Guest editorial

Compared to other energy sources, wind power excels in producing energy with low emission of carbon dioxide (CO_2). Wind power energy is thus considered a strong and viable alternative to conventional sources such as oil, coal or natural gas to produce electricity. Although more expensive, wind energy production in Europe has moved from onshore to offshore sites for several reasons: high energy potential associated with larger turbines; the vastness of offshore areas; stronger and more stable winds at sea; and fewer negative effects on residents such as visual impact, noise production and shadow casting. Offshore sites are also more attractive for companies because they can easily transport large turbine parts by sea and thus install larger turbines offshore than onshore.

Despite its explosive growth within the past decade, the offshore wind industry can still be described as immature compared to other energy sectors that have had the chance to mature over several decades. The offshore wind industry was born in an established energy market and has to compete with well-integrated and fully developed industries. Government subsidies had helped the offshore wind industry to develop initially, but these subsidies will soon expire. The offshore wind industry, therefore, needs to quickly become a more competitive energy source or else it will be swallowed up by the energy market. For these reasons, the industry's top priority is to reduce the cost of energy production in wind power systems. Costs can be reduced not only through the adoption of new technologies but also through balanced redesigns of the supply chain, and developing new configurations of collaboration and integration among existing and new supply actors within this industry (e.g. energy companies, wind turbine generator manufacturers, foundation suppliers, subsea cable suppliers and installation suppliers).

Hence, reducing the costs of energy production will require a widened supply chain management perspective that transcends individual companies within the offshore supply chain. The offshore wind energy sector needs to implement structural changes within the next five to ten years to successfully compete with fossil fuel-based energy sources. Evolutionary economic theory suggests that such structural changes should include a shakeout process wherein the number of companies decline, but the few firms that remain become larger and more integrated (Agarwal *et al.*, 2002; Klepper, 1997; Menzel and Fornahl, 2009). Experts have observed that this shakeout process is currently occurring.

But this may not be enough as the industry is simultaneously undergoing a consolidation phase. A new perspective, one that is at the interface of technical and social science disciplines, is needed to realise integrated business and technology solutions. Similar to how other industries have evolved, the wind energy industry has focused primarily on product innovation. Life cycle theory predicts, however, that as emergent and proven product technologies compete against each other, certain technologies will emerge as superior in terms of their performance and promise as well as in their ability to fulfil market demand. Others will fail as they are rejected as inferior products (Abernathy and Utterback, 1978; Menzel and Fornahl, 2009). The results of this

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competition will lead to a gradual shifting in focus from product innovation to process innovation as the industry matures (Peltoniemi, 2011; Jensen and Thoms, 2015).

From the technological development and innovation perspective, the movement toward becoming a more mature industry is characterised by a shift from competition between technological trajectories to a state wherein a "*de facto*" product standard is developed (Bos *et al.*, 2013; Peltoniemi, 2011). It can be argued that the industry has already met what Abernathy and Utterback (1978) term as dominant design which refers to a single design, or even a narrow class of designs, that has successfully satisfied the needs of a broad class of users. In this context, product and process innovation are often depicted as the other's opposite and are, therefore, inconsistent concepts; i.e. incremental process innovation cannot be achieved when product innovation is radical (Abernathy and Utterback, 1978; Klepper, 1997; Peltoniemi, 2011). The main argument is that increasing process innovation through automation and specialisation increases the cost of implementing radical product innovation to such a prohibitively level high that established production equipment becomes obsolete, thus jeopardising large, dedicated investments (Abernathy and Utterback, 1978; Jensen and Thoms, 2015). Thus far, there seems to be a need for a significant shift in the industry to focus process innovation to drive down the cost of producing energy from offshore wind farms. These processes innovations are found in the offshore wind supply chain.

Against this backdrop, this call for papers is concerned with supply chain innovation spanning the offshore wind supply chain processes. Supply chain innovation is defined as:

> […] a change (incremental or radical) within a supply chain network, supply chain technology, or supply chain process (or a combination of these) that occur in a company function, within a company, in an industry or in a supply chain in order to enhance new value creation for the stakeholder (Arlbjørn *et al.*, 2011, p. 8).

It offers an approach to identifying and addressing supply chain management development initiatives in the supply chain. Supply chain innovation may provide superior relational advantages not only to the innovators themselves but also to their partners (Arlbjørn and Paulraj, 2013).

The industry also faces great pressure for standardisation as a lever for reducing cost of energy. One of the significant characteristics of a mature industry is the standardisation product interfaces as well as its processes and procedures. Lack of standardisation is a significant cost driver. One example of standardisation is the creation of uniform rules in the health and safety area. If industry actors, who maintain different farms and brands, have different rules even for seemingly minor issues, such as the colour of safety helmets, additional and unnecessary costs are added to the supply chain. Standardisation usually occurs during the maturing process of the industry. The problem for the offshore wind energy industry is that it is under severe time pressure to mature to significantly reduce the costs of energy production. Hence, the industry has a twofold task: first, the individual companies must quickly learn to collaborate with each other on standardisation issues such as health and safety if they are to effectively compete against other energy producing industries; second, they also need to compete with each other on the individual tender for commissioning their farms. These challenges require that firms in the offshore wind energy industry be considered as a whole, rather than in isolation.

This special issue contains six papers that address the different aspects of supply chain innovation in the offshore wind energy sector.

The first paper by Jan Stentoft and Ram Narasimhan introduces a conceptual framework that highlights the promise and potential of supply chain management to reduce the costs of energy production by the offshore wind energy sector. The framework's three interdependent aspects – innovation, industrialisation and supplier partnering – can help guide the industry to identify the appropriate measures to reduce their production costs.

The second paper by Patrick Henley and Chee Yew Wong focuses on the formation of new inter-firm relationships in the UK offshore wind sector. The ways by which the selective process is being managed, according to the authors, is as important as the levels of compatibility and complementarities. They found that new suppliers make significant investments to build customer trust and remove uncertainty; however, the size of the investment does not always guarantee the development of a long-term committed relationship.

Written by Ivan Martinez-Neri, the third paper is a literature review of supply chain integration. He discusses the state of research in the various types of studied industries and manufacturing environments. He concludes that although supply chain integration has become an influential topic in the field of supply chain management, the extant literature on project-based manufacturing environments and renewable energy projects do not adequately include supply chain integration research.

The fourth paper by Kristian Petersen, Erik Skov Madsen and Arne Bilberg deals with how maintenance tasks can be planned and executed in a smarter way with a view to improving the modularisation of the operations and maintenance of offshore wind power installations. The authors develop a process to identify the resources needed for maintenance so that the modularisation of maintenance tasks and resources can occur.

Victoria Baagø-Engels and Jan Stentoft wrote the fifth paper which provides an overview of operations and maintenance issues in the offshore wind energy sector by using empirical data. Based on a Delphi study, they identified three main issues that lead to increasing costs in O&M: the proliferation of too many predefined rules that limits development, the lack of coordinated planning for the different services offered at the wind farms and the lack of a common approach on how O&M should be managed strategically. The authors then propose new initiatives to drive down the costs of energy production by offshore wind farms.

The sixth paper in this special issue is written by Kannan Govindan and Madan Shankar who provide an Indian perspective in their evaluation of the essential barriers to offshore wind energy. They developed a framework together with a five phase-methodology to explore these barriers, which were then evaluated using an analytical hierarchy process. They found that the most essential barrier in offshore wind energy farms is high capital cost.

The papers in this special issue provide different perspectives of supply chain innovations in the offshore wind energy sector. The sector itself spans a wide number of different subject areas within the four generic wind farm life-cycle phases: development and consent; installation and commissioning; operations and maintenance; and decommissioning. Extant literature, however, have concentrated on the first two phases; it is only recently that the operations and maintenance phase has received increased research interest from a supply chain perspective. The last phase, decommissioning,

also entails challenging tasks for the industry whereby inputs to solutions can come from supply chain management. Future research is needed to further explore last phase.

We hope that you enjoy reading the six papers in this special issue.

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