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The influence of stakeholder groups in operation and maintenance services of offshore wind farms: Lesson from Denmark

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One of the prime challenges in offshore wind is to manage and coordinate with the various stakeholders involved in the operation and maintenance (O&M) phase. Therefore the aims of this paper are: i) to map the stakeholder groups involved in O&M of Offshore Wind Farm (OWF), ii) to assess the identified stakeholder group's interest and power to influence O&M, iii) to evaluate the relationship between different stakeholder groups and iv) to highlight potential strategies to manage the stakeholder groups. In this article, the stakeholder analysis approach is used. The results reveal that eleven key stakeholder groups are directly involved in the O&M phase. Among those, the stakeholder groups named Investor/owner, Turbine supplier, Operator's own technicians, Port facility and Vessel supplier are the most powerful stakeholders. In contrast, Onshore service providers and Component suppliers are considered less influential stakeholders. A friendly relationship exists between the governmental agency and the owner of OWFs. The operators consider themselves as competitors. The operator-subcontractor relationship is top-down. The relationship among the sub-contractors is complex because of the perception of losing business if they cooperate with their competitors. From the sustainability point of angel, achieving cooperative advantage is always preferable than competitive advantage.

1. Introduction

Recent trend indicates that there is a significant global effort to produce energy from green sources [1]. Offshore wind power is expected to contribute significantly to the future growth of green energy [2]. Large Offshore Wind Farms (OWF) can provide CO_2 free energy for society, which will in return reduce the impact of global climate change. The statistics of the European Wind Energy Association indicate that in 2015, the capacity of offshore wind energy in the EU was 3034.5 MW which was 24% of the total EU wind power capacity in 2015 [3]. However, the EU targets to produce more electricity (the target is up to 234 GW) from offshore wind by 2050 [4].

The North Sea is one of the primary locations for offshore wind energy not only for Denmark but also for the UK and Germany. In fact, Denmark is the world's first country to move from pilot-scale OWF (the Vindeby OWF was built in 1991 for demonstration purpose) to large commercial OWF's [5]. The first and second commercial OWFs (Horns Rev 1 and Nysted) were constructed in 2002 and 2004, respectively. Since then, the offshore wind power sector has experienced dramatic growth, especially in Denmark, UK and Germany [6]. In 2015, Denmark produced about 42% and in 2016 about 38% of the electricity from wind [7]. In 2009, Horns Rev 2 OWF (total capacity 209 MW; 91 turbines with 2.3 MW capacity for each turbine) started its operation in Denmark. Subsequently, Rodsand II OWF (total capacity 207 MW; 90 turbines, each with 2.3 MW capacity) was commissioned in 2010. Furthermore, Denmark built an even larger OWF named Anholt OWF (total capacity 400 MW; 111 turbines, each with 3.6 MW capacity) commissioned in 2013. Another big project, Horns Rev 3 OWF (total capacity 400 MW; 49 turbines, each with 8.3 MW capacity) will be constructed in 2017–2019 and is expected to start full production from January 2020 (Table 1) [8].

The modern seabed fixed offshore wind turbines can be installed a long distance from the shoreline (up to 50 m depth of water). Therefore, nowadays, OWFs are moved long distances from the shoreline to provide the larger space for the benefit of economy of scale and to obtain higher average wind speeds, to get lower turbulence than onshore, to minimize visual impact and to ensure

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Table 1
Renewable energy production from offshore in Denmark (Danish Energy Agency, 2017).

Offshore wind farm	Year in operation	Turbines (numbers)	Total capacity (MW)
Existing Offshore Wind Farms			
Vindeby	1991	11	5
Tuno Knob	1995	10	5
Middelgrunden	2000	20	40
Horns Rev I	2002	80	160
Ronland	2003	8	17
Nysted	2003	72	166
Samso	2003	10	23
Frederikshavn	2003	3	8
Horns Rev II	2010	91	209
Avedore Holme	2009/10	3	11
Sprogo	2009	7	21
Rodsand II	2010	90	207
Anholt	2013	111	400
Upcoming Offshore Wind Farms			
Horns Rev III	2020	49	400
Krigers Flak	–	75	600
Nearshore OWF	–	44	350

subsidies from public fund [9]. However, the cost of installation and Operation & Maintenance (O&M) increases with the depth of the water and distance to the shoreline [10,11]. So, due to high installation and O&M costs, the cost of energy from OWF is much higher than from any other conventional energy source. For instance, the installation costs of an offshore wind turbine, more than 60 nautical miles from shore and in 40–60 m of water depth, are expected to be 230% higher than for the sites less than 12 nautical miles from shore and in 0–20 m of water depth [12]. It has been reported that no OWF construction project has been completed without a contractor or sub-contractor facing bankruptcy [13]. There is also a significant risk that O&M costs will be higher than predicted, because there is no certain way of knowing exactly what the repair and maintenance costs of an OWF will be over a 25 year operational life [14]. This relatively newly emerged industry is still in the phase of the learning curve. Repairs are an estimated 5–10 times more expensive to perform offshore than onshore, mainly due to the need for expensive crane vessels and waiting time for suitable working weather windows [15]. The perception that OWF involves financial risk has increased because of several high profile failures (e.g. multiple failures in gearboxes, generators and transformers) in early OWFs. Several OWF projects have already suffered major delays in supplying key inputs and these ended up incurring additional cost [14.] Safety risk is another prime concerns in the O&M phases of an OWF. There is a general concern about how to maintain the high safety standards in offshore working environment (particularly personnel movements, working at height, working with high voltages and currents) [14]. Technicians working in the OWFs need to be transported by crew vessel from the service port on a daily basis for O&M purposes, which is time consuming. Sometimes it can be uncomfortable and may cause that the technicians are sea sick and thus unable to perform their duties as efficiently as they would otherwise be able to do [10]. Apart from that, another challenge that faces the offshore wind industry is the risk of a shortage of vessels for construction and O&M purposes. Because of the above mentioned challenges the industry is already heavily subsidized by public funds and the big question is for how long will the public support still be available? Therefore, a combined effort from all stakeholders concerned is required to reduce the levelized cost of energy (LCOE) of OWF.

1.1. Offshore wind farm O&M stakeholders

Many scholars from different disciplines have tried to define the term stakeholder. Freeman [16], who is one of the founders of the stakeholder theory, defines the concept of stakeholders as any group or individual who can affect, or is affected by, the achievement of an organization's objectives. According to this definition, a broad range of stakeholder groups would typically be involved in a project or an organization. From the managerial point of view, it might be very difficult to address/handle a large group of stakeholders. A question for debate has been how to define the term stakeholder more precisely, so that it comprises figures who contribute positively to a firm's value creation process [17]. Therefore, a narrow definition of stakeholder has been proposed by some scholars. For instance, Carroll [18] who defines a stakeholder as an individual or group who proclaims to have one or more stakes in a company. Through these “stakes”, they can affect or be affected by the operation of the company. Stakeholders are consequently the groups who “interact with the firm and thus make its operation possible” as mentioned by Nasi [19]. The need to define stakeholders more specifically is further supported by Starik [20] who defines stakeholders as individuals or groups with whom a company or an industry interacts and who have a “stake”, or vested interest, in the firm in question. According to Donaldson and Preston [21] stakeholders are “persons or groups with legitimate interests in procedural and/or substantive aspects of company activity”. Johnson and Scholes [22] defines the term stakeholder as “those individuals or groups who depend on the organization to fulfill their own goals and on whom, in turn, the organization depends”. Later on, Freemen [23] actually comes up with a modified definition of stakeholders by attributing the concept to “the groups who are vital to the survival and success of the organization”. For the purpose of this study, Freemen's second definition of stakeholder is applied, because this definition is obviously much narrower than his previous definition (any group or individual who can affect, or is affected by, the achievement of an organization's objectives) and it is a completely organization focused-definition.

It has been mentioned earlier that stakeholders of a firm can significantly affect the achievement of firm's objective [16]. Friedman and Miles [24] also claim that the success of a company largely depends on several issues such as: Does the organization have the competencies to understand the stakeholder concerns? How should these concerns be addressed in practice? Is there evidence of organizational learning through engagement and is the organizational learning implemented in policies and decisions?

Stakeholder analysis is considered a useful strategic tool for a company to identify current and future collaboration opportunities