Developing a MegaWatt Scale Array of Vertical-Axis Wind Turbines (VAWTs) on a Single Floating Platform

Joseph Mee[1], William Flynn[2], Michael O'Shea[2], Brian Mannion[3], Tomas Flanagan[3], Darragh Burke[3], Eoghan Clifford[1], William Finnegan[1]

1. School of Engineering, University of Galway, H91 TK33, Galway, Ireland; 2. ERI, MaREI Research, University College Cork, P43 C573 Cork, Ireland;
 3. Emerald Energies, Údarás Industrial Estate, An Choill Rua, Inverin, H91 Y923, Galway, Ireland

Introduction

Wind energy technology is advancing into deeper waters to take advantage of the abundant wind resources available at sea. While Horizontal Axis Wind Turbines (HAWTs) have historically dominated the wind energy sector, it may be premature to conclude that this technology is the most effective option for generating energy in deep-water environments. Vertical Axis Wind Turbines (VAWTs) could provide a more suitable alternative for harnessing energy in such locations. The MEGA4Wind project is an SEAI-funded collaboration between the University of Galway, the University College Cork and Marine Material Ireland, focusing on the development of a megawatt-scale array of VAWTs on a single floating platform.

The Platform

In the initial stage of the research, a number of platform types will be analysed that are based on spar-buoy, tension leg and semi-submersible designs. The size of the platform will be determined by turbine spacing and configuration based on 2D models generated by a project partner.

A 3D coupled wave and wind computational fluid dynamics (CFD) analysis will be conducted using ANSYS for all the concept platform designs. Scaled models of these designs will be 3D printed and tested in a meter-wide wave tank at the University of Galway. A scaled version of the most promising design will be constructed and tested at the National Ocean Test Facility, which will be used to verify the small-scale test and CFD analysis.
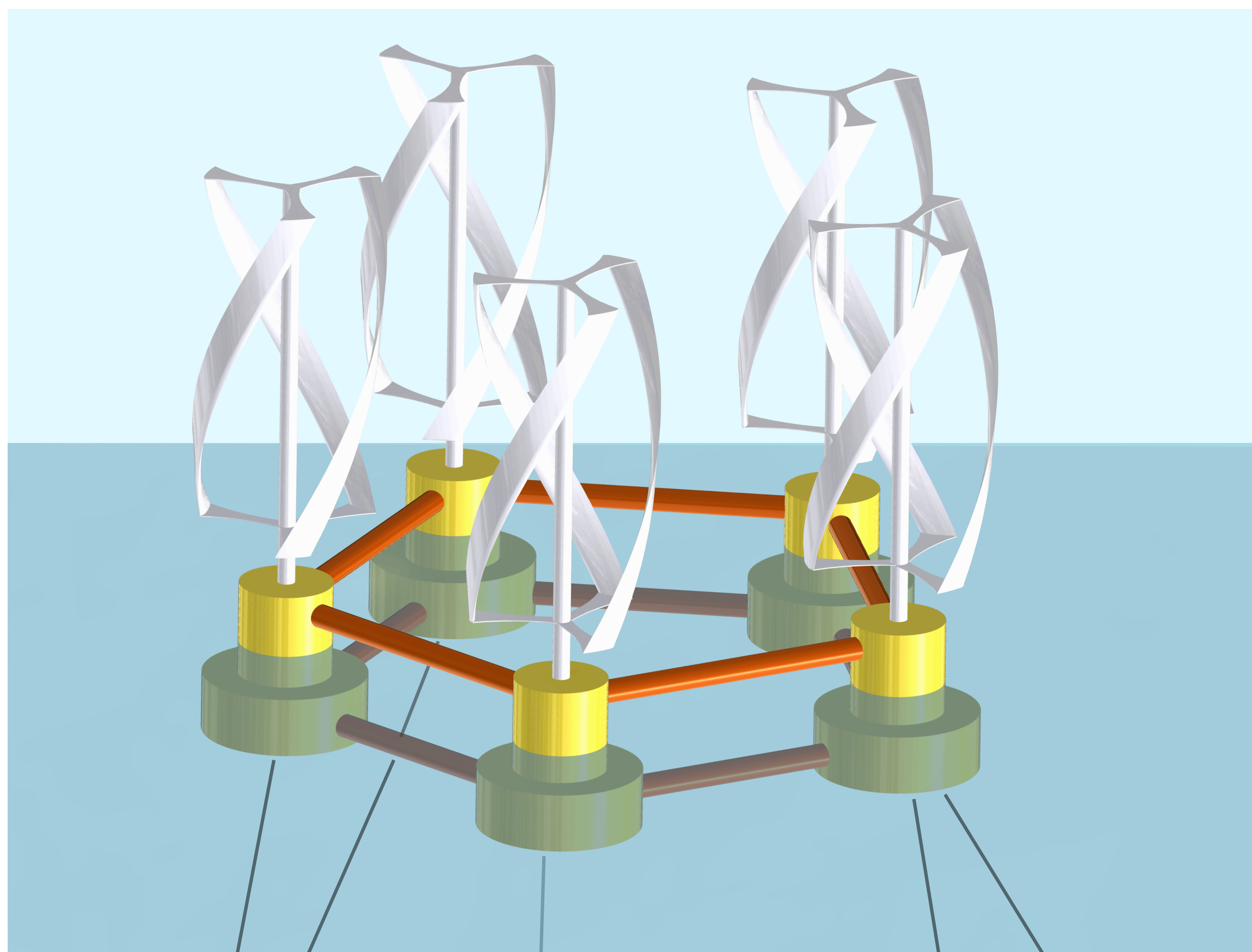

Figure 1. Five vertical-axis wind turbines supported on a single semi-submersible platform

The Location

Appropriate locations for offshore floating wind turbine installations within Ireland's exclusive economic zone will be identified using a geographic information systems (GIS) approach. This methodology draws upon the research conducted by Díaz and Guedes Soares (2020), which explored site suitability in the exclusive economic zones of Portugal, Spain, and France.

The Irish Weather Buoy Network offers detailed records of meteorological and oceanographic conditions along the Irish coastline. Each buoy location will undergo an assessment of its suitability, focusing on factors, such as storm survivability, wind speed consistency and weather windows.
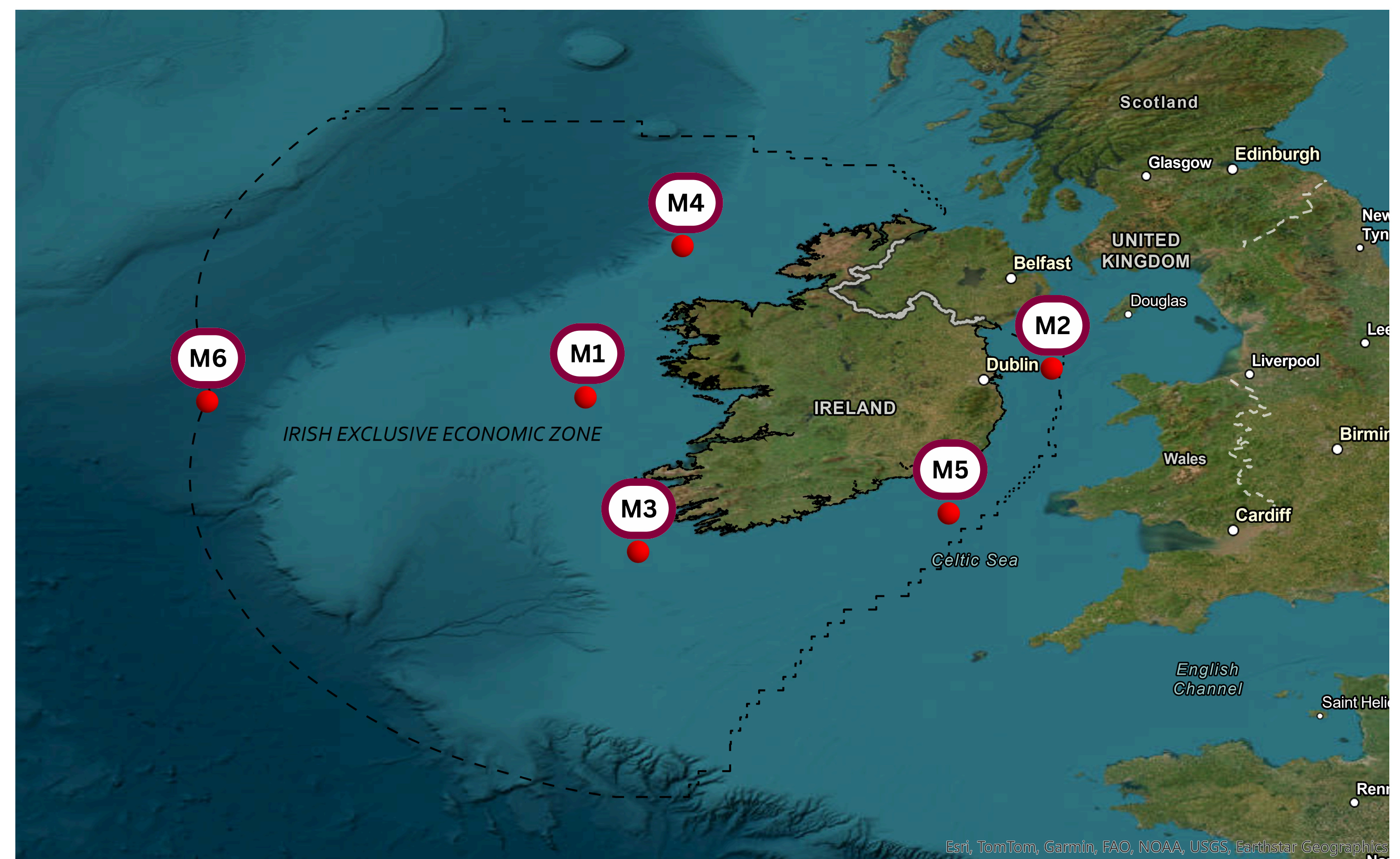

Figure 2. Locations of buoys M1-M6 in the Irish Weather Buoy Network. Bouy M1 was moved to location M6 in 2007

The Blade

DeepWindDemo serves as a precursor to the MEGA4Wind project. This project involved the development of a 10 kW VAWT, which consists of two turbines, each with three blades, all mounted on a single platform. In addition, a separate blade has been constructed for testing at the University of Galway's Structural Testing Lab. This blade will undergo various static loading conditions, and the results will be compared to Finite Element Analysis models to verify their accuracy.

The insights gained from this testing, along with an evaluation of the manufacturing methods and materials used, will inform the design of the MEGA4Wind blade. The sustainability of the blade will be assessed using Life Cycle Analysis, and alternative materials will be explored. Additionally, manufacturing methods will be evaluated, and the process of scaling up production will be investigated.

Acknowledgements