Integrated Asset Management Practices for Offshore Wind Power Industry:
A Critical Review and a Road Map to the Future

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ABSTRACT

In comparison with their onshore counterparts, offshore wind farms and their life cycle operations provide a number of different aspects to consider. Nowadays, different technological solutions are being tested for the design, construction, installation, operation and maintenance of offshore wind farms. Still the challenges are quite diverse and mostly relate to: design of electrical infrastructure; structural design and material choice for aggressive environmental and seasonal conditions; site assessment and optimal set-up; substructures; installation methods; logistics; technical service access; operations and maintenance, etc. Firstly this paper reviews the technical and physical aspects of the mechanical, electrical, and structural subsystems and their critical failure scenarios as a stand point for assessing the current technological solutions and industrial applications. The second part of the paper attempts to map the status quo within offshore wind industries and assess the current status with respect to expected optimum performance criteria. It critically reviews, in particular, the technical and operational integrity concepts which have some influence from systems design process, cost-optimal maintenance approaches, and supportive decision-making applications, intelligent remote diagnostics prognostics techniques and their feasibility, etc. Thus this paper contributes in many different ways, bringing a multi-disciplinary perspective, and leading the way toward further research and industrial applications from an integrated asset management point of view.

KEY WORDS: asset management; operation and maintenance; wind power; offshore; cold climate.

INTRODUCTION: FROM OPERATION & MAINTENANCE TO INTEGRATED ASSET MANAGEMENT

This section provides an overview of the asset management approach and the whole life cycle philosophy which have been used for building this review. According to the classical view, the maintenance is to fix broken items. Taking such narrow a perspective within wind power applications will be confined to the reactive tasks of repair actions or component replacement triggered by failures. Geraerd (1972) has a more recent view of maintenance as “all activities aimed at keeping an item in, or restoring it to, the physical state considered necessary for fulfillment of its production function.” Pintelon (2000) modified the previous definition into the “set of activities required to keep physical assets in the desired operating condition or restore them to this condition.” More related to the operating or production conditions than production function, the last definition seems to be a more pragmatic view, specifying the key objective of maintenance management as total asset life cycle optimization. Using this type of enlarged view of maintenance will have a cost-effective advantage, particularly as the failure consequence costs are very significantly higher in the wind power domain than in other industrial domains, in addition to the high maintenance visit costs. Therefore, the modern view (Jardine 2006) of maintenance includes the proactive tasks such as routine service and periodic inspection, preventive replacement, condition monitoring and continuous improvement methods such as reliability-centered maintenance and total productive maintenance. These give the maintenance management system the capability to take operational decisions and make design modifications in order to enhance asset operational availability. Beyond any doubt, the asset management tasks are complex in terms of the number of systems, stakeholders, interfaces and degree of control. The new British Standard, PAS 55, defines asset management as “systematic and coordinated activities and practices through which an organization optimally manages its physical assets and their associated performance, risks and expenditures over their lifecycles for the purpose of achieving its organizational strategic plan.”

This sets the goal, but how does a company get there? How do we know, and demonstrate, what is ‘optimal’? How do we coordinate component activities to this goal? How can such a joined-up, whole-life performance responsibility be established? How do we develop the skills, tools and processes to establish and sustain such an environment in the first place? Thus, four main factors have been included in order to define asset management in the wind power context: (1) Technology and its changes; for example, Liyanage (2009) mentioned that, “traditionally, condition based maintenance has not been that attractive for offshore applications, but with the current advancement in application technologies, particularly, the ICT sector, it appears that a new avenue of growth has been opened up.” (2) Operations’ trends and