FlexH2

Flexible Offshore Wind Hydrogen Power Plant Module

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This project “FlexH2” is part of the GROW programme on offshore wind energy. The GROW programme aims to reduce levelised costs of offshore wind electricity, to create added value for the Dutch economy and to strengthen the Dutch offshore wind industry. In the GROW programme 17 partners cooperate (April 2021). The focus of the project is on the integration of offshore wind energy and hydrogen production.

1 Public summary

1.1. Title of the project

Flexible Offshore Wind Hydrogen Power Plant Module (FlexH2)

1.2. Background of the project

The EU Green Deal sets out an ambitious plan for Europe to become the first continent to achieve carbon neutrality by 2050. The Commission's proposal to cut greenhouse gas (GHG) emissions by at least 55% by 2030 sets Europe on a responsible path to reach the carbon-neutral goal by 2050.[1] Contributing to the EU-wide GHG emission reduction target, the Netherlands is committed to significantly increase the renewable electricity production from wind and solar to account for 70% of electricity supply[2] by 2030. Due to the great potential of offshore wind (~70 GW offshore wind by 2050), a holistic energy system design and technological innovations are crucial to limit expensive grid expansion cost because of offshore wind power infeed, and to avoid excessive volatility in the energy balancing mechanisms, caused by intermittency and possible forecast errors of offshore wind power output.

1.3. Objectives of the project

By the end of the FlexH2 project:

1. lightweight and compact HVDC transmission system utilizing the line-commutated converter and grid-forming offshore wind turbines have been developed, which reduces the offshore wind transmission infrastructure LCOE by 30% in comparison to typical MMC-VSC HVDC power infrastructure.
2. MW-level AC/DC solid state transformer has been developed, which reduces the weight and volume by 20% and 30%, respectively, compared with the conventional line frequency transformer.
3. a flexible grid interface has been created, which not only offers the flexibility to regulate the power export/import but also respects the technical constraints imposed on the production (i.e. offshore wind production) and demand-side (i.e. hydrogen electrolysis).
4. a modular energy and risk management system has been developed, which is able to optimize its integration with the existing electric infrastructure and hydrogen infrastructure.

Leveraging these technological innovations, the FlexH2 project can reduce the overall Levelized Cost of Hydrogen (LCOH) for green hydrogen by 0.35 €/kg, therefore provide a cost-competitive solution for the CO_2 emission reduction.

1.4. Results of the project

[1] Link: https://ec.europa.eu/clima/policies/eu-climate-action/2030_ctp_en, Accessed: by Yin Sun, 2021-05-02.

[2] Bestemming Parijs: Wegwijzer voor klimaatkeuzes 2030, 2050; Studiegroep Invulling klimaatopgave Green Deal, January 2021

1. Technology research and development
    - Increase of the TRL of grid-forming wind turbine technology for the offshore wind deployment.
    - Increase of the TRL of AC/DC solid-state transformer for the MW-level hydrogen electrolysis application.
    - Increase of the TRL of power plant controllers for offshore wind hydrogen production assets as described in this proposal.
2. Functional specification that defines the minimum interface requirements for the three technological innovation pillars:
    - Grid-forming wind turbine functional specifications that enable the electrical coupling with the line-commutated power converter.
    - AC/DC solid-state transformer functional specification that enables direct electrical coupling with onshore converter station DC link.
    - Onshore converter station specification that enables flexible connection to the onshore power grid.
3. Performance specification that defines the optimal operational philosophy of the flexible offshore wind hydrogen power plant module.

1.5. Short description of the project activities

In this project, we will develop a scalable solution for the wind-hydrogen power plant module. Specifically, the activities on three key aspects will be carried out:

- Three key technological innovation pillars: (1) Grid-forming offshore wind farms, and (2) high-performance solid-state transformer for large-scale electrolysers and (3) multi-terminal hybrid HVDC transmission systems and its system integration.
- System-level optimization and operation: Flexible design and operation of offshore wind hydrogen power plant module.
- Technology Demonstration: MV-kW level demonstrator to advance the TRL (technology readiness level) of the innovation in this research proposal.

1.6. Location(s) where the project will be carried out (city, country)

The FlexH2 project will be executed in the Netherlands. The FlexH2 demonstrators will be built by TU Eindhoven and VONK, respectively, and TU Eindhoven will host the final demonstration unit.

1.7. Links in the energy chain on which the project is aimed

Generation	X
Transport/distribution	X
Storage/conversion	X
Demand	