1. Project details

Title
TEHE115052 - Spring balanced offshore access bridge (Seaqualizer)

Project summary
This project has built, tested and analyzed both numeric and scale models of the “Seaqualizer”, an offshore access bridge with a spring balanced motion compensation system. It was demonstrated the technology has the potential to increase accessibility of wind turbines to >95%, offering significant energy reduction, lower build and operating cost, improved safety, a larger operating window and increased load capacity compared to existing solutions.

Focus
Lowering the cost of the production of renewable energy (offshore wind) by methods designated in the “Regeling aanwijzing categorieën duurzame energieproductie (SDE+ designation regulation) for any calendar year.

Locations where the project has been executed
Wageningen (Marin), Petten (ECN), Sliedrecht, (IHC), Utrecht (NHLO).

Confidentiality
The contents of this proposal may be disclosed *except* the appendices, which are all considered confidential.

2. Public summary

Opportunity
Existing solutions for accessing wind turbines during high seas states are inherently unsafe and expensive energy guzzlers with limited operating window and load capacity. By combining modern hydro-pneumatics with the old métier of spring balance, NHLO has developed a technology bringing significant improvements to these drawbacks.

Project goal
This project has built, tested and analyzed numeric and scale models of the Seaqualizer, a spring balanced access bridge for safe, low-cost and energy efficient transfer of staff and cargo to wind-turbines. If commercially available in full scale, the Seaqualizer will increase their accessibility to >95%, decreasing downtime and the cost of installation, maintenance & intervention, leading to SDE+ savings of >€80 mln (2017-2023).

Project description
Marin has built and tested the prototype in a tank simulation, advancing the technology from TRL4 to TRL5. ECN and IHC have been involved in the design and evaluation of the prototype in order to assess its technical feasibility and the benefits of the innovation compared to existing solutions.

Result
The project has enabled the project partners to define the key design parameters required to build a full-scale prototype of the Seaqualizer. This full-scale prototype is to be co-designed, engineered, built and tested by strategically well positioned player(s) in the offshore access market, advancing the technology to TRL6 and validating the generic technology of spring balanced offshore motion compensation.

3. Publications

Public information regarding this project has been disclosed by Marin and ECN through several channels and is briefly summarized on our website, including some video containing video footage of the tank tests at Marin (https://www.nhlo.nl/seaqualize).

4. Project evaluation (summary)

Timeline

The main scope of the project was executed within the proposed timeline. Two workpackages (1.5 - Reliability quantification (ECN), and 2.3 - HEMP - Hazard Effect Management Process (NHLO) were postponed with consent of RVO.

Unexpected technical challenges encountered

The project partners found hydraulics do not scale and no research on miniaturized hydraulics is available publicly. The project partners have done a significant amount of unforeseen technical work in order to design a scale model simulating the properties of full scale hydraulics on a miniature level. This has been done by engaging specifically chosen and tuned electromechanical actuators controlled by custom made actuation algorithms.

Technical challenges outstanding

One of the research questions for the full scale prototype is to assess the characteristics of the hydraulic components in a spring balanced configuration in full scale. While all available knowledge at Marin, IHC and NHLO has been deployed to scale hydraulics behavior as well as possible, several assumptions of these simulations require full scale verification.

Objectives met

With the results of the project the project partners are convinced the technology tested will contribute to decreasing the cost per kWh of offshore wind energy. It has enabled the project partners to set the key design parameters to build a full-scale prototype for a cheap, green and safe access bridge. The design parameters have been technically assessed by Marin up to TRL5 and the business case and the improvements compared to existing solutions has been validated by IHC and ECN.

Research results

During the whole project the attainability of the initial design parameters, their related benefits and the impact of any adjustment of these parameters on the business case have been assessed. The key questions for setting the optimal design parameters of a full-scale prototype have been answered:

- The minimum vessel size: the Seaqualizer can be mounted on much smaller vessels compared to existing solutions, because the system can be built lighter and draws less energy.

- The maximum sea state attainable is higher compared to existing solutions, because the system requires less energy for the same precision of movement.

- The energy reduction of the luffing actuator is >80%, overall system energy reduction is >50%.

- The Seaqualizer is more safe then known actively actuated (redundant) systems due to fully passive landing. The sea states attainable with passive landing engaged depend on vessel parameters.

- The Seaqualizer is cheaper compared to known actively actuated (redundant) systems due to a lesser part count and less dependency on redundant parts and control algorithms in order to attain the same (increased) level of safety. It saves operational cost by reducing the amount of fuel required.

- The technology has proven to be a beneficial factor (increasing safety and reducing cost) for any suitable access system (almost any access system not mounted on a hexapod) up to TRL5.

The results of the project have been shared with RVO in detail as the appendices for the subsidy request for a full scale prototype, granted as TEHE116106.The results of two postponed workpackages are shared with RVO as appendices to this final report.

Results - outlook

With the results of the project, the project partners decided to move on and build and test a full scale prototype. Two elements of the scale model tested are of significant commercial potential and can benefit to the decrease of the price for offshore wind energy:

1. Potential for energy reduction of 50-80% is a rare find. It has a powerful marketing value ("lowest emission") and a commercial value due to lower cost for installed power (capex) and lower operating cost (lower opex).
2. Potential for passive landing has a commercial potential for safer transfer and a decrease in cost for required redundancy (capex).

Funding for the full scale prototype has been requested and granted by RVO (TEHE116106). After funding was granted, however, IHC has decided not to enter the market of offshore access bridges due to changing conditions in the offshore market in general.

In the offshore access market specifically, many new players have announced entering the market since the start of this project. In this currently very competitive market, the benefits of the technology tested may not be strong enough to make a successful market entry *independently*. However, several proven and/or strategically well positioned existing players have expressed their interest to enhance their current or future offerings with the technology tested.

As soon as a new partner replacing IHC has been contracted and approved by RVO, the engineering of the full scale prototype will start. A market ready product is planned to be commercially introduced around a year later. The market ready product will bring a reduction in overall cost of ownership compared to currently available access systems of >50%, and will increase availability of offshore wind turbines to >95%. The significant decrease in both operational and capital expenditure will lead to a quick adoption in the market for offshore wind energy. This will lead to cost savings of €25-30mln compared to currently available solutions, and to cost savings of over € 80mln based on increased accessibility.[1] In addition a number of access bridges will be sold to the Oil & Gas market, leading to further reduction of energy consumption.

[1] Please refer to chapter 4. Cost reduction.

5. In depth project results – (confidential)

The deliverables of this project are shared with RVO as confidential appendices and cannot be disclosed.

Deliverables shared with RVO as appendices to the TEHE116106 subsidy request:

Design

1. NHLO - Prototype design
2. NHLO - Preliminary system architecture
3. IHC - Preliminary design study
4. IHC - Preliminary control design
5. IHC - Preliminary hydraulic concept diagram

Economic benefits

6. NHLO - Benefits over existing solutions
7. NHLO - Business case - CONFIDENTIAL
8. ECN - Economic review: Access for Offshore Wind Operations and Maintenance
9. ECN - Calculation of SDE+ reduction for full scale prototype
10. ECN - Safety/Reliability
11. IHC - Hydraulics energy calculations

Tests & analyses

12. NHLO - Miniature hydraulic tests
13. Marin - AnySim model tests
14. Marin - Scale model tests
15. NHLO - Project risk analysis
16. NHLO - Preliminary FMEA

Shared with RVO as appendices to this final report:

Results of postponed workpackages:

- NHLO - Preliminary HEMP
- ECN - Safety/Reliability quantification module

Final reports and audit forms:

- NHLO - Audit form