Identification and Evaluation of RAMS+I Factors Affecting the Value-Added by Different Offshore Wind Turbine Concepts in Nordic Context

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ABSTRACT

In offshore wind energy sector there are many different conceptual wind turbine structures depending on the water depth from traditional mono-pile structures to floating platforms. Decisions made before the formal design phase define strongly the costs and benefits gained through the whole lifecycle of a wind turbine. Management of reliability, availability, maintainability and safety issues (RAMS) are essential as early as possible in the beginning of turbine conceptual design phase. This paper presents guidelines to compare different offshore wind energy assets and their critical components from system availability and safety point of view. Classification and evaluation criteria for different RAMS+I (Reliability, Availability, Maintainability, Safety and Inspectability) factors are outlined and discussed.

KEY WORDS: RAMS+I; offshore; wind turbine; availability; safety; design; concepts

INTRODUCTION

Offshore wind turbines are complex machinery systems consisting of many multi technology subsystems. Beginning with the underwater substructures, there are many different conceptual structures depending on the water depth from traditional mono-piles to new floating platforms.

Current offshore turbines in shallow waters are mostly developed from onshore designs. According to EWEA’s medium and long term scenarios offshore wind turbine concepts will be changed from onshore based constructions to specifically for offshore environment designed turbine types. The main driver for offshore wind turbine development is efficiency, rather than generator size. (EWEA, 2009 a)

The development based on land-based designs, is not optimum for offshore wind turbines because of some fundamental differences in the offshore operating environment and infrastructure. Sites are far from harbours and support bases, construction costs are much higher and operations are highly dependent on weather conditions, wave height and wind speed. Corrosive seawater exposure, wave loading added to extreme wind and fatigue load combinations and other external conditions requiring special attention (e.g., ice and hurricanes) require different technological solutions for offshore structures and solutions. Because of these differences, future trends may move toward significant divergences between offshore and land-based designs. (Musial & Ram, 2010)

Interest on floating wind turbine technology has accelerated over the last few years and many technology demonstrations have been carried out. The main drivers for floating technology are said to be access to useful resource areas in a range of locations, varying from shallow to deep water. The developments indicate a growing potential for standard equipment that is relatively independent of water depth and seabed conditions, support the easier installation and decommissioning, and the developers have begun to look for possibility of system retrieval as a maintenance option. At the moment, the main obstacles to the realization of floating technologies development appears to relate to effective design concepts and demonstration that take into account different profit and cost profiles.

Wind turbines in cold climates like in northern Europe are exposed to conditions outside the design limits of standard wind turbines. According to Baring-Gould et al. (2010) specific issues in Nordic context such as accessibility, temperature, ice, snow, energy potential, technology, economic risk, public safety, infrastructure, and occupational safety will require special solutions.

Based on the information the European Wind Energy Association has published (EWEA, 2009b) the market needs in offshore wind energy are said to be contradictory what comes to turbine development. To achieve large production volumes for the rapidly growing market the manufacturers should focus on producing continuous, incremental improvements in the current basic concepts to improve product reliability, to increase component lifetime and to develop preventive maintenance strategies. On the other hand offshore project designers and wind farm operators are requesting completely new - robust, easy to assemble, install and maintain - wind turbine concepts. New designs could be an opportunity to make significant improvements in availability and reduction in the cost of energy. In practice this requires