Insurability of Floating Offshore Wind

World Forum Offshore Wind (WFO)

Imprint
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Status: October 2021

Acknowledgments

WFO's 70+ members represent the entire offshore wind value chain including but not limited to utility companies, manufacturers, service firms, consultancies and other non-profit organizations.

This document is the result of one year's worth of monthly discussions between participating WFO members during meetings of WFO's Floating Offshore Wind Committee on the topic of floating wind insurability. WFO would like to thank everyone who has contributed their time and expertise during the discussions and additional analyses carried out for this study.

Disclaimer

The views in this report do not necessarily represent the views of all WFO members but are based on a synthesis of recorded insights undertaken by WFO and the WFO Insurance Subcommittee Chairman over the last year. The findings are also designed to serve as an initial account of floating offshore wind risk perception and therefore should not be generalised and are subject to evolve along with the industry.

Foreword

The launch of commercial-scale tenders across the globe and the foreseeable commissioning of most of these arrays before the end of this decade sends out the undeniable signal that floating offshore wind is on the right path to achieve the job- and value-creating mass deployments we have been working hard to promote.
These GW of new assets will be a fast-growing and much-needed contribution to many countries' renewables and decarbonisation targets.
More and more stakeholders every day – as demonstrated by the exponential growth of WFO's Floating Offshore Wind Committee in less than a year – are accelerating their mobilization to ensure that floating wind gets the opportunities its current level of maturity deserves. Policymakers and governmental agencies, industrial players big and small, utilities and developers, academia and consultancies as well as many other talented people and organisations are finally all starting to row in the same direction, jointly promoting the acceleration of our industry. Floating wind is now, more than ever.

However, the road remains long and our incredibly promising yet burgeoning industry remains fragile. Fragile because we are in the spotlight of thousands of new observers every day; fragile because any mishap on a project could set the entire industry back several years … at best.

The set-up of an Insurance Sub-committee that would highlight and address some of the key risks of our young industry could encounter was consequently a no-brainer.
Insurability rhymes with bankability, rhymes with credibility and above all rhymes with feasibility, especially at this early stage of the game. "Better safe than sorry" ought to be one of our industry's mottos if we aim to achieve – and hopefully surpass – the sustainability and build-up on solid and durable foundations (no pun intended) we witnessed with bottom-fixed wind.

I am extremely grateful to the Insurance Subcommittee's Chair and proactive members who have worked hard this last year to produce a consensual yet clear document that will without a doubt orient the insurance strategy of floating wind. This document is the first of many more to be published and I fully trust it will be seen as a cornerstone reference paper for years to come.

Bruno G. GESCHIER
Chairman of WFO's Floating Offshore Wind Committee
Chief Sales & Marketing Officer of BW Ideol
Chairman of FOWT's Scientific and Technical Committee
Founding Chairman of WindEurope's Floating Offshore Wind Task Force (now Work Group)

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1 Introduction

The Insurance Subcommittee was founded as part of the Floating Offshore Wind Committee (FOWC) under the auspices of the World Forum Offshore Wind (WFO). Members who have decided to join the Insurance Subcommittee represent all sectors in the Floating Offshore Wind (FOW) industry, ranging from major international developers, investors and contractors to research & development companies, manufacturers, consultants, brokers and insurers.

Considering the core business and scale of individual members of the Committee, which is truly manifold, it is inevitable that so is the risk perception and readiness and ability to cope with the risk´s eventual manifestation. Considering further the direct competition between certain members, it is understandable that there is no single view or recommendation that all members would commonly pursue with respect to the development of floating offshore wind technology. There is, however, a common factor unifying the industry and shared by all members, which is the wish to help accelerate the deployment of commercial scale floating offshore wind.

For the acceleration of the new technology deployment, investment is a prerequisite. It is therefore necessary to gain trust of investors and financiers to enable the projects to move from a demonstrator to a commercial scale. Insurance is the security on which both Investors and Lenders rely when making their investment decision and which makes investment possible.

The Insurance Subcommittee has therefore set as its goal to look into the parameters of floating offshore wind which could help the technology secure the level of insurance coverage Investors and Lenders would expect to receive, in analogy with the well-defined expectation arising out of their experience with bottom-fixed offshore wind, a sector in which they have massively invested over the past 10 – 15 years.

The premise initially set by the Insurance Subcommittee was to look for analogies with bottom-fixed offshore wind – which has enjoyed a significantly high level of insurance protection – to ultimately identify the major differences and consider how these could be evaluated, mitigated and presented to the insurance industry with the aim of qualifying for a comparable insurance coverage.

Major differences have been identified in the risk perception of moorings, dynamic cables and repair and maintenance concepts. Turbines, including different floating platform concepts, have on the other hand not been perceived as a major obstacle to achieving an enhanced level of insurability. With respect to the latter, it was nevertheless considered of high importance to have the turbine and floating platform design integrity independently reviewed and evaluated. Special thanks go to the international certification body Det Norske Veritas (DNV) and the renowned Hamburg-based engineering bureau Jörss-Blunck-Ordemann (JBO) for their excellent contribution enabling us to provide insurers with a high level of transparency in this area.

Alongside the Insurance Subcommittee, two other subcommittees were founded: the Moorings Subcommittee and the Operation and Maintenance (O&M) Subcommittee. In addition to their individual achievements, both groups represent a great contribution to the work of the Insurance Subcommittee. The Moorings Subcommittee is focusing on recent developments in station-keeping systems while the O&M Subcommittee is analyzing different floating offshore wind maintenance and repair concepts, both on-site and tow-to-port. The three Subcommittees mutually foster the evolution of a "floating offshore wind dialogue" in that the outcomes of the discussions and the development of the floating offshore wind know-how in the technical subcommittees are gradually transmitted to the Insurance Subcommittee which intends to formulate the latest stage of development and available concepts into risk perception alternatives to be presented to the insurance industry.

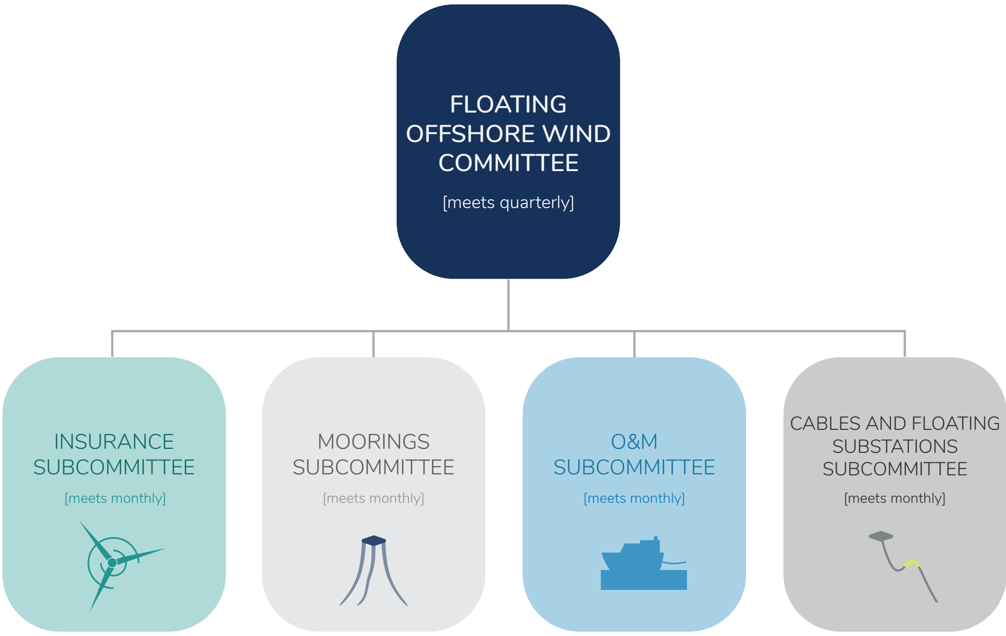

Figure 1. *WFO Floating Offshore Wind Committee organizational chart*

With respect to the risk perception alternatives which directly translate into the level of insurance coverage alternatives, it was noted that while turbines mounted on the floating structures continue to benefit from the availability guarantee of the Operations and Maintenance (O&M) contract – in analogy with bottom-fixed offshore wind – the floating platforms and station-keeping systems do not and are therefore perceived as a higher risk by insurers when evaluating whether or not to insure them and at what terms. In particular, it was noted that in the absence of a contractual availability guarantee, redundancy of the station-keeping systems might be the concept on which insurers would rely until they have gained sufficient return on experience: either in terms of *(n-1)* redundancy, which means securing the uninterrupted energy production; or a well-thought spare parts concept that secures a prompt replacement of the damaged or lost items, therefore reducing the loss of energy production below the maximum number of days of the Waiting Period[1] of the Business Interruption insurance policy.

Key parameters with a positive influence on insurability which have been identified include:

- **(1)** Floating Offshore Wind Turbine (FOWT) integrity – design phase considerations,
- **(2)** Mooring Integrity Management – risk mitigation considerations,
- **(3)** Dynamic cable reliability,
- **(4)** Efficient concept for repair or exchange of major components,
- **(5)** Special Operation & Maintenance concept.

The present 1st Insurance Subcommittee White Paper summarizes the industry views, outcomes of currently available studies and concepts and "insurability" alternatives on (1) and (2) and will be subject to further reviews and extensions as updated results and solutions from the Moorings Subcommittee and O&M Subcommittee progress, enabling the Insurance Subcommittee to present the insurance industry with a gradually enhancing risk profile including technology news as well as updated statistics and trends on the way to the commercial scale FOWTs. FOWC industry views on (3) to (5) necessitate further evaluation

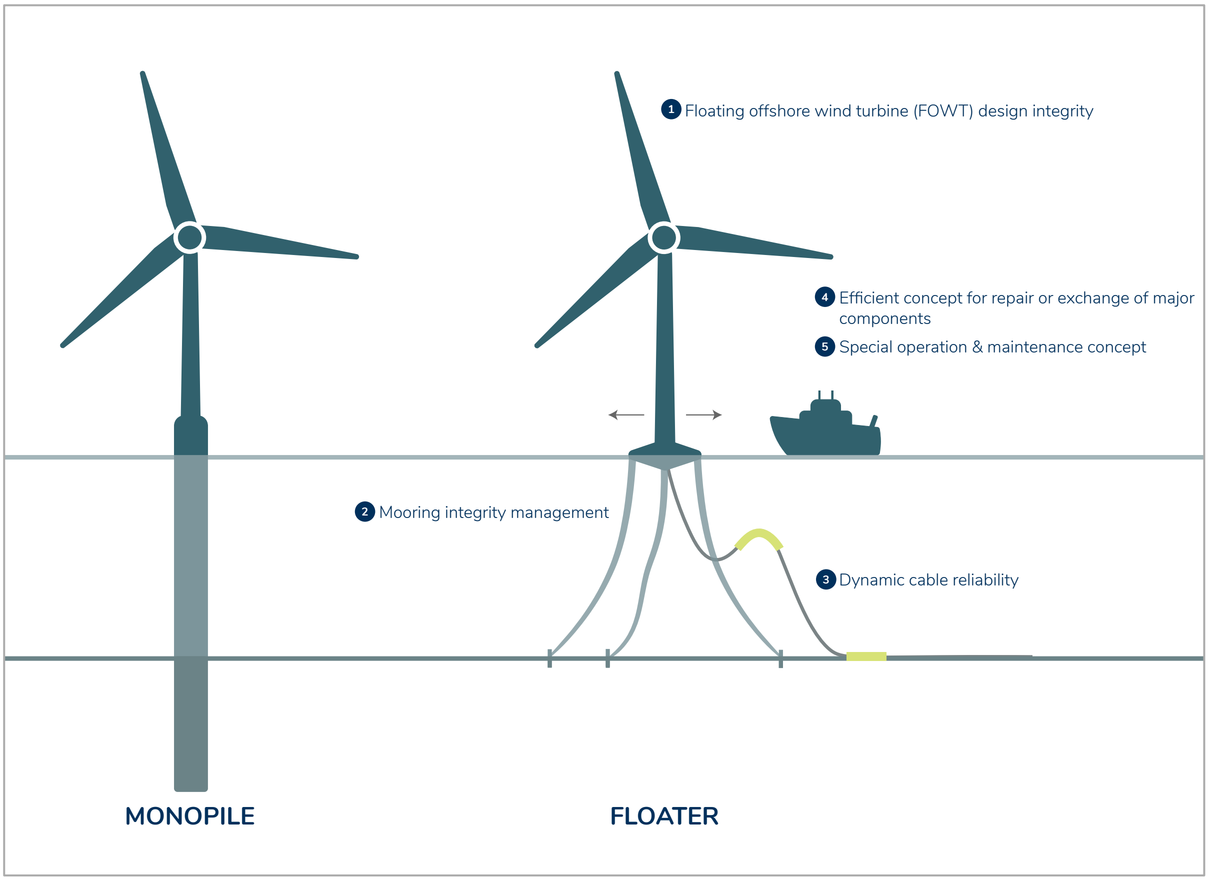

Figure 2. *Achieving Monopilian Behavior in FOW*

[1] Waiting Period (Definition): The number of days, typically between 60 and 90 days, for which insurers are not liable. Following an insured physical damage, the Waiting Period commences when the feed-in of electricity into the grid starts to be reduced or interrupted.

before they can be formulated into strategies and recommendations and are intended to be provided in the following versions.

Important Note: In the 1st Insurance Subcommittee White Paper, for reasons of expediency and limited input presently available, no particular consideration was given to the specific requirements in natural catastrophe-prone areas, e.g additional security measures necessary due to floating offshore wind units being exposed to and potentially impacted by earthquake, tsunami, typhoon/hurricane/tornado or lightning strike. Further investigation into parameters with major impact on the integrity and sustainability of floating offshore wind structures in natural catastrophe- (NATCAT) prone areas will be necessary and is intended to be undertaken by the members in all three Subcommittees. Understanding these parameters will enable further recommendations to be made by the industry for risks affecting Floating Offshore Wind in these parts of the worlds.

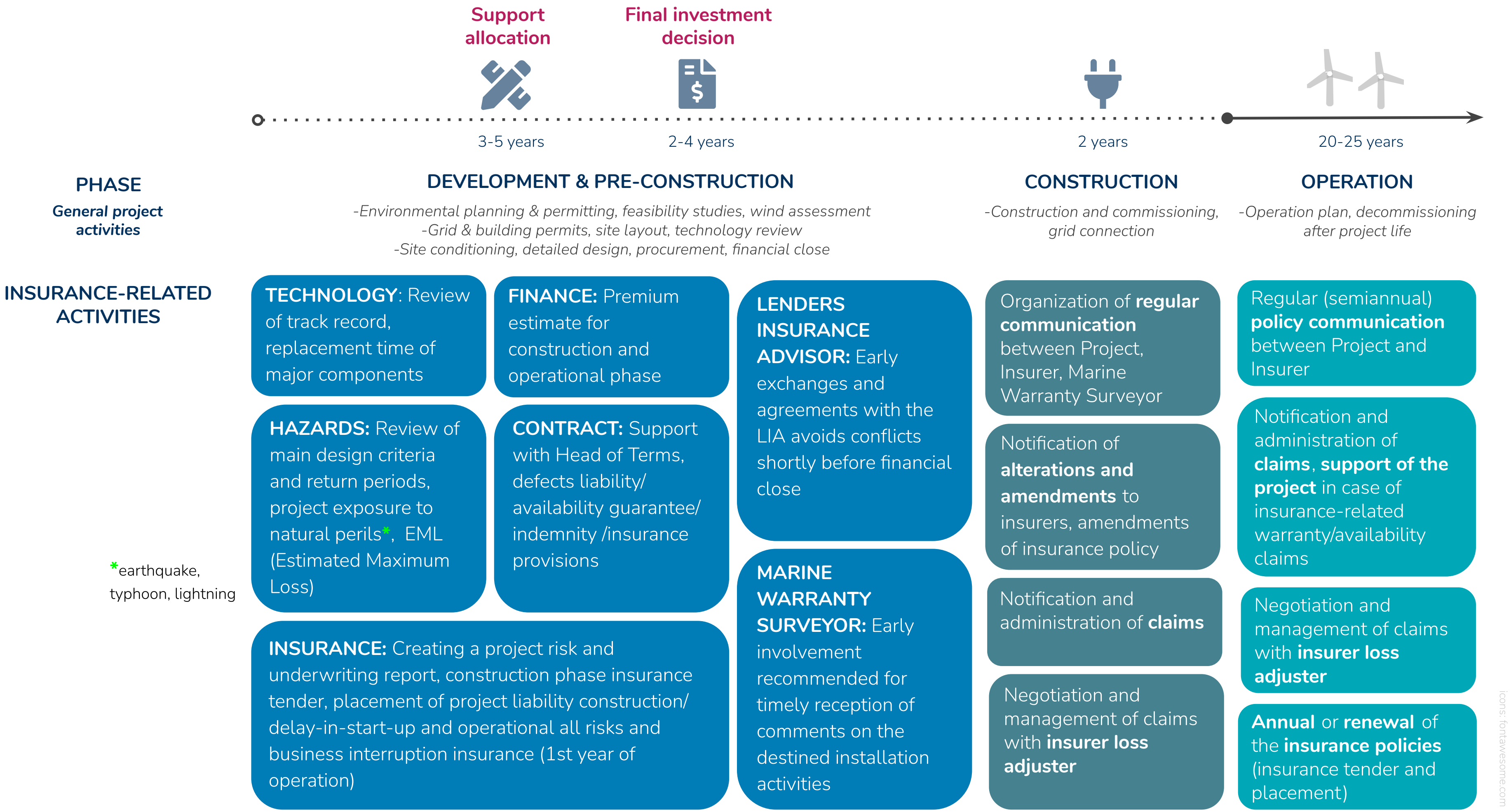

Figure 3. *Recommended activities to improve insurability of FOW*

2 Integrity of a Floating Offshore Wind Turbine – design phase considerations

A very important factor to be considered in the design phase of floating offshore wind technology is that the parameters set as its basis today will still have to be valid in 2050, which corresponds to the end of the expected lifetime of the floating offshore wind farms being currently designed and developed. Coupled with the effects of climate change which are increasing the frequency of extreme events – for example where large storm events that would hit a certain region only once in 10 to 15 years in the past are now occurring more than once per year – the experts present in the FOWC, namely the Hamburg-based engineering bureau JBO and the international certification body DNV (as a guest of the FOWC), performed an additional review of the technology parameters focusing on those which could be optimized to better face and insure the upcoming climate-change-related challenges. The aspects focused on were the following:

2.1 Accidental Limit State

The ALS is currently based on calculating the probability of occurrence or return of a certain natural event, such as a devastating storm or a major flood, on the so called "50-year event". This means that the ALS is calculated to withstand the load of the major event where "major" is considering the probability of such an event occurring once in 50 years. While this calculation might be substantiated considering the expected lifetime of the floating platform, e.g. 25 years compared to "50-year event" probability, the concern had been raised due to the presently dramatically accelerating climate change which has for a consequence that events which historically occurred once in 50 years now occur more frequently, bringing a completely new perspective into the risk evaluation. As a response, in the absence of an increased figure for a 50-year event being available, it was recommended increasing the probability of occurrence to e.g a 500-year event. This means that FOWT integrity and ALS would be based on the calculation which assumes that units have to withstand being affected by a NATCAT event with the intensity of an event that occurs once in 500 years.

The calculation based on the above assumption of a "500-year event" was performed by JBO and led to the conclusion that the increase in cost for such additional stability of a FOWT would lie between 2 to 3% of CAPEX of the floater for floating areas in Europe only. Other areas of the world were not investigated. For other areas, meaningful and comparable requirements should be taken into account that also cover extreme events like e.g. a typhoon. While this figure is not negligible, the additional level of safety that this extra investment would secure is deemed recommendable considering the design life of the FOWT and the risk perception of insurers during the 25 years of its operation against the background of accelerating climate change.

In June 2021, DNV amended its *STANDARD Floating wind turbine structures* (DNV-ST-0119) which now reflects a higher safety level – as discussed in our Subcommittee – by taking

500 years for a single event into account: "For load combinations relevant for the design against the ALS, the characteristic load effect is a specified value with a return period of either 1 year for post-damage cases or 500 years for single events [e.g. for the loss of a single mooring line], dependent on operational requirements." [2]

2.2 Design fatigue factor

The design fatigue factor was also looked into during the calculation of the Limit State levels and the conclusion reached is that there is no necessity to revise or increase the present factor upon which the design fatigue is calculated. There is no additional recommendation on design, safety or investment necessary in this regard.

2.3 Collision risk

Two options were identified with respect to the "collision risk", which is defined as the risk of a vessel accidentally colliding with a FOWT. The first option is to perform a detailed "collision analysis" for each individual floating offshore wind farm that takes into consideration its location – in particular its distance to a main shipping line – as well as the wind farm layout and floating platform type including the mooring system as there are major differences to be considered due to the floating platform shape, material used and moorings topology. The second option is to migitate risk by means of installation of warning systems such as visual and sonic warning, including cameras with constant real-time monitoring that allow for immediate action in case of imminent danger.

Depending on the floating platform type, the conclusion reached is that substantial CAPEX savings could be achieved if projects opt for the risk mitigation alternative and install the warning systems rather than perform the collision analysis, which in certain areas and for certain floating platform types can be very expensive. The application of warning and real-time monitoring systems would significantly reduce the Levelized Cost of Energy of a FOW project, most probably without having a negative impact on its insurability (to be further investigated by the risk and insurance experts).[3]

[2] Standard – DNV-ST-0119, Edition June 2021 Floating wind turbine structures, Chapter 2.5.3.1

[3] Keywords: available limits of liability for the Protection & Indemnity Insurance of floating platforms, maximum liability of the wind farm owner by law for damage to vessels caused by floating platforms

3 Mooring Line Integrity – risk mitigation considerations

Transferring the know-how from the floating oil & gas industry and transposing it to the floating offshore wind industry has helped identify a number of parameters influencing its safety level and thus directly contributed to its risk perception and insurability. A number of experts in the FOWC Subommittees suggest that updates of the presently summarized findings are necessary to reflect the actual status of the industry, and that studies should be extended to new mooring materials such as nylon or polyester fiber. The outcomes of the most recent available studies have been taken as the basis for further consideration. These parameters are listed below.

In a study from 2014[4], the "historical" failure rate of mooring line systems was stated to lie between 2,5 x 10^{-3} p.a. [individual line failure] and 2% p.a. for a multi-line Floating Production Storage and Offloading Units (FPSO). The study expresses that the observed increase in the number of failures was proportional to the increase of the FPSO population since the early 2000, with the underlying failure rate per mooring line approximately constant over the ten years before 2014. For a Floating Offshore Windfarm with 40 units and 120 lines this would equal approximately 8 lines failing per project lifetime. There are different reasons for the mooring lines failure, including e.g. corrosion, faulty manufacturing or initial damage during installation handling.

Considering the opinions of mooring experts participating at the FOW Subcommittees, the above failure rate data are not directly transferrable to FOW. The FOWC is not aware of mooring line failure incidents having happened at Floating Offshore Windfarms since 2009. An assessment by DNV has shown that the failure rate for floating wind may lie / can be assumed to be between 2% - 0.1% [5].

Collecting relevant data from the existing and upcoming projects will be key and confidentiality issues will have to be overcome. An anonymized voluntary system could be most appropriate.

From an insurance perspective, the following points might be worth to consider:

According to DNV expert opinion, "the current project design certification process already mitigates the risk of a total loss of a floating turbine significantly. For station-keeping systems without redundancy, all structural components in the station-keeping system shall be designed to "consequence class 2" (target safety level 10^{-5} p.a)."[6]

Further investigation, including testing of new materials such as synthetic fiber ropes, is currently being undertaken[7] along with with the introduction of new anchor systems and load

[4] Paper presented at the Offshore Technology Conference, Houston, Texas, May 2014, OTC-25273-MS

[5] DNV Presentation from 25 February Moorings Subcommittee

[6] DNV presentation SC Insurance 19 Nov 2020

[7] Moorsure and BW Ideol Presentations SC Moorings 31 Mar 2021

reduction devices[8] in an effort to increase the station-keeping system integrity. Such integrity is one of the major factors contributing to the security of uninterrupted energy production, playing a significant role in lowering the Levelized Cost of Energy for future large commercial scale projects.

The presentations held by leading offshore experts at the Moorings Subcommittee are demonstrating that the implementation of a Mooring Integrity Management that consists of a reliable tension and motion monitoring system[9] combined with risk-based inspection and maintenance with a proactive spare part strategy can significantly decrease the mooring line failure rate and mitigate the consequences of an eventual failure.

Presently, early projects necessitate that a tailor-made risk approach be adopted.[10] It will be important to safeguard the growth of the FOW industry to commercial scale and at the same time provide insurers with enough comfort that they can provide the necessary insurance capacity to support and secure this growth.

At recent FOW projects, insurers were providing between EUR 30,000,000 and EUR 60,000,000 capacity per insurance company, which means that a medium-sized Floating Offshore Wind Farm with 20 to 30 wind turbines must negotiate and agree separately with 5 to 10 insurance companies to reach sufficient coverage. As a consequence, it might make sense for FOW projects to follow a more conservative project risk approach in which a comprehensive risk engineering report demonstrates that their risk perception is similar to bottom-fixed offshore wind farms. This is especially important due to the fact that the number of insurance companies being capable to underwrite offshore wind risks is limited.[11]

The main reason why the failure rate of mooring lines received such a prominent focus in the Insurance Subcommittee discussions is because this is the major difference to bottom fixed monopile or jacket based offshore wind projects. Throughout the Subommittee's numerous discussions, members finally identified 2 alternatives for how projects could consider decreasing the failure rate or mitigating its eventual consequences:

Concept A: Avoidance of total loss of the FOWT unit and Acceptance of revenue loss

- the FOWT unit is equipped with 3 mooring lines, 1 mooring line fails
- the remaining 2 mooring lines shall be able to handle the additional forces without being damaged and without needing to be replaced
- different new and additional loads will affect the remaining anchor points
- due to the drifting of the floater, the dynamic cable will be damaged followed by loss of revenue due to interrupted energy production

[8] Vryhof and Dublin Offshore Presentations SC Moorings 29 Apr 2021

[9] Fugro and MooringSense Presentations SC Moorings 7 Jul 2021

[10] Minutes of Meeting SC Moorings 27 May 2021

[11] Source: Skowronnek & Bechnak International Risk & Insurance Advisors, project confidential

- in a "daisy chain" constellation, more than one turbine might be out of energy production and in an emergency mode
- several weeks of loss of revenue

Concept B: Avoidance of total loss of the FOWT unit and Avoidance of revenue loss

- the FOWT unit is equipped with a larger number of mooring lines including some for redundancy so that in case of a failure of 1 mooring line, the floater remains under control and continues producing electricity (n-1)
- limited risk of damage to the dynamic cable, limited "daisy chain" revenue loss risk of other turbines
- limited energy production downtime

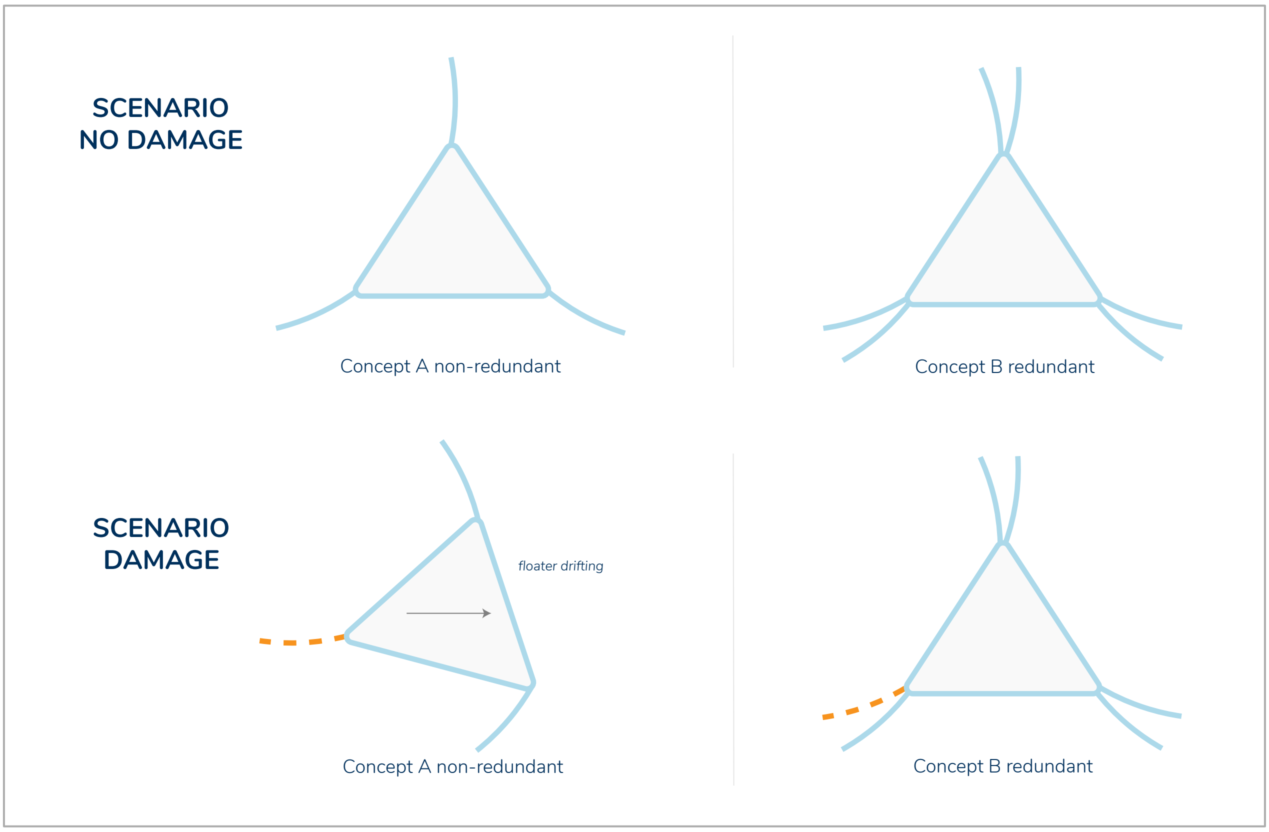

***Figure 4**. Illustration of Redundancy Concept*

Without going deeper into quantification, it seems to be obvious that Concept A might lead to a longer business interruption of the affected turbines than the (*n-1*) redundancy of Concept B. The Insurance Subcommittee initiated a brief survey on additional costs necessary to achieve (*n-1*) redundancy which entails no damage of the dynamic cable in case of one mooring line failure and continuation of energy production after such a failure event. Companies Saitec and BW Ideol came to the conclusion that the additional costs are within a range of 1 to 2% of the project CAPEX.

The counter-arguments exchanged in the Subcommittee were in particular the higher environmental footprint that using a (*n-1*) redundant mooring line system entails and the higher operation and maintenance expenses due to the double number of mooring lines, accessories and anchors. Most of the current multiple-turbine projects in operation and under development are following the approach of using the lowest number of mooring lines possible and reducing the repair time after failure of a mooring line by an enhanced spare parts management and associated Operation & Maintenance agreements.

Once again, these strategies may need to be revised once developments move into areas subject to natural catastrophes (e.g. typhoon).

4 First White Paper Preliminary Conclusions

For the acceleration of the new technology deployment, investment is a prerequisite. It is therefore necessary to gain trust of investors and financiers to enable the projects to move from a demonstrator to a commercial scale. Insurance is the security on which both Investors and Lenders rely when making their investment decision and which makes investment possible.

Due to the necessity to receive sufficient insurance coverage from a larger number of insurers, the Insurance Subcommittee would recommend projects following an approach that mitigates the losses below the property damage and business interruption deductible. This could be achieved either by (*n-1*) redundancy concepts or by a proactive spare parts strategy (in particular for cables and moorings) combined with sufficient defects liability provisions in the Supply and Installation contracts. In case of a loss caused by a single failure, this combined technical/contractual mitigation would enable the project to exchange the damaged parts within a short time frame and without each time having to ask the insurance for indemnification of property damage and business interruption.

The Insurance Subcommittee trusts that FOW projects capable of demonstrating a solid combination of technical and contractual risk mitigation will receive sufficient insurance coverage. Insurers feel comfortable with providing coverage for losses with a very low probability of occurrence and a high loss amount as such concept is much closer to their original business.

And finally, this concept also represents what the Floating Offshore Wind Industry is striving to achieve because it wants to be considered a solid and progressive industry standing independently on its own feet, with recourse to insurers being the last resort.

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