Reliability Models for Ocean Energy Converters

Mo Haghigi, Prof P J Tavner, Durham University
Work Stream 8:WS 8.1

Introduction

Current knowledge about the predicted reliability of marine renewable energy converters is small because the number of demonstrators built to date are few and are of widely differing topologies.

However, there are rich sources of information about the reliability of wind power converters and from the offshore industry. The objective of this work is to take the lessons learnt from reliability studies in the wind industry and then apply them, using offshore industry data, to a Tidal Stream Converter topology. The intent is that with experience the project will be able to develop generic reliability models to apply to other marine renewable energy topologies

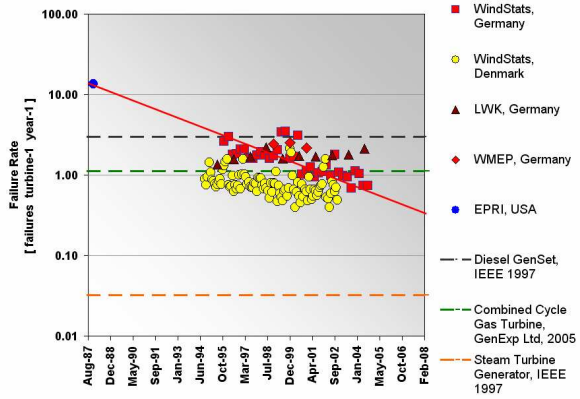
Wind Turbine Reliability

The wind industry has expanded rapidly in the last 30 years and more than 100,000 turbines have been installed world wide. The reliability of wind turbines has steadily improved as shown in the figure below, taken from European and US experience on about 7000 turbines. But this has not been achieved by designing for reliability but by the deployment of enormous numbers of devices.

Marine energy converter designers and developers cannot afford the large scale deployment of demonstrators and must use other methods to assure the reliability of their pre-production prototypes and production converters.

Tidal Stream Converters

Tidal Stream Converters, as shown in the adjacent figures, are representative marine renewable sources with many similarities to wind energy converters , which have shown such significant reliability improvement.



This work proposes building representative reliability models for such converters, based on experience from the wind industry, but to use models as a basis for evaluating future demonstrators and proposed designs before undergoing sea trials, to signficantly improve the performance of prototypes under trial.

Sources of Data

There are substantial sources of reliability data available from the wind industry over the past 15 years, exemplified by the references below.

The offshore and electrical industries also have sources of data which can be used to predict and confirm of component reliabilities for Tidal Stream Converters.

Reliability Models

A typical reliability model, developed using Markov chain methods, is shown below, developed for a particular configuration of wind power converter, to study its reliability with respect to other configurations.

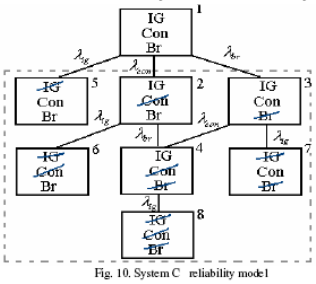


Fig. 10. System C reliability model

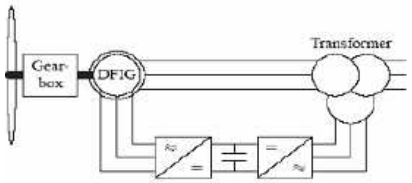


Fig. 3. Variable-speed wind turbine with DFIG, System C

The intent is to develop similar models, based on this approach, for the Tidal Stream Converter. Such models could then be the basis for future model configurations to study other converters.

References

Tavner, P J, Xiang, J, Spinato, F. (2007). Reliability Analysis for WTs. Wind Energy; 10:1–18. [5]

Polinder, H, van der Pijl, F F A, de Vilder, G J, Tavner, P J. (2006). Comparison of direct-drive and geared generator concepts for WTs. IEEE Transactions on Energy Conversion, EC-21(3): 725-733.

IEEE, Gold Book (1990). Recommended Practice for Design of Reliable Industrial and Commercial Power Systems, IEEE Press, Piscataway. [9]

Spinato F. (2008). The Reliability of Wind Turbines, PhD Thesis, Durham University

OREDA, Offshore Reliability Data, SINTEF, DNV, 2002.

Arabian-Hoseynabadi, H, Oraee, H,Tavner, P J, Impact of generator & converter reliability on wind turbine production, Trans IEEE, Energy Conversion, under review.

Institute for Energy Systems
The University of Edinburgh

Engineering and Physical Sciences Research Council