PO.225

Developing a Framework for the Assurance of Floating Wind

How do you achieve attractive cost of energy for floating wind without compromising on risk?

James Nichols (1), Peter Davies (2), Steven Martin (3), Anand Bahuguni (4)
(1) Lloyds Register EMEA London United Kingdom (2) Lloyds Register EMEA, Aberdeen, United Kingdom
(3) Wind Energy Systems Doctoral Training Centre, University of Strathclyde, Glasgow, United Kingdom (4) Lloyd's Register GTC, Singapore, Singapore

Lloyd's Register Energy

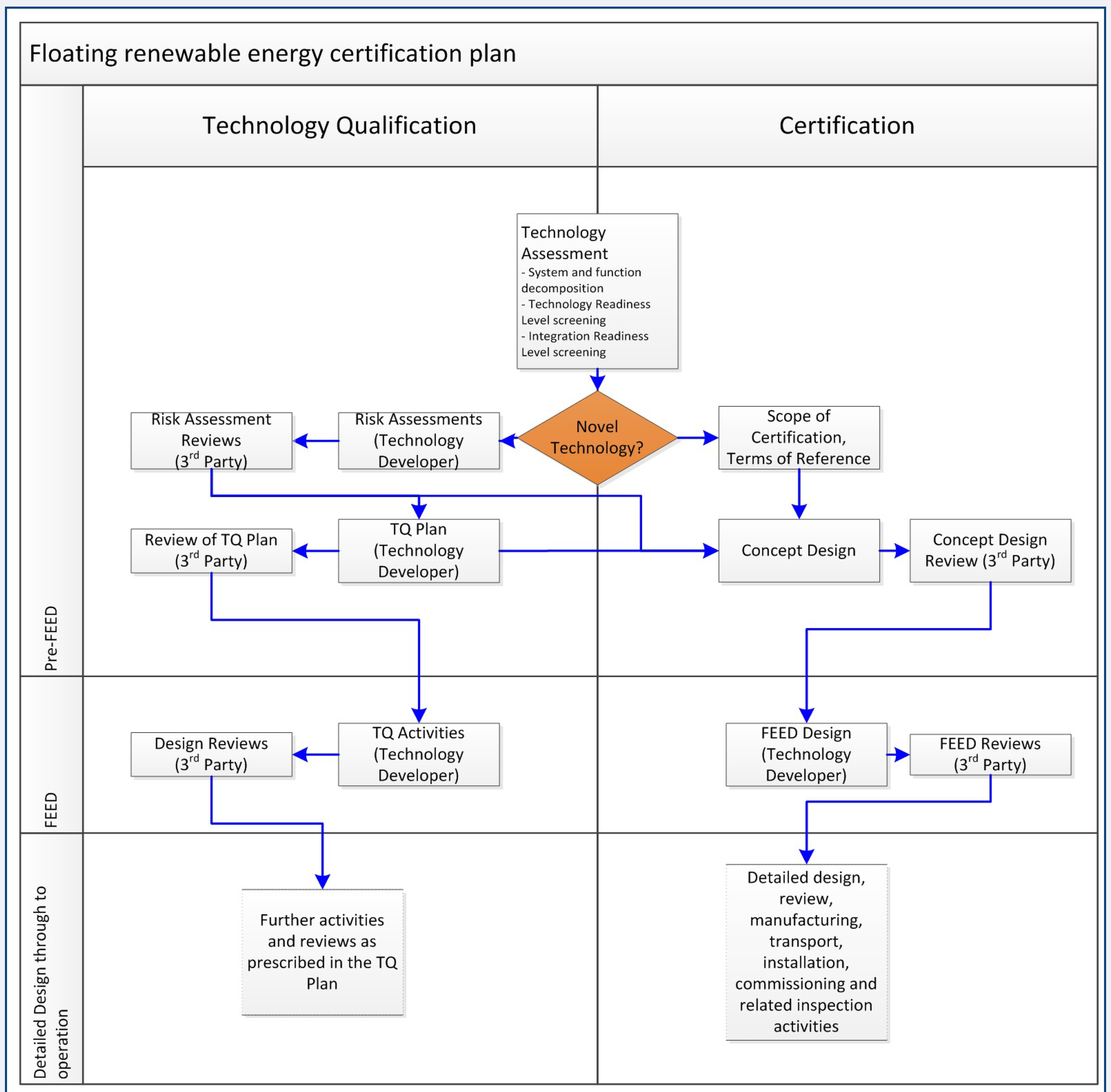
Abstract

Floating offshore wind turbines span a variety of different technologies with an equally broad range of experience in different sectors. The challenge is to identify which items are truly novel and which combinations of individually tried and tested components lead to higher levels of risk. This paper outlines a Technology Qualification process against which novel platforms can be certified along with the technology items which are generic to all floating wind systems which have been tackled in collaboration between Lloyd's Register and academia with a view to providing clearer guidance. The process also outlines how the Technology Qualification of novel items can take place alongside Certification of areas covered by existing codes and standards.

A key part of a Technology Qualification plan is to assess the goals against which the device will be judged. These can encompass far more than just the structural integrity which a traditional certification covers, such as uncertainty in power performance, ease of maintenance and reliability. An important stage of the Technology Qualification process is to break down the system into components and subcomponents in order to identify the technology which is inherently novel. Novel items require testing and other qualification activities in order to reduce the risk of failure at the time of full-scale deployment.

Even if the system consists of no component which is of itself a novel item, the combination of technologies or the way in which they interact with the environment may mean that risks are introduced. In Lloyd's Register's Technology Qualification approach, this is achieved by means of adjusting the Technology Maturity Level with an Integration Maturity Level based on the experience with the interface between different technologies. One of the key areas of research is the effect of the motion of floating wind turbines on the rotor aerodynamics and the consequential effect on power capture and structural loading. Lloyd's Register has been performing a series of research projects with a view to developing a next generation fully coupled simulation model floating offshore wind turbines that can capture all of the loading effects which will be seen in the field. One PhD project has been completed on the CFD modelling of a rotor undergoing surge motion; two further PhD projects are in progress focussing on the validation of CFD modelling using scale model testing and development of enhanced empirical models.

Overall Methodology



Critical Technology Elements for Floating Offshore Wind

The first stage is to identify which Technology Elements are Critical and will need to undergo the process of Technology Qualification as they are not sufficiently covered by existing codes and standards.

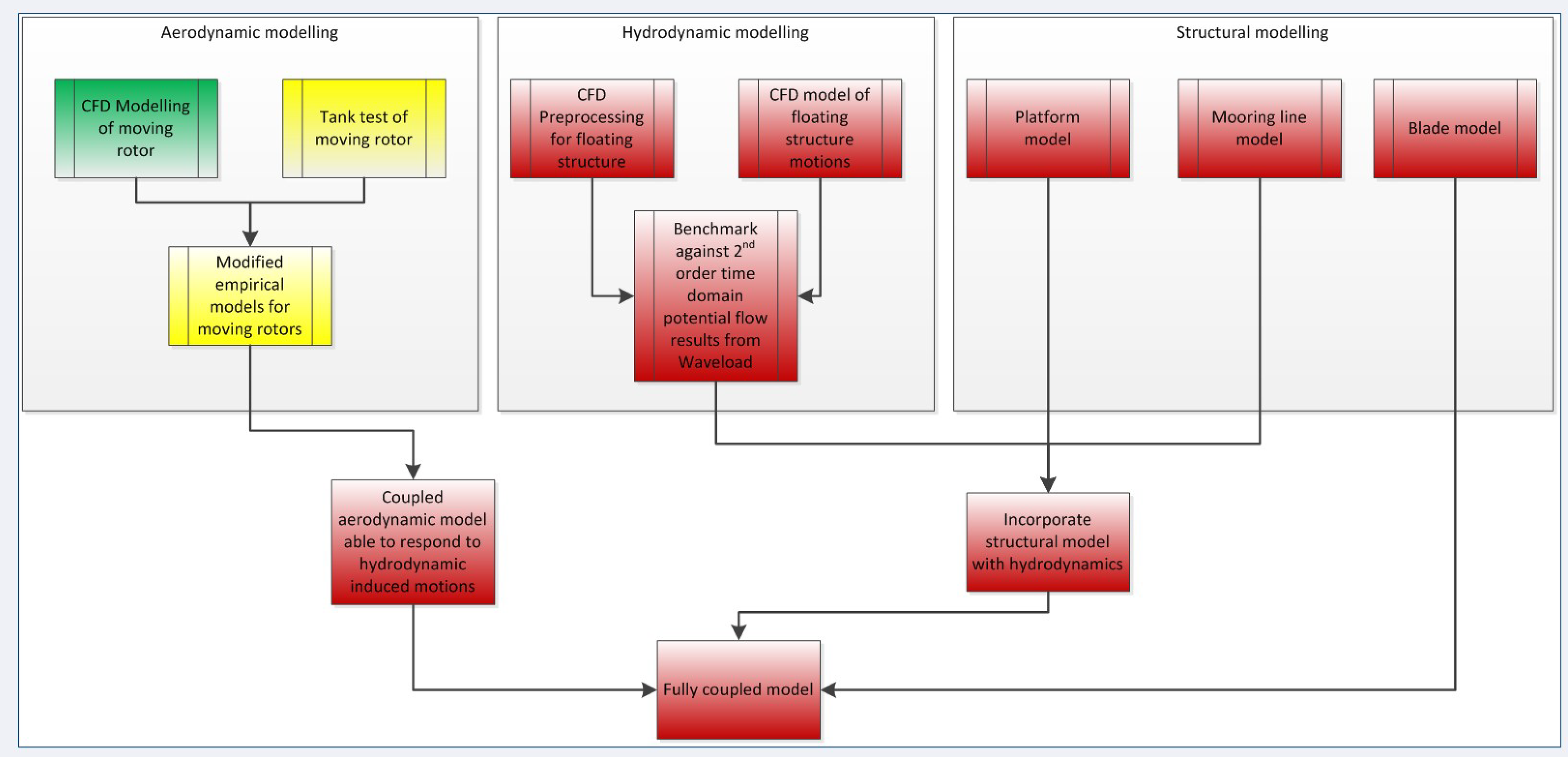
Potential system specific Critical Technology Elements:

- Materials
- Components
- Platform concepts
- Control systems
- Floating wind and wave energy combinations

Generic Critical Technology Elements for Floating Offshore Wind:

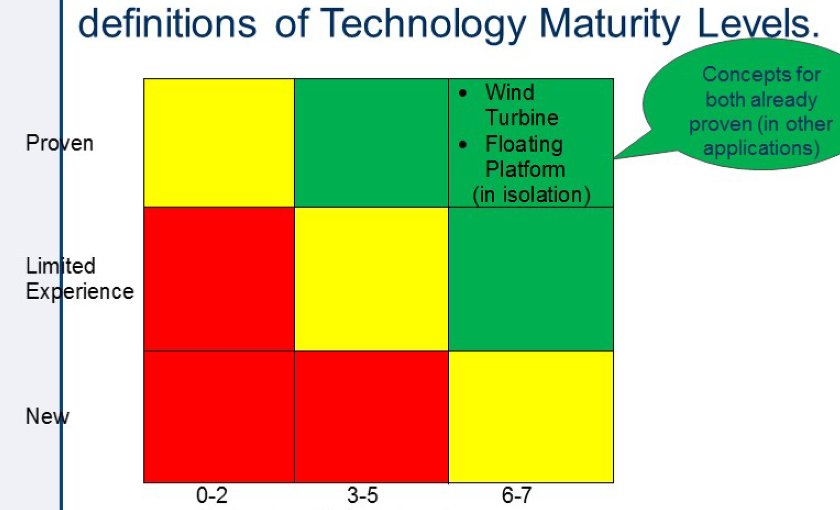
- Integration of unproven turbine and platform combinations
- Load assumptions
- Wake effects

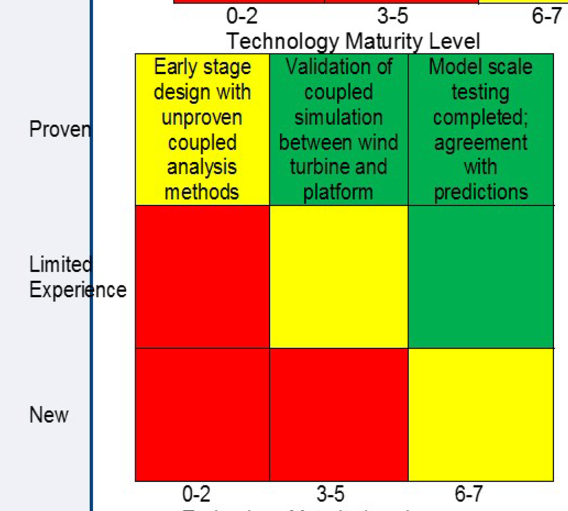
Work plan for addressing load assumption uncertainty for floating wind



Interpretation of Technology Maturity Levels

In the instance of a conventional spar, semi-submersible or tension-leg platform design for floating wind turbines, both the wind turbine and platform fulfil the requirements of Technology Maturity Level 7 since concepts can be chosen for both, based on field proven examples with well over the 3 years of experience required by commonly accepted definitions of Technology Maturity Levels.





However, with the example of a novel combination of turbine and platform which has not been field tested before, the maximum Integration Maturity Level which could be reached is 7. The Integration Maturity Level was originally designed for software (Sauser, 2010) and hence a degree of interpretation is required to apply it to engineering structures where the interface is more abstract (in the case where influence is more than a bolted connection). Achieving an integration maturity level of 7 is sufficient to leave the TML at 6 which would mean that, subject to analysis of the detailed components, the system does not require technology qualification, even if there was limited experience with either the turbine or platform. However, this IML of 7 would imply validation which we can take to mean some form of scale test to provide evidence that the behaviour of the system is in-line with the modelling assumptions used in design. Achieving the IML of 3 required to avoid performing Technology Qualification on the load analysis would require compatibility in the coupling so it must be shown that the practical methods for modelling the combined system are in accordance with sound theoretical models and have been well tested from a software control point of view.

Conclusions

An approach for combining a Technology Qualification process with a traditional certification process has been outlined. The process has been elaborated to discuss the activities which may be carried out in order to mitigate the risks for Critical Technology Elements for a range of floating wind systems.

References

1. Bahuguni, A., Sivalingam, K., Davies, P., Gullman-Strand, J., & Nguyen, V. (2014). Implementation of Computational Methods to Obtain Accurate Induction Factors for Offshore Wind Turbines. *Proceedings of the ASME 2014 33rd International Conference on Ocean, Offshore and Arctic Engineering. San Francisco.*
2. Bellew, S., Yde, A., & Verelst, D. (2014). Application of the Aero-Hydro-Elastic Model, HAWC2-WAMIT, to Offshore Data from Floating Power Plants Hybrid Wind- and Wave-Energy Test Platform, P37. *The 5th International Conference on Ocean Energy (ICOE). Halifax, Canada.*
3. (2014). *Guidance Notes for Technology Qualification.* London: Lloyd's Register Group Ltd.
4. (2009). *IEC 61400-3: Wind Turbines - Part 3: Design Requirements for Offshore Wind Turbines.* IEC.
5. Jonkman, B., & Jonkman, J. (2014). *ReadMe File for FAST v8.09.00a-bjj.* Golden, Colorado: National Renewable Energy Laboratory.
6. Jonkman, J. (2007). *Dynamics Modeling and Loads Analysis of an Offshore Floating Wind Turbine.* Golden, Colorado: National Renewable Energy Laboratory.
7. Larsen, G. (2008). Wake meandering - a pragmatic approach. *Wind Energy.*
8. Martin, S., Day, A., & Infield, D. (2014). An Experimental Methodology for the Measurement of Wind Turbine Rotor Loads at Scale. *International Conference on Offshore Renewable Energy.* Glasgow, UK.
9. Namik, H., & Stol, K. (2009). Disturbance Accommodating Control of Floating. *47th AIAA Aerospace Sciences Meeting Including The New Horizons Forum and Aerospace Exposition.* Orlando.
10. Sauser, B. (2010). *Integration maturity metrics: Development of an integration readiness level.* Information Knowledge Systems Management, DOI 10.3233/IKS-2010-0133.
11. Stewart, G. (2013). Assessing Fatigue and Ultimate Load Uncertainty in Floating Offshore Wind Turbines Due to Varying Simulation Length. *11th International Conference on Structural Safety and Reliability.*

EWEA 2015 PARIS
EUROPE'S PREMIER WIND ENERGY EVENT
EWEA 2015 – Paris – 17-20 November 2015