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Fabrication and installation constraints for floating wind and implications on current infrastructure and design

Denis Matha[a]*, Christopher Brons-Illig[a], Alexander Mitzlaff[a], Ron Scheffler[ab]

[a]Ramboll, Stadtdeich 7, 20097 Hamburg, Germany
[b]Hamburg University of Applied Sciences, Berliner Tor 5, 20099 Hamburg, Germany

Abstract

Industrialization of floating wind technology is key for future cost reductions to become competitive. Within the scope of the LIFES50+ H2020 research project, the floating-specific constraints with respect to fabrication, assembly and installation for different floating substructure concepts are investigated for large future 10MW floating wind turbines and 500MW wind farms. The presented study focusses on three selected LIFES50+ sites in the Scottish North Sea, French Mediterranean and Gulf of Maine. General constraints are identified, which are not specific for a certain proprietary concept, but depending on the material, concept type, fabrication, assembly and installation procedures and site location.

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Keywords: floating; offshore; wind; turbines; fabrication; installation; infrastructure; design

1. Introduction

Industrialization of the floating wind technology is considered a key for future cost reductions to become competitive. While developing innovative solutions and at the same time following proven offshore engineering principles and standards for safe, reliable and cost-efficient solutions, it is common industry understanding that one-

* Denis Matha. Tel.: +49 151 58015213;
E-mail address: denis.matha@ramboll.com

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dimensional design optimizations should be avoided: All relevant technical Key Performance Indicators (KPIs) need to be considered such as the floater's dynamic characteristics, and key cost drivers including fabrication, assembly, standardization, installation, operation and maintenance.

Within the scope of the LIFES50+ research project, the floating-specific constraints with respect to fabrication, assembly and installation for floating substructure concepts are investigated. These constraints are particularly relevant in LIFES50+, where designs for large future 10MW floating wind turbines and large 500+MW wind farms are developed which feature larger dimensions, weights and more demanding project timelines than the currently installed single unit prototypes and upcoming small pre-commercial arrays.

The study is based on generalized analyses of publicly available information about existing Floating Offshore Wind Turbines (FOWTs) which are already installed or close to completion, including Principle Power's WindFloat, Statoil's Hywind and Hywind Scotland, Fukushima FORWARD, Ideol's FLOATGEN and GICON's SOFWA. Also experiences from fixed-bottom projects, as well as from installation vessel projects are used. From this investigation, general constraints are identified and presented, which are independent from a certain proprietary concept, but rather depending on the utilized material (steel, concrete), concept type (semi, barge, tension leg platform (TLP), spar), chosen fabrication, assembly and installation procedures and site location. It shall be explicitly noted, that no results from concept specific studies within the LIFES50+ consortium are used for this publication, but the important items identified are generally valid for any floating concept, including the concepts investigated in LIFES50+.

The investigation is made for the three selected LIFES50+ sites in the Scottish North Sea, French Mediterranean and Gulf of Maine, defined in the LIFES50+ Design Basis [1].

While the paper is based on reviews of existing methods for fabrication and installation, the application on the LIFES50+ case offers new insight into issues related to upcoming large commercial floating wind farm projects. Furthermore within the study a dedicated tool was developed in order to assess the installation phase and identify important constraints for selected specific sites.

2. Fabrication

2.1. Steel floater

Of the 33 different substructures that are presented in the Floating Offshore Wind: Market and Technology Review by Carbon Trust, only six use concrete as their primary material, making steel the most widely applied material. The important advantages and challenges of the material choice are presented below.

Table 1. Advantages and Challenges for Steel floaters

Advantages	Challenges
• Established in the offshore wind industry: o Know-how existing o Proven solutions and standards exist to avoid issues related to corrosion due to saltwater and salty air, wind turbine load, etc. • Assembly can be execute relatively fast if components are pre-fabricated (consists of welding operations and positioning of the parts only) • Lighter substructures are possible (compared with concrete)	• Large dimension components/parts: o Need to be built at rare large scale steel mills, typically not at construction site, which is a challenge for mass production o Heavy/large parts need to be transported to construction site, suitable access (road, railways, waterways) required o Suitable storage area at port required • Expensive material, price fluctuating, planning difficult • Specialized equipment (e.g. large scale welding machines and cranes with sufficient lift capacity) required, shipyard preferable