

Digital Twin Modelling for Offshore Wind Farms

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ABSTRACT

A digital twin (DT) is a virtual model that replicates a physical system in real-time. It continuously mirrors the behavior and performance of the physical system by integrating real-time data, advanced modelling techniques, and simulation processes. In the context of an offshore wind farm (OWF), DTs serve as wide-ranging representations of various elements, such as individual wind turbines or their components like drive trains, wind turbine generators, and so on, entire wind farms, or even broader marine ecosystems. The uses of DTs cover the entire lifecycle of OWFs. A DT assists in managing the effects of wind farm construction, operation, and/or decommissioning on marine environments, allowing for better monitoring, mitigation, and decision-making. Such DT development needs to be tailored to the local context, not only in terms of the data, models, and sensor platforms embedded in the DT, but also to the regulatory, policy, and stakeholder context in which such a DT would be used.

In a Nova Scotian context, given that the OWF industry is in its infancy and is still evolving, there is a lack of knowledge about the stakeholder views on the value of such a DT-OWF and about what developing such a system would entail. To advance this understanding, Dalhousie University, in partnership with Net Zero Atlantic (NZA), has initiated a collaborative project, *“Exploring the use of Digital Twins (DTs) to mitigate environmental risks of offshore wind farms (OWFs) through stakeholder consultations in Nova Scotia (NS)”*. The overall goal of this research project is to understand the views and concerns of stakeholders on the potential development of a DT technology for managing OWFs in NS, with particular emphasis on monitoring, predicting, and optimizing trade-offs regarding environmental impacts. By engaging a range of stakeholders, including industry professionals, officials from provincial and federal government agencies, academics, NGOs, and local communities, the project aims to develop a comprehensive understanding of what stakeholders believe about the prospects of a DT-OWF, and what design requirements should be considered in its development, should this be pursued. By aligning the development of a DT-OWF system with stakeholder priorities, NS can advance both its renewable energy goals and marine conservation efforts in a manner that benefits both the environment and society.