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Memo

to
from C-NERGY consortium
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Subject **Press release results C-NERGY project – Energie Transitie Fonds (ETF)**

C-NERGY consortium investigated the potential of energy islands off the Belgian coast

In 2019, DEME together with Econopolis nv, Tractebel Engineering nv/sa and University of Liège joined forces in a study on the potential of energy islands off the Belgian coast. Future energy developments off the coast represent an important driver of the blue growth in Belgium and promotes therefore the energy transition to achieve our ambitious climate goals in 2030 and 2050.

Introduction

Energy islands off the coast offer a number of possibilities for both production, transmission and storage of energy. However, the complexity of such projects and the financial feasibility are the most important barriers to actual development. With the support of the Energy Transition Fund (ETF), the partners of the C-NERGY consortium studied the feasibility of a multifunctional island with an important energy function, from a technical, economic and environmental perspective.

The feasibility study considers a combination of different innovative techniques for renewable energy generation and storage on an artificial, multifunctional island at sea. The focus lies on identifying and calculating all possible synergies of the different functions on a common infrastructure (artificial island) in order to determine what the feasibility will be in the medium and long term. The cost reduction through the application of smart predictive maintenance techniques on wind turbines on the island is explicitly examined and integrated in this feasibility study as potential cost optimization. The added value of other activities and their mutual synergies, such as aquaculture, are not explicitly calculated in this study. However, the high level values of these additional activities are included in the discussion of the results.

Economic potential of energy islands

The economic potential of a combination of wind turbines, a fixed and floating solar farm and a pumped hydro storage facility on an artificial island were studied. Econopolis and DEME have developed a multi-cash flow model, which allows to input the spatial attributes of a certain island configuration and get the economic potential of these configurations as output (in terms of NPV, revenues, payback period, etc.).

On an island, however, other functions can offer added value as well, such as aquaculture, ecotourism, energy transmission, 5G telecommunication, etc. This can lead to a more diversified business model and a potentially higher return on investment. In this study, multifunctional configurations with both energy functions and aquaculture functions were calculated.

Net Present Value is the main measure to evaluate whether the general island case is financially attractive or not. The discount rate is determined based on the costs of equity and the costs of debt of similar projects. On a function-level, LCOEs and ROIs are used to measure the economic feasibility of each function. These measures are compared to these of similar projects, preferably in Belgium. Furthermore, it should be noted that the wind and solar activities include green energy certificate subsidies in the base case. The capacity remuneration mechanism is not included in the base case for pumped hydro storage.

The results show that exploiting energy storage in the form of pumped hydro storage on a multifunctional island can be a financially attractive activity. The main sources of income are coming from delivering ancillary services to the Transmission System Operator TSO (R2 reserves) and the execution of arbitrage activities on the day-ahead and intraday markets. A third source of income consists of supplying black start services to the TSO. There are, however, a number of important uncertainties in the business model of energy storage, such as the future volatility of electricity prices, future imbalance prices, etc.

Furthermore, the study indicates that it is financially feasible to exploit energy production in the form of wind and solar energy on a multifunctional island. The analysis shows that the levelized cost of energy (LCOE) is the lowest for wind energy. Wind turbines on an island have a number of advantages: lower installation and maintenance costs compared to offshore wind turbines and higher revenues compared to onshore wind turbines (due to a higher capacity factor at sea). However, part of the dredging costs must be allocated to the business model of the wind turbines. This study shows that this trade-off is economically sound.

Furthermore, a business case was created for fixed solar panels on the island and floating solar panels at the surface of the inner basin. Both functions are financially feasible and have similar LCOEs in a multifunctional program. Floating solar panels have a higher energy efficiency due to the cooling effect of the water but are slightly more expensive in terms of maintenance and system costs.

However, the energy functions are only economically feasible in a multifunctional island setting. This means that additional sources of income from other activities are necessary to create a profitable business case. Activities that could be potentially interesting on an artificial island off the Belgian coast are aquaculture, desalination, port activities, 5G telecommunication, etc. In this study, only aquaculture was considered as an additional activity. The overall results of the financial impact assessment shows that a multifunctional island, which is an energy island with other types of functions integrated as well, has a positive net present value, which means that this island can generate added value for investors.

Environmental impact of energy islands

Within the environmental work package, four distinct and specific research questions were addressed, which provided important information for the further design and financial analysis of the project.

For the first question regarding the project's social acceptance criteria, including the aspects of visual disturbance, a roadmap was elaborated for the future phases of consultations, when an island project would be further developed. This task was largely based on a critical analysis of international literature and a fine selection of other research papers.

Secondly, the legal-administrative bottlenecks were carefully mapped, allowing to speed up and facilitate subsequent permitting processes. Particular attention was paid to the status of the special protection areas in the Belgian part of the North Sea and their possible restrictive impact on marine project developments like C-NERGY.

The impact of C-NERGY on the existing and expected ecosystem services was determined on a qualitative basis under the third question. For some of the aspects it was possible to produce the necessary figures to optimize the financial analysis within the scope of this study. The detailed analysis of the ecosystem services underlined the overall positive impact of the scheduled project on resilient coastal protection and the production and buffering of renewable energy. In addition, elements that can further increase the environmental benefits emerged from the conducted environmental research. More specifically, it is referred to the qualitative and quantitative evaluation of other ecosystem services during and after the period of exploitation, which may not only contribute to the conservation or the improvement of the natural environment and biodiversity, but also may create a positive impact on food production and food safety (aquacultures, sustainable fisheries, etc.).

Eventually, an analysis and evaluation were prepared for the island's possible decommissioning scenarios after completion of the operational phase. By means of a critical analysis of different decommissioning options and measures, and their respective role in environmental protection and in climate change mitigation and adaptation, the elements from this fourth research part can be linked rapidly to the financial data, and further elaborated and finetuned in subsequent scenario analyses.

The potential of predictive maintenance of wind turbines on the island

The ULiège contribution has demonstrated the possibility to increase the service life of the C-NERGY wind turbine support structures. Through predictive inspection and maintenance, a lifetime extension of the whole wind turbine structure is feasible (by 1-3 years for load monitoring, but it can reach 5-10 years with structural health monitoring), and consequently a significant reduction of the LCOE of offshore wind energy may also be expected.

The question was: *"How to make the best use of the database of load monitoring (e.g. wind speed measurement), structural response monitoring (e.g. strain measurement), and crack maintenance data for taking decision on the lifetime extension".*

The answer is: "The data monitoring (wind and strain measurement) reflects the structural behaviour while the crack inspection data reflects the structural health. The study has shown how these two types of information can be combined to update the failure probability of the structure and subsequently to assess the remaining fatigue life. The report demonstrates that using the monitoring data, fatigue failures can be foreseen, and actions can be taken on time. In combination with crack maintenance data (crack inspection is performed, and any detected crack are repaired), a specific extended life for each scenario of wind severity can be derived".

Conclusion

The feasibility study shows that artificial energy islands off the Belgian coast can be economically feasible in a multifunctional island setting. Multifunctional islands are islands on which multiple activities are integrated and where multiple use of space is encouraged. In this way, a diversified business model can be created with potentially higher returns. Finally, artificial energy islands can make a significant contribution to major societal challenges, such as the energy transition.

The social, environmental and legal-administrative challenges were examined in the second research part. The results show that an appropriate communication strategy is desirable in the development of artificial island concepts, in which the citizen should be involved as much as possible. It is also shown that artificial islands can provide certain ecosystem services, such as water quality regulation.

Finally, the third part of the C-NERGY study shows that predictive inspection and maintenance can lead to a higher lifetime of wind turbine structures, which can consistently reduce the LCOEs.

This study has been conducted with the support of the Energy Transition Fund (ETF).