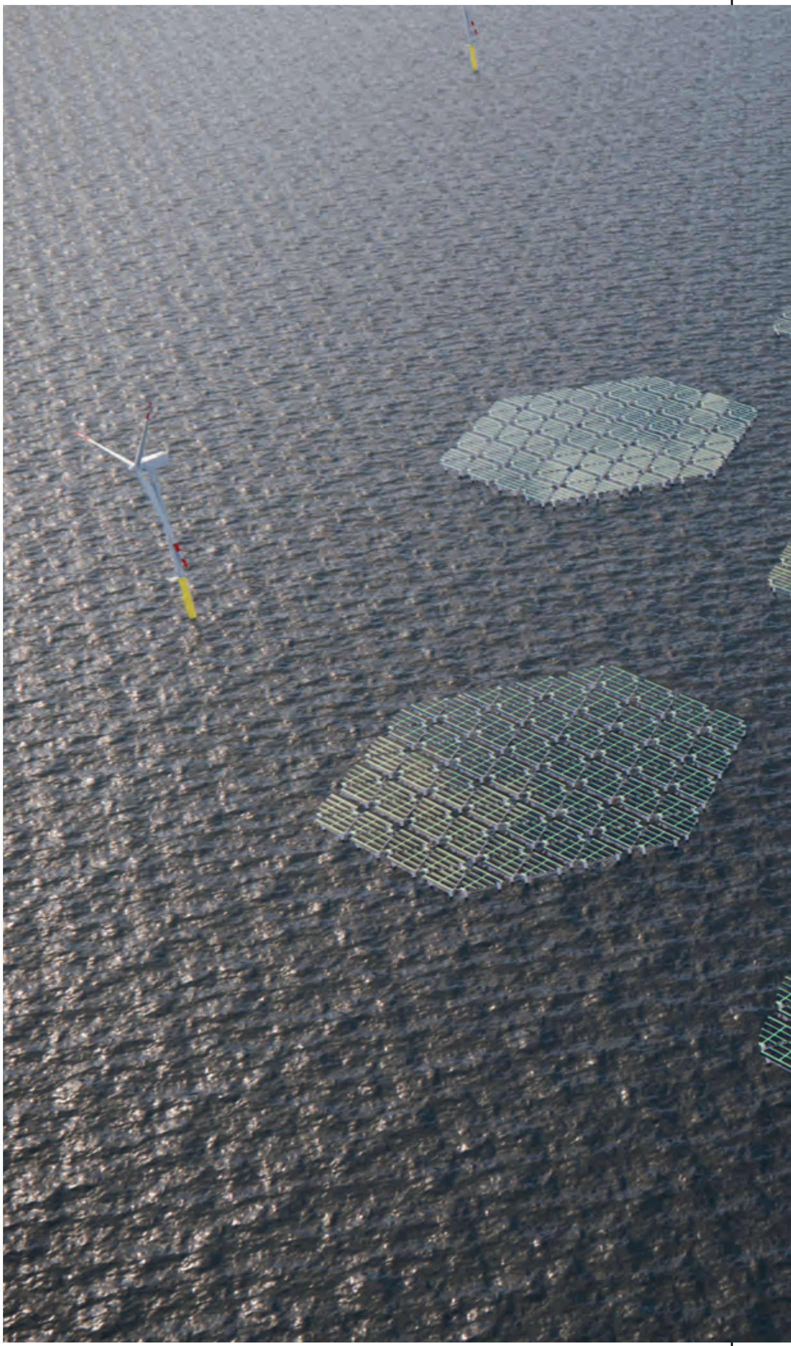
SolarDuck's technology is also part of RWE's bid for the Hollandse Kust West wind farm, winning bids for which are due to be announced in Q4. That could see 700MW of offshore wind twinned with 5Mwp of floating solar, all using the same export infrastructure, and, thanks to the natural patterns of solar and wind (often occurring at different times), less than 8% curtailment, says Burgers.

Some 8-12 of these hexagons could fit between turbines and while some spatial planning would be needed to allow vessel access, that's still feasible, says Burgers. "This offers great potential. Wind and solar are complementary. In sunnier conditions you could more than double the energy capacity at a wind farm by bringing in solar," he says.

"We are in this for utility scale – scale is everything. We're looking at 5-10MW and multiples of that and we are currently participating in projects of 100MWp and more," he says. "It's a really exciting journey. At the end of the day, it's a very cost-effective, scalable technology, which can be deployed really fast. The cost levels are pretty low very competitive and can be deployed either in combination with wind or as stand-alone energy plants." In future, there's also capacity on the structures to build in energy storage. Initially, that would be with compressed air, says Burgers. But further in the future that could also be hydrogen.

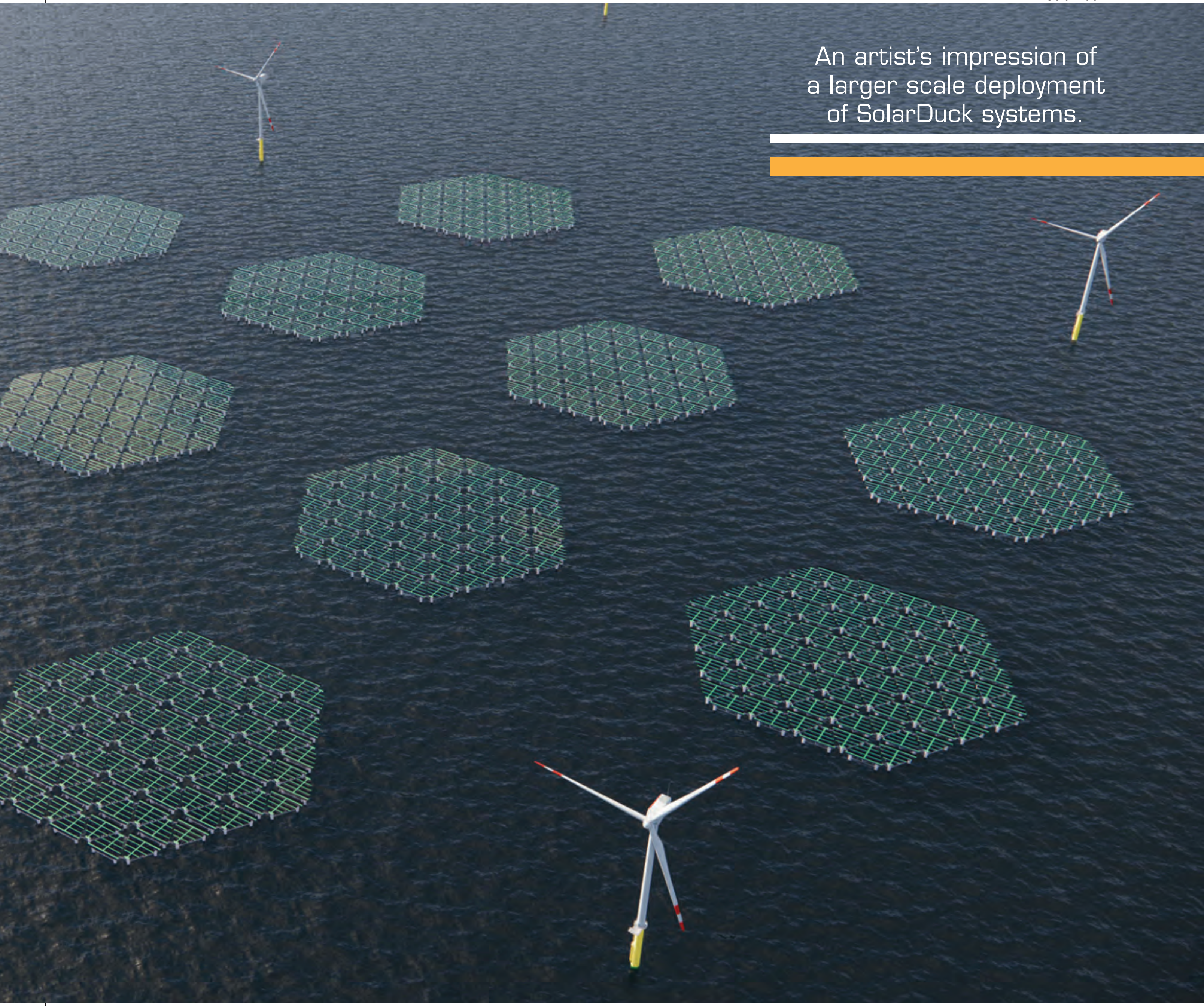
DEVELOPERS GETTING IN ON IT

RWE isn't alone in offering floating solar in an offshore



wind bid. For its Hollandse Kust Noord bid, Crosswind (Shell and Eneco JV) also included floating solar. Others are also working on floating solar technologies. In 2019, Oceans of Energy, a spin-off of Delft University of Technology, installed an 8.5kW offshore PV system 1km off the Dutch coast, as part of a consortium. In 2020, it was expanded to 50 kW and then placed 15km offshore where it withstood up to 13m high waves and 62kt winds. Op-

SolarDuck



An artist's impression of a larger scale deployment of SolarDuck systems.

erating since 2020, it's now being expanded to 1MW. Oceans of Energy is also planning a 3MW project co-located with offshore wind offshore Belgium, under the European SCalable Offshore Renewable Energy Sources (EU-SCORES) project.

A Belgian consortium including DEME, solar manufacturer Soltech, Ghent University and Tractebel is working on a marine PV project. The €2 million PV array will be built near an aquaculture farm and offshore wind project. Norway's Moss Maritime (part of Saipem) has also been working on floating solar concepts, working with Equinor.

Meanwhile TNO is leading a consortium including petrochemical company SABIC, Equinor, and the municipality of Westvoorne that's testing three designs over a year on a lake near Rotterdam Europort.

*Ocean Sun.

RETROFITTING AUTONOMOUS INFLOW CONTROL DEVICES OFFSHORE CHINA

By Mojtaba Moradi, Jingheng Hau and Michael Konopczynski,
Tendeka and Ling Dai et al, CNOOC China Ltd

Water breakthrough in a horizontal well is often the result of varying reservoir properties, layer pressure, and fluid contacts in zones intersected by the well. While inflow control devices (ICDs) can be used to mitigate and manage the reservoir fluid influx toward the wellbore, the technology is unable to adapt to the dynamic change in the reservoir if there is a high mobility contrast between the viscous oil and water. In addition, successful water production control with ICDs requires isolation in the annulus between the formation and the wellbore1&2.

During an intervention campaign in the Pearl River Mouth Basin of the South China Sea, CNOOC aimed to improve production by retrofitting a horizontal well located about 120km southeast of Hong Kong. Water mobility in the reservoir was at least 20 times higher than oil mobility and a strong aquifer was located below the well. The well was drilled along a heterogeneous formation with varying properties resulting in an uneven reservoir influx toward the wellbore. Although the well was already completed with passive ICDs, within a couple of weeks of starting production, the well suffered from severe early water breakthrough.

Global production optimization specialist, Tendeka, was contracted to perform an integrated study comprising history matching and performance evaluation of the existing completion. Sensitivity analyses were used to determine the best retrofit completion for the well using autonomous ICDs (AICDs) to ensure a balanced contribution from all reservoir sections. The bi-stable devices can control the reservoir fluid influx toward the wellbore while significantly limiting water production[3-5].

Retrofit application

A well with a horizontal length of 536m was drilled in a thin formation with the oil column averaging 5m. In the initial production phase, 2,411 barrels of liquid were produced daily, including 1,885 barrels of oil with water cut of 21.8%. After one week, the water cut exceeded 40% and after one month reached 60% and decreased rapidly after that. The results of running PLT showed that the water rapidly broke through the high permeability zones and the horizontal section was unevenly produced even with installed ICDs. As the crude oil viscosity of the producer well was 18.7cp, there was still residual oil around the well, and the remaining recoverable reserves was estimated to be 69,000m3, the implementation of AICDs was considered to improve the well performance. AICDs were introduced to function as standard ICDs prior to the breakthrough (proactive solution). It limits the production of unwanted effluents with lower viscosity after breakthrough such as gas in light oil and both gas and water in heavy oil production (reactive solution). It is a viscosity and density-dependent device which is typically incorporated as part of a screen joint as shown in Figure 1. For retrofit applications, an inner string consisting of AICD subs and swellable packers is installed within the existing wellbore. In this case, compartmentalization is driven by the existing wellbore, whether that be standalone screens or gravel-packed completion along with packers for zonal isolation as shown in Figure 2, or with cased and perforated wells. If extra compartmentalization is required, chemical annular isolations can be used.

Flow loop testing was performed to check AICD functionality where single-phase oil and water, and multiphase samples were flowed through the AICD to evaluate its performance. Under 500kPa differential pressure, the single-phase oil flow rate through the AICD is about 1m3/h, which is about 5.5 times higher than the flow rate of single-phase water. For multiphase oil-water mixtures under the same pressure difference, the higher the water cut in the oil-water mixture, the smaller the flow rate through the AICD. Several other tests with other fluids with viscosity

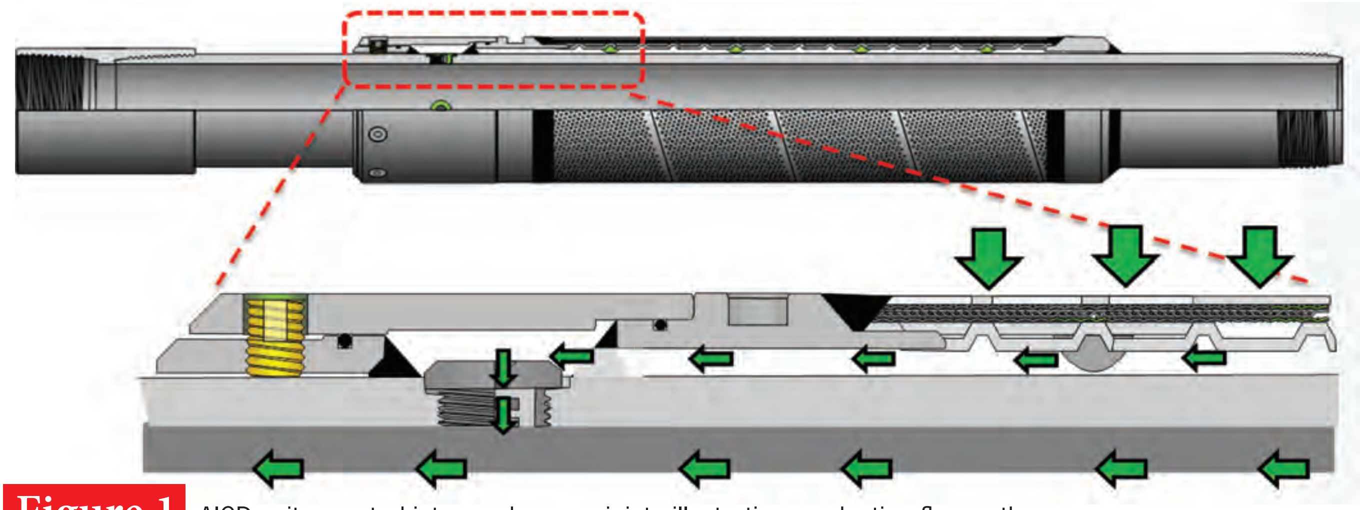


Figure 1 AICD unit mounted into sand screen joints illustrating production flow path.

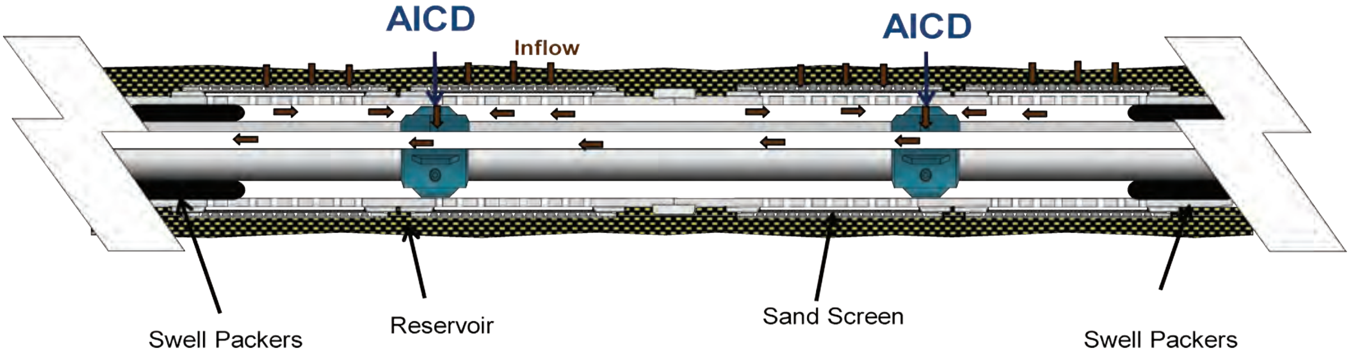


Figure 2 Retrofit AICD completion in existing standalone screen with the production flow path.

ranges from 12 to 200cP have been reported.

It was possible for the well to install 3-1/2" AICD subs with swellable packers to retrofit the AICD completion. As shown in Figure 3, 54 AICD 7.5mm devices were retrofitted into the existing 5-1/2" ICD screen based on results of a static wellbore modeling. If necessary, chemical packing material can be placed in the annulus at the original packer position to enhance the effective separation of the horizontal section.

The optimum retrofit completion was to install a 2 3/8" inner string consisting of AICD subs and swellable packers inside the existing ICD/screen completion.

Optimized well performance

The well was successfully re-completed with FloSure AICD completions and over a nine-month period of production, well performance was optimized. ACID valves restricted liquid production from the first and fourth sections with high permeabilities especially undesirable fluids, and greatly increased oil production in the second and third sections of well with low permeability, effectively controlling water production from the bottom aquifer.

In summary, water cut was reduced from 97% to 87% helping produce 200% more oil compared to production prior to re-completion (Figure 4).

The performance simulation analysis shows optimum water control could be achieved by imposing effective back pressure against water production when daily liquid production rate is around 11,000bbl/d. It is expected that future liquid production rate will be maintained at 11,000bbl/d while the current water cut will be maintained with the AICD retrofit completion, compared to the existing ICD completion in which the water cut continues to increase.

Although the well was at very late stage of its lifetime with an increasing trend of water cut (above 97%) and a significant volume of original liquid was already produced before operation, it is estimated that total oil production of 71,100Sm3 could be produced by the AICD completion. This is significant when noting that the well without AICDs could produce total oil volume of only 30,200Sm3 oil. In other words, an extra 40,900Sm3 cumulative oil

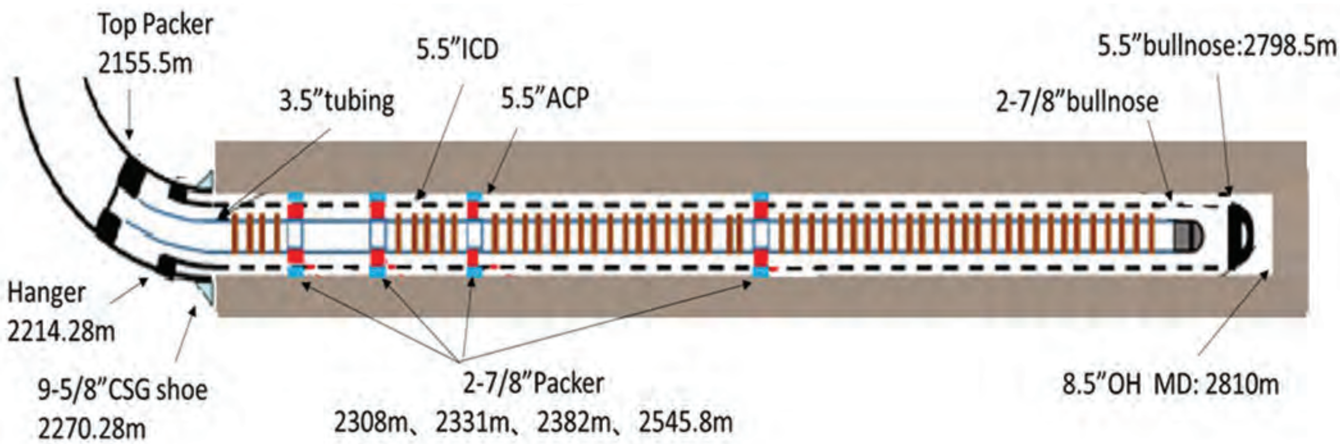


Figure 3 The retrofitted AICD completion schematics.

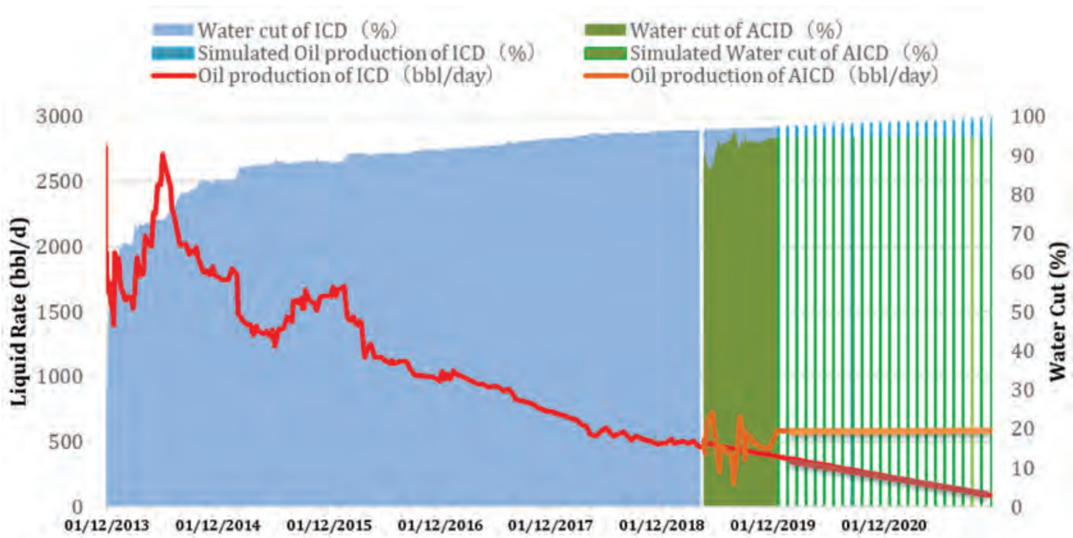


Figure 4 Well production profile (including prediction by simulation).

production could be achieved by retrofitted AICDs completion extending well life for additional four years than previously anticipated.

The AICD completions effectively not only boosted oil production and saved the treatment cost of extra water production and chemicals but also allowed adding other low water cut wells to the production systems as extra capacities on the surface facilities became available. This successful application of AICD in this well has also opened up other similar opportunities that are currently being evaluated for the same application. To date, more than 280 wells have been completed with FloSure AICD technology. With more than 50 of the wells completed successfully with AICDs in high oil viscosity environments, the technology has proven a robust solution to develop challenging reservoirs more efficiently. Retrofitting the existing completions with AICDs is now a common practice for some operators following successful installation in the pilot wells.

References

1. Dowlatabad, M. M. (2015, June 1). Novel Integrated Approach Simultaneously Optimising AFI Locations Plus Number and (A)ICD Sizes. Society of Petroleum Engineers. doi:10.2118/174309-MS
2. MoradiDowlatabad, M., Zarei, F., & Akbari, M. (2015, April 22). The Improvement of Production Profile While Managing Reservoir Uncertainties with Inflow Control Devices Completions. Society of Petroleum Engineers. doi:10.2118/173841-MS
3. Mohd Ismail, I., Che Sidik, N. A., Syarani Wahi, F., Tan, G. L., Tom, F., & Hillis, F. (2018, September 17). Increased Oil Production in Super Thin Oil Rim Using the Application of Autonomous Inflow Control Devices. Society of Petroleum Engineers. doi:10.2118/191590-MS
4. Moradi, M., Konopczynski, M., Mohd Ismail, I., & Oguche, I. (2018, December 10). Production Optimisation of Heavy Oil Wells Using Autonomous Inflow Control Devices. Society of Petroleum Engineers. doi:10.2118/193718-MS
5. MoradiDowlatabad, M., Muradov, K. M., & Davies, D. (2014, December 10). Novel Workflow to Optimise Annular Flow Isolation in Advanced Wells. International Petroleum Technology Conference. doi:10.2523/IPTC-17716-MS

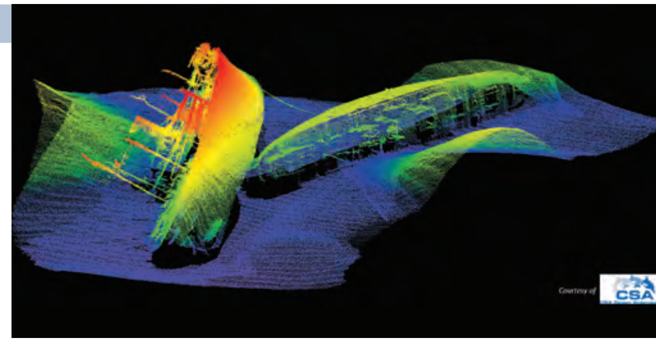
All images courtesy Acteon

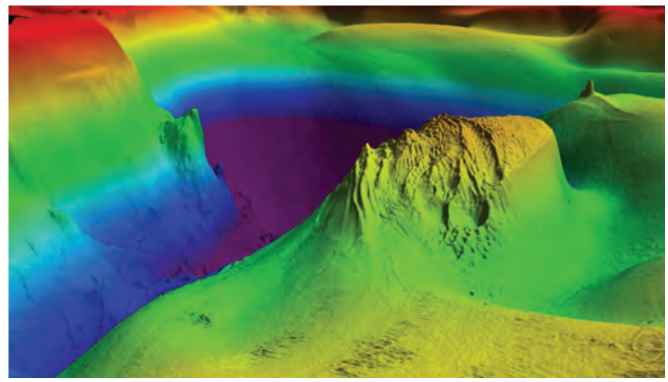
ACTEON PREPS FOR "MEGA-CYCLE" OF INVESTMENT

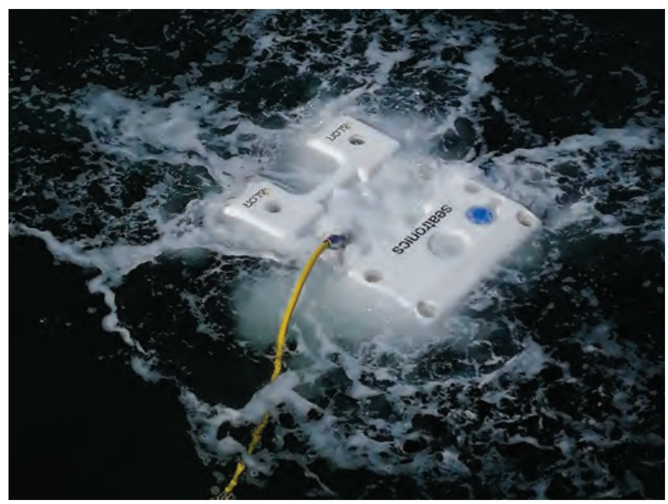
Striking a balance between traditional offshore oil and gas and renewable markets is neither straight nor clear. ***Carl Trowell, CEO, Acteon Group*** *discusses his company's strategy to capitalize on what he sees as resurgence offshore oil and gas investment premised on energy security concerns, plus a "mega-cycle" of investment in offshore wind energy in the long term.*

By Greg Trauthwein

Survey work, prior to installation as well as throughout an asset's lifecycle, will become increasingly important to Acteon Group.







To start us off, can you give a 'by the numbers' look at Acteon Group today?

The group overall has a turnover about half a billion pounds in revenue, and we have about 2,000 employees worldwide, working in three global divisions. We've worked on more than 80 major renewable projects and we've installed almost 2,500 driven monopile foundations for wind farms. We've completed more than 1,000 mooring installations, 300 decommissioning projects, and we've worked in over 100 countries.

When you look at the industries you serve, what do you consider to be the key technologies that are central to your future?

I'll pick three to emphasize. One of our divisions specializes in survey work, both ahead of installation of in-sea infrastructure and then post installation for ongoing integrity and inspection monitoring; that technology is an area that we are going to emphasize going forward, as there's going to be such a huge amount of infrastructure going in the sea over the next few years. Where we see real technological advancement is in putting sensor packages on autonomous vehicles, surface or subsurface.

Another area where we're putting a lot of innovation is around geotechnical site investigation, particularly with the building need for the installation of big offshore wind

farms where the foundations are getting more complicated. Rock soil parameters are important, and to give you one example, we've developed a new remotely operated sea floor drill specifically for shallow water, unconsolidated sands relevant to the renewables market. We've been doing this for years in the deep water for oil and gas, but we've particularly developed a new product for the renewables market.

The third are where we are putting a lot of time and effort into is new foundation technologies and techniques, particularly, again, for renewables. We're taking techniques that have been developed in the oil and gas world and now applying them as the offshore wind market begins to move away from areas where it's easy to just put in simple monopiles to where you're going to have to do more complex foundations, hard rock, difficult substrates. But also the fact that the turbines are just getting bigger and bigger, which means the foundations are getting more challenging.

Can you point to one technology, one capability where you sit back as a CEO and just think, "wow, we actually do that?

Our ability to engineer and store complex foundations would have been what I picked until a few weeks ago, but then I sat through a review with our engineering group where we're building a digital twin for an offshore floating wind installation. We've helped the operator engineer and model the whole floating system from the turbine through to the semisub and the anchoring systems, and come up with a digital monitoring system. We're building a digital twin so that you can then use it to predict failures, problems and downtime on the other units in the field. I've seen a lot of PowerPoint presentations on it, but I actually saw it for real and I saw it on a live project. I did step back and say, "Wow, we can do that." So that's a nice question with nice timing.

Has the most recent offshore oil and gas crash from 2014 to '21 fundamentally changed the needs of your clients, and as a result, your company?

Historically Acteon saw itself as an oil field services business, when in fact actually, if you step back, it's an insea infrastructure company. To some extent, a lot of the services we provide are somewhat agnostic as to whether they work for oil and gas, renewables or other nearshore

"There's going to be more infrastructure going into the sea in the next decade from offshore wind than went in throughout the whole lifetime of oil and gas... *it's going to be off the scale of the number of moorings. We're at the beginning of what will be a mega cycle of investment."*

– Carl Trowell, CEO, Acteon Group

Watch the interview on OETV

infrastructure projects. But the heritage of the company came from the oil and gas side and it still remains a big leg, one of the key legs for us on the stool. But as you say, the downturn from 2014 onwards was quite drastic. (Personally) I've been through maybe three or four big downturns in my career and this one felt very different from most, if for no other reason the duration.

What we saw is a couple of things. We saw from our customer base a real entrenchment and a focus on cash flow, cash flow generation, return back to shareholders rather than pumping money back into lots of new projects. As a consequence, we saw a lot of our customers focus on investment in existing infrastructure, existing bases and existing projects. Accordingly, we cut our business to match that. I think Acteon now, versus where it was in 2014, is much more focused on oil and gas services that are related to the installed base. So helping with existing optimization with late life extensions, with intervening on infrastructure to add additional capacity or extra wells. So you're getting more from the install base all the way through to decommissioning. And so our business in the oil and gas is much more focused now late life and decommissioning than it was in 2014. I think we will see a resurgence in some of the green field new developments, but I think in general that will still be biased a bit more onshore than it is offshore. And in the offshore arena, I think that we will still bias our services towards that existing infrastructure services.

The other thing is part of our customer base started to seriously get focused on the energy transition. As we've seen their focus change, we've been moving with them.

It's going to be very interesting now to see how much the focus on energy security, and the need for oil and gas in the interim, how much that really drives a wave of investment. We're seeing it, but is it sustainable?

That leads perfectly to the next question. On one hand you're leaning on the traditional oil and gas projects and revenues, while you're also investing in the future, the renewable markets that are still maturing. How do you balance the two?

The challenge is a bit less consequential for us because a lot of what Acteon does is within servicing in-sea infrastructure, somewhat agnostic as to whether that's oil and gas infrastructure, renewables or other structures. It means for all of our services, it's a move or a nudge over in that direction, or it's a repurposing or dual-use of some solutions.

I can give you an example of that in what we have within our moorings and anchors business unit, InterMoor. There, we developed a SEPLA anchor, a suction embedded plate anchor which was used in the oil and gas industry in many places all around the world for certain anchoring purposes. It turns out, it's incredibly applicable to floating wind. So we've slightly re-engineered it, we've looked at a deployment technique, and we have a product which is equally applicable in both spaces.

Then 2H, our engineering group, specializes in risers and umbilicals. In the energy transition they've been successful taking that expertise and applying it decarbonization of the oil and gas industry.

So they're taking that expertise, reversing it and coming up with engineered solutions to, for example, do cold-water cooling on FPSOs, reducing the energy requirements because (by using seawater for the cooling). They're doing something similar to provide air conditioning into airports and hospitals by using deep water.

Overall, there are a lot that companies and individuals that grew up engineering in the oil and gas business (now able to address the challenges associated with the energy transition.)

The attitudes have changed quickly and I think that's driven a lot by following the money.

I think there's something that everyone has to think about, which is there's going to be more infrastructure going into the sea in the next decade from offshore wind than went in throughout the whole lifetime of oil and gas. If you just look at the number of units, the number of installations, when you start moving to floating wind, it's going to be off the scale of the number of moorings. If you're in this sector you should be turning your eyes to this because we're at the beginning of what will be a mega cycle of investment.

How has the war in Ukraine and continued supply chain snarls materially impacted the Acteon Group and what measures have been enacted to help mitigate that risk?

It's had limited direct influence on us in the sense that we don't and haven't historically had very many operations around that part of the world or with Russia. But, of course, a lot of the knock-on effects are having big implications. On the negative side, I think the biggest thing is cost inflation in the supply chain, risk in the supply chain of equipment, key components, materials being ready is a challenge.

The other consequence though, which is somewhat in the opposite direction, is that it's brought a real focus to energy security. It's brought a revised view to supply and investment in oil and gas, and particularly gas, triggering (for us) a bit of a resurgence in that market. And you mentioned the downturn 2014 to 2021 or so. I think during that time there were people who thought that a dollar would never be spent in oil and gas ever again. That's under revision at the moment.

You almost have a perfect storm at the moment, where most offshore oil and gas sectors are picking up and seeing a new surge of investment, while at the same time, the renewables market is coming up and at the same time people are working on things like nearshore defenses and coastal structures. They're all happening at the same time and that just adds another layer of back pressure into the supply chain.

Acteon Group has built and acquired a family of brands across the marine and the energy industries. What's next?

For us, we have a new structure, working with three divisions now on a global scale. That's been the latest evolution, and we see the benefits of further integration both from technology synergies and probably new product development, from bringing those companies closer together. But I think there is a mega cycle coming of investment and where that lies between offshore wind and oil and gas, we'll have to see. I think there's room for further consolidation amongst the supply chain. But on the back of the last oil and gas downturn, we have a lot of smaller subscale oil field services business and I think there's going to be some consolidation there.

With respect to the renewables, you've got this huge investment cycle coming. We did a recent piece of work and we found out that on a typical offshore wind project, you've got almost 10 times as many companies independently contracted in the supply chain than you do in an equivalent oil and gas project. So we think logic would tell you that there's a need there from an efficiency and delivery point of view for consolidation. And there's also room for there to be big global offshore service companies focused on the offshore wind developed because we're only at the beginning of this evolution. So you could see the need for bigger companies to service the industry on a global scale developing. And we see ourselves as a platform for future M&A, be that bolt in to our structure or if we take part in some of the bigger combination.

While offshore wind is growing rapidly, energy security issues due to the war in Ukraine have generated a resurgence in traditional offshore oil and gas spending.

UNITED STATES POSTAL SERVICE®

Statement of Ownership, Management, and Circulation (Requester Publications Only)

1. Publication Title: Offshore Engineer	2. Publication Number: 0 1 7 - 0 5 8	3. Filing Date: September 20,2022
4. Issue Frequency: Bi-Monthly	5. Number of Issues Published Annually: 6	6. Annual Subscription Price (if any): None

7. Complete Mailing Address of Known Office of Publication (Not printer): Atcomedia, Inc 118 East 25th Street, 2nd Floor, New York, NY 10010
Contact Person: Kathleen Hickey
Telephone (Include area code): 212-477-6700

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer): Atcomedia, Inc. 118 East 25th Street, 2nd Floor, New York. NY 10010

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank)
Publisher (Name and complete mailing address): John C. O'Malley, Atcomedia, Inc. 118 East 25th Street, 2nd Floor, New York, NY 10010
Editor (Name and complete mailing address): Bartolomej Tomic, Atcomedia, Inc. 118 East 25th Street, 2nd Floor, New York, NY 10010
Managing Editor (Name and complete mailing address):

10. Owner

Full Name	Complete Mailing Address
John C. O'Malley	Atcomedia, Inc 118 East 25th Street, 2nd Floor New York, NY 10010

11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box ► ☒ None

Full Name	Complete Mailing Address

12. Tax Status
☒ Has Not Changed During Preceding 12 Months
☐ Has Changed During Preceding 12 Months

PS Form 3526-R, July 2014 (Page 1 of 4) PRIVACY NOTICE: See our privacy policy on www.usps.com

13. Publication Title: Offshore Engineer		14. Issue Date for Circulation Data Below: March/April 2022	
15. Extent and Nature of Circulation: Requester		Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies (Net press run)		2340	4079
b. Legitimate Paid and/or Requested Distribution (By mail and outside the mail)	(1) Outside County Paid/Requested Mail Subscriptions stated on PS Form 3541	1595	2800
	(2) In-County Paid/Requested Mail Subscriptions stated on PS Form 3541	0	0
	(3) Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid or Requested Distribution Outside USPS®	0	0
	(4) Requested Copies Distributed by Other Mail Classes Through the USPS (e.g., First-Class Mail®)	234	373
c. Total Paid and/or Requested Circulation (Sum of 15b (1), (2), (3), and (4))		1829	3173
d. Non-requested Distribution (By mail and outside the mail)	(1) Outside County Nonrequested Copies Stated on PS Form 3541	0	0
	(2) In-County Nonrequested Copies Stated on PS Form 3541	0	0
	(3) Nonrequested Copies Distributed Through the USPS by Other Classes of Mail	18	21
	(4) Nonrequested Copies Distributed Outside the Mail	450	800
e. Total Nonrequested Distribution (Sum of 15d (1), (2), (3) and (4))		468	821
f. Total Distribution (Sum of 15c and e)		2297	3994
g. Copies not Distributed		43	85
h. Total (Sum of 15f and g)		2340	4079
i. Percent Paid and/or Requested Circulation (15c divided by 15f times 100)		79.6%	79.4%

PS Form 3526-R, July 2014 (Page 2 of 4)

UNITED STATES POSTAL SERVICE®

Statement of Ownership, Management, and Circulation (Requester Publications Only)

16. Electronic Copy Circulation	Average No. Copies Each Issue During Previous 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Requested and Paid Electronic Copies	1784	3108
b. Total Requested and Paid Print Copies (Line 15c) + Requested/Paid Electronic Copies (Line 16a)	3613	6281
c. Total Requested Copy Distribution (Line 15f) + Requested/Paid Electronic Copies (Line 16a)	4081	7102
d. Percent Paid and/or Requested Circulation (Both Print & Electronic Copies) (16b divided by 16c × 100)	88.5%	88.4%

☒ I certify that 50% of all my distributed copies (electronic and print) are legitimate requests or paid copies.

17. Publication of Statement of Ownership for a Requester Publication is required and will be printed in the September/October 2022 issue of this publication.

18. Signature and Title of Editor, Publisher, Business Manager, or Owner: Kathleen Hickey — Date: 9/20/2022

PS Form 3526-R, July 2014 (Page 3 of 4) PRIVACY NOTICE: See our privacy policy on www.usps.com

ADVERTISER'S INDEX


ABS
DELIVERING OUR VISION OF
TOMORROW'S ENERGY, TODAY.
LEARN MORE TODAY
www.eagle.org/offshorewind
www.eagle.org/offshorewindvessels