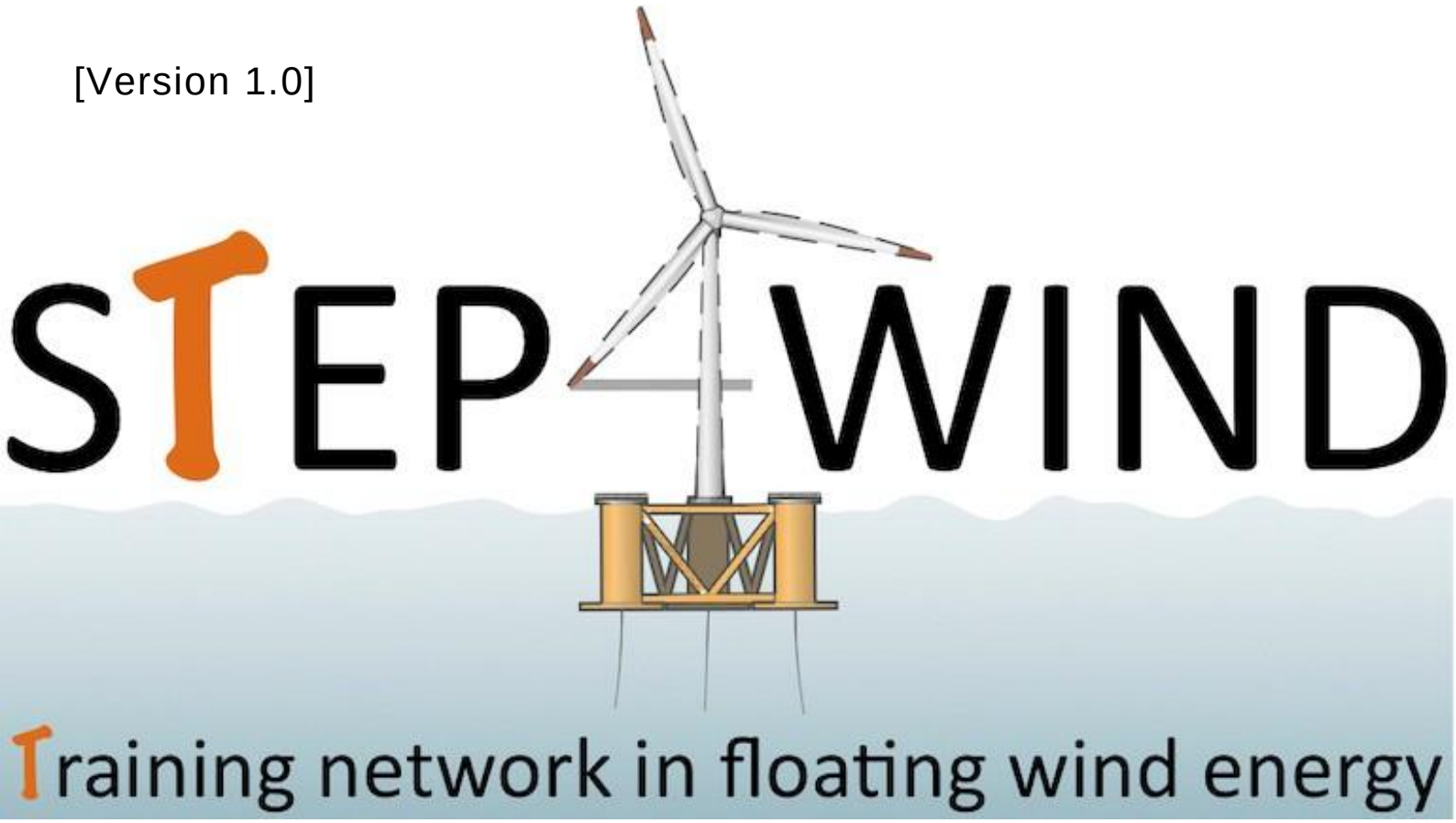
D3.1. Review of Robotic Solutions for Floating Wind

[Version 1.0]



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Document History

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1. Overview

This report pertains to the manuscript discussing the applications of different robotic systems for Operations and Maintenance (O&M) of Floating Offshore Wind Farms (FOWFs). The manuscript has been accepted as an open access journal publication in the *Wind Energy* journal titled "*Applications of robotics in floating offshore wind farm operations and maintenance: literature review and trends*". This report provides a general overview of the publication and its conclusions. The reader is directed to the journal publication for further details.

2. Abstract

Marine operations required to transfer technicians and equipment represent a significant proportion of the total cost of offshore wind. The profile of sites being considered for FOWFs e.g., further from the shore and in harsher environments, indicates that these costs need to be assessed by taking into account the maintenance requirements and restricted weather windows. There is an immediate need to investigate the potential use of robotic systems in the wind farm's O&M activities, to reduce the need for costly manned visits. The use of robotic systems can be critical, not only to replace repetitive activities, and bring down the Levelised Cost Of Energy (LCOE) but also to reduce the Health and Safety (H&S) risks by supporting human operators in performing the desired inspections.

This paper provides a review of the state-of-the-art in the applications of climbing robots, Unmanned Aerial Vehicles (UAVs), subsea robots and Autonomous Surface Vessels (ASVs) for the O&M of FOWFs. Emerging technology trends and associated challenges and opportunities are highlighted, followed by an outline of the agenda for future research in this domain.

3. Objectives

In the paper, an overview of the state-of-the-art in the application of robotics-based O&M for FOWFs is provided with the objectives of:

1. Identifying O&M tasks that could be performed or supported by the robots.
2. Determining the technical feasibility of incorporating different types of robots in the FOWF environment.
3. Discussing challenges and future trends to make robotics-based O&M commercially viable.

4. Conclusions

The FOWF industry is destined to grow in the future, and as such, the demand for efficient O&M practices with lower expenditures is expected to be more pronounced. Restricted weather windows, long-distance logistics, and the need to ably maneuver, gather high quality data, and conduct O&M of FOWF assets are challenging tasks for which the traditional methods are not sustainable. In this paper, a range of robotic systems and their applications for the FOWF-specific O&M are presented. While the adoption of robots in industrial sector has seen significant traction in recent years, various challenges remain for their wide-scale incorporation into the FOWF domain. An overview of this research outlook is illustrated in Figure 1. Hereby, a non-exhaustive list of discussion points include:

- In terms of autonomous offshore logistics, the advancement in battery technology augurs well for the use of battery powered ROVs which will allow tether-free access along with increasing the endurance of UAVs.
- The usage of ROVs for burial and inspection of underwater cables have seen considerable progress. The challenge remains in terms of increasing the TRL of existing systems, and enhancing the operational range of ROVs, which can eliminate the need for divers and expensive tether management system.
- While the use of ASVs is still in nascent stage, benefits in terms of improved safety and higher efficiency can be reaped by their usage in longer-duration missions and especially under harsh weather conditions.
- The development of autonomous industrial robots has culminated in the availability of advanced yet low-cost sensors for data acquisition. For instance, thermographic cameras and ultrasonic sensors can greatly aid in gathering feature-rich data from the FOWF assets in comparison to traditional manned methods of visual inspection.
- The automated gathering and retrieval of data is ushering in the usage of AI and data-driven approaches for continuous maintenance and inspection. This could aid in better management of available resources and increased availability of the FOWF assets.
- The modular design and low-cost versions of climbing robots and UAVs aid in their applicability for various O&M tasks. Sensors and payload of different characteristics can be mounted as per the specific mission requirements.

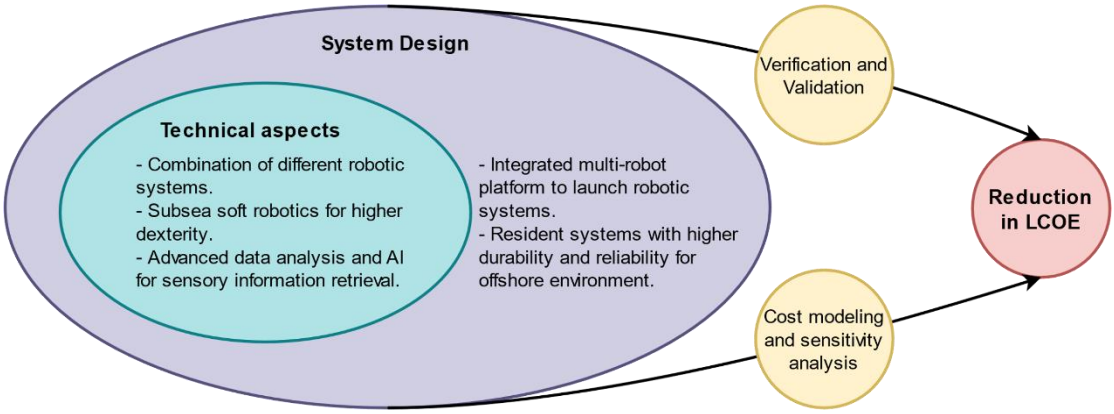

Figure 1: Research outlook for the adoption of robotics in O&M.

For the FOWF industry, the benefits of enhancing O&M through robotic systems range from efficiency in terms of cost and resource management to enhanced and accurate data gathering. Furthermore, the long-term impacts of FOWF infrastructure in oceans can be assessed and understood. With this knowledge comes improved decision-making for conducting continuous O&M at FOWFs deeper into the sea. The robotic system providers need to be cognisant of the emerging trends in O&M while also taking into account the regulatory and certification barriers. This can improve the TRLs of the robots, provide a viable commercial roadmap along with enhancing the value-chain in the robotics-based O&M sector.