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FOREWORD BY
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While proven technology and economically viable projects allow the mature bottom-fixed offshore wind industry to compete with other sources of energy, the floating offshore wind turbine industry (FOWT) is still young, currently transitioning from the conception to prototype stage. It has numerous challenges to overcome before large-scale commercial farms become viable. Bureau Veritas offers services specifically created to meet its needs: certification for components, prototypes and full FOWT farms, and technical assistance for the entire asset lifecycle. We are currently certifying several pilot farms in France: Provence Grand Large, Groix & Belle Île, and Leucate. FOWT 2018, which will take place in Marseille from April 25 – 27 2018, will boost the industry by enabling stakeholders to learn, observe state-of-the-art technologies, and generate business opportunities.

Visit us at FOWT 2018.

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WORKING TOWARDS A BRIGHTER FUTURE WITH TECHNICAL MARINE RENEWABLE ENERGY SERVICES

Investment in renewable power is now more than double that of fossil fuels, with average annual investment of \$267 billion from 2011 to 2016. This will increase as countries rush to reduce reliance on fossil fuels and meet COP21.

As battery-powered vehicles replace internal combustion engines, our cities will become cleaner and safer. Electric vehicles (EVs) complement offshore wind power generation as surplus wind energy can be used to recharge EVs and battery storage systems.

Recent zero-subsidy offshore wind auctions in Germany and the Netherlands are fantastic news for taxpayers, but create new challenges for the industry. Zero-subsidy bids are predicated on the development of next generation turbines with power ratings over 10MW. While most major manufacturers plan to build such machines, the whole supply chain must adapt to install and maintain them.

So, how do you ensure new vessel designs and operating procedures are safe and cost effective? How do you ensure turbine and foundation designs will last for 25+ years with minimum maintenance? As we move further offshore, increasing water depths rule out bottom-fixed turbines. Numerous floating

wind turbine designs are waiting to meet this challenge, but can you ensure your dynamic power cables will operate at utility-scale currents and voltages? Can you guarantee your turbine, its floater, and its moorings can withstand the hydro-dynamic loads of a typhoon?

Bureau Veritas Marine Renewable Energy (MRE) experts can review vessel, floater, cable and turbine designs, from a basic Approval in Principle to a full class or type-certified solution. This reduces project developers' exposure to risks, limits costs, and helps attract investors who see offshore wind as a "cash cow" for long-term returns.

Bureau Veritas is also working with wave and tidal technology developers as well as companies exploring next-generation technologies like ocean thermal energy conversion. Significant testing and demonstration will be required, and we are ready to support clients testing their prototype designs at highly accelerated lifetime testing facilities like the UK's Offshore Renewable Energy Catapult, or offshore test sites such as SEM-REV, the European Marine Energy Centre and Wave Hub.

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AIMING FOR FIRST

The stakes are high for EDF Energies Nouvelles' Provence Grand Large project: when it is due to be commissioned in 2020, it may be one of the Industry's first floating wind farms to be connected to the national grid (RTE) and most probably the first of its kind in France.

"Provence Grand Large is a pilot project, which aims to demonstrate that generating electricity from floating wind technology is both technically and commercially viable", explains Julien Simon, EDF Energies Nouvelles' manager in charge of engineering and certification for the project.

The Provence Grand Large project won the tender from the French Environment and Energy Management Agency (ADEME) in 2016. The project consists of three 8MW Siemens Gamesa Renewable Energy wind turbines. It will be installed on Tension Leg Platform-type floating sub-structure supplied by SBM Offshore, producing a total capacity of 24MW, or enough electricity to power a town of 40,000 inhabitants. The wind farm is located approximately 40km west off Marseille Coast.

"Floating offshore wind power is a very new technology, with only a handful of prototypes in the world", continues

Julien. "It's therefore vital we get it right before we start developing large-scale production floating wind farms."

Bureau Veritas came on board a year ago to provide project certification services.

"Bureau Veritas' dual expertise in wind power and naval engineering is interesting for this project. We have requested full scope certification services, from evaluation of site conditions through construction and right up to commissioning. The Bureau Veritas team has already started working with Siemens Gamesa Renewable Energy and SBM Offshore to certify the design basis."

Bureau Veritas is following the IEC 61400 standard for wind turbines, with experience feeding into its own Guidance Note for floating wind projects.

"We selected Bureau Veritas for their technical strength and expertise. This is a hugely innovative project – that's why, going forward, their flexibility and ability to respond quickly will be really important."

www.edf-energies-nouvelles.com



Julien Simon

Design Manager Marine Energy,
EDF Energies Nouvelles

UPDATED GUIDELINES TACKLE FLOATING WIND CHALLENGES

In order to facilitate market developments, Bureau Veritas is working on updating a Guidance Note for Classification and Certification of Floating Offshore Wind Turbines (NI572). The previous edition, published in October 2015, drew on experience gained from various research programs dedicated to Floating Offshore Wind Turbines (FOWT).

Recently, Bureau Veritas was awarded contracts for pilot farm project certification and design evaluation certification (as per the IEC 61400-22 standard), including Provence Grand Large and Les Eoliennes Flottantes du Golfe du Lion in the Mediterranean, and Groix & Belle-Île in the West Atlantic. These projects are now well on track, and the commitment and professionalism of our certification team has allowed us to consolidate our expertise in this growing activity.

Since the technology involved is now more mature, the updated Guidance Note responds to industry demand and sets out the requirements to address the technical and operational challenges specific to the floating offshore wind sector. Technical requirements cover, for example:

corrosion protection with a full maintenance plan; stability, taking into account restoring forces due to the mooring lines; description of the design load cases applicable for assessment of mooring and floaters; and detailed methodology to assess the structural strength of floaters.

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OMDYN2 PROJECT LAUNCHES WITH AMBITIOUS AIMS



In January, Bureau Veritas' Subsea Umbilicals Risers, Flowlines & Jacket team took part in a kick-off meeting to launch France Energies Marine's (FEM) OMbilicaux DYNamiques Phase 2 (OMDYN2). The three-year project focuses on dynamic subsea power cables for FOWT.

Dynamic subsea power cables are key enabling components in the development of FOWT farms. Relatively shallow waters combined with severe offshore weather conditions and vessel motions/offsets create

significant dynamic loadings on the cables. The targeted voltage levels typically range from 33kV to 66kV for inter-array cables and up to 225kV for export cables linking commercial wind farms to the onshore electrical network.

Under tension and cycling bending loads, complex local behavior is observed in the power cores, tensile armors and fiber optics bundled together within polymer sheath. Furthermore, mechanical, electrical and thermal effects lead to long-term degradation mechanisms that we do not yet fully understand.

The OMDYN2 project's main objectives are to: experimentally characterize the thermo-electro-mechanical behavior of dynamic power cables; develop numerical models for local cross-section analysis and lifetime prediction; address the issue of marine growth; and evaluate methods for monitoring cable integrity and fatigue life.

Other project partners are: EDF-EN, Naval Group, RTE, STX, Total, Ifremer and INNOSEA, as well as several universities (Centrale Nantes, Université de Nantes, ENSTA Bretagne).

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FLOATING TO SUCCESS

When naval architect Dominique Roddier co-founded a marine technology consultancy firm in 2004, little did he know that in just 10 years, he would be Chief Technology Officer for one of the most cutting-edge suppliers of technology and services to the offshore wind industry.

After earning his PhD in the USA, Roddier worked for ExxonMobil before creating Marine Innovation & Technology with friend and business partner Christian Cermelli. Over the next decade, the marine renewable energy sector mushroomed, and in 2014 the small firm merged with Principle Power. Its aim: to provide competitive, safe and environmentally friendly technology for deep-water offshore wind projects.

"Principle Power's flagship technology is the WindFloat - a floating wind turbine foundation - that reduces costs and risks for the installation and operations of offshore wind turbines. The technology is 'turbine-agnostic', which means the WindFloat can be used with any turbines project developers want to deploy."

Following Bureau Veritas' issue of an Approval in Principle of the company's floater concept two years ago, Dominique is now working on the first commercial project to use WindFloat, Les Eoliennes Flottantes du Golfe du Lion, located 18 km off the French Mediterranean coast and developed by a consortium made up of ENGIE, EDPR and Caisse des Dépôts.

"With a capacity of 24 MW, this project is an excellent demonstration of industrialization. It will be a landmark project for both us and the industry. Industrialization requires a great deal of innovation: when you're building 30 or 40 units, the methodology is different than if you're building just one. Your work has to be optimized and



Courtesy Principle Power

safe, and you also have to be able to reproduce it." For Dominique, Bureau Veritas has been a valuable partner:

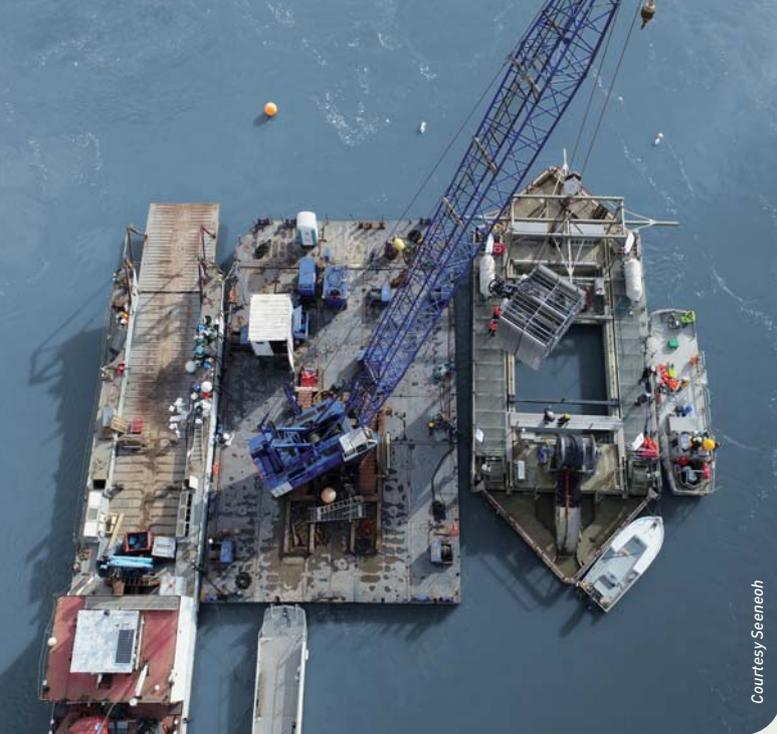
"First Bureau Veritas approved our technology, now they are certifying the hull and mooring for the project. We are working to several standards, and Bureau Veritas has proved to be very open-minded, present and responsive. They understand that standards have to evolve, and when we find specifications that are simply not appropriate for our technology, they are willing to work with us to adjust requirements. They have also been great about reaching out to other certification agencies to learn from their work on similar projects. We'll definitely work with them again."

WindFloat technology has already been deployed as a 2-MW prototype off the coast of Portugal: the company is now working on a 25-MW project, also offshore Portugal, for deployment in 2019.

www.principlepowerinc.com



Dominique Roddier
CTO, Principle Power



Courtesy Seeneoh

WORKING TOWARDS TIDAL POWER CURVE CERTIFICATION

Bureau Veritas participates actively in the International Electrotechnical Commission's (IEC) Technical Committee TC114 for the development of international technical specifications in IEC62600 series for wave, tidal and other water energy converters. As Bureau Veritas is the chairman of the French mirror committees for standards & certification scheme

development, we have as well the responsibility of assisting french companies in implementing those developments for their local industry.

Thus, two years ago, Bureau Veritas worked together with SEENEHO to adapt the IEC requirements related to power performance assessment of tidal & river turbines to the specificities of its estuarine test site. The result was an adaptation of the technical specification IEC TS 62600-200:2013 initially made for tidal turbines. Adaptation provides now a methodology for evaluating power performance of turbines to be tested in SEENEHO in line with current and future IEC requirements.

SEENEHO is an estuarine tidal test site for full-scale river and intermediate-scale ocean tidal devices, located upstream on the Gironde estuary. Its strategic position close to the center of Bordeaux offers easy access for test monitoring and turbine maintenance and reduces machine deployment costs. The adaptation of this technical specification aims at providing SEENEHO with a competitive advantage by proposing a power curve certification based on a solid procedure, in addition to all the expert services SEENEHO offers in its package. With Bureau Veritas' support, SEENEHO is hoping to achieve the world's first power curve certification for its clients machines in 2018.

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MAC STRENGTHENS MRE CAPABILITIES

Bureau Veritas' acquisition of Maritime Assurance and Consulting (MAC) in 2016 reinforced our offshore marine assurance and consulting capabilities, particularly in dynamic positioning and marine warranty services. Since then, hundreds of man-years of transferrable skills and experience in offshore oil and gas have been leveraged to support the global marine renewables business.

with recognized standards, and that the requirements and interests of the project insurance underwriters are maintained. With a global team of over 60 experts and contract personnel, MAC is ideally positioned to help clients minimize risks in marine renewables operations, anywhere in the world.

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In the United States, the first commercial offshore wind farm – Deepwater Wind's 30-MW Block Island project – was installed in late 2016. Future large-scale deployments in the region, however, will be influenced by factors such as the country's Jones Act restrictions on non-US flagged vessels. Furthermore, the current lack of specialized installation and service vessels could create additional issues with an impact on the safety and efficiency of offshore wind operations.

US offshore vessels designed for the oil and gas market will require significant modification prior to service in large-scale wind farm deployment. Alternatively, new industry-specific vessels will need to be US-built, flagged and crewed to meet Jones Act stipulations. MAC's highly experienced engineering team can provide independent expert advice to vessel owners and operators, as well as project developers.

MAC is also a recognized expert in the provision of marine warranty surveys. This encompasses reviewing, approving and witnessing procedures to ensure marine activities are carried out in accordance



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