Department	School of Engineering and the Built Environment
Supervisors	DoS: Dr Pablo Jaen Sola; 2nd Supervisor: Dr Keng Goh; 3rd Supervisor: Dr Sung-Ho Hur from Kyungpook National University (Korea, Republic of)
Project Title	Evaluating the Impact of the Control Strategy in the Optimization of MultiMW Offshore Direct-Drive Wind Turbine Structures

PROJECT DESCRIPTION

The School of Computing, Engineering and the Built Environment, "SCEBE", at Edinburgh Napier University is a portal for research and knowledge transfer that has contributed extensively to develop and promote renewable and sustainable energy devices in the UK and abroad over the last 30 years. Through the expert services that the School offers industry has been supported in meeting the demanding energy challenges and government requirements.

A self-funded 3-year PhD position is available to work with a team of experienced researchers on one of the most challenging areas that the offshore wind energy industry is facing at the moment. Offshore wind energy is a vibrant energy engineering sector with an important role to play in tackling climate change. Recent trends show how direct-driven wind turbines have drawn the attention of manufacturers as higher availability, efficiency and reliability are achieved due to the elimination of the gearbox from the powertrain. However, this innovative design also introduces a new set of challenges. With the removal of the gearbox loads coming from the wind turbine rotor are directly transmitted into the powertrain supporting structure only composed by the electrical generator. In order to maintain the power rating of the turbine it is necessary to increase the size of the generator, which in turn leads to a very large and heavy piece of machinery.

A control system will be designed with the aim of maximizing the power extraction capability and alleviating the aerodynamic loads of the National Renewable Energy Lab, NREL 15MW Offshore DirectDrive Wind Turbine. Relevant data obtained from the controller, such as torque and rotational speed, will be then used as input parameters to a mechanical/structural model of the machine so its structure can be optimized employing computational techniques. A dynamically efficient and lightweight machine capable of withstanding the severe conditions imposed by the harsh offshore environment will help to reduce the current capital and O&M costs in a substantial manner. Characterisation of loads and their use in our modelling capabilities is of interest for both the academic partners (Edinburgh Napier University and Kyungpook National University) and our industrial partners, participating in this project. Industrial support will ensure the alignment of the project with the sector necessities.

Academic qualifications
A first degree (at least a 2.1) ideally in control engineering with a good fundamental knowledge of mechanical design.

English language requirement
IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:
- Experience of fundamental control engineering applied to renewable energy devices
- Competent in Matlab and Simulink
- Knowledge of optimization and simulation
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project

• Good time management **Desirable attributes:** Good mechanical engineering knowledge Interest in finite element analysis techniques	
Indicative Bibliography	P. Jaen-Sola, "Advanced Structural Modelling and Design of Wind Turbine Electrical Generators", PhD. Thesis, Wind Energy Systems DTC, University of Strathclyde, Glasgow, 2017. P. Jaen-Sola, A.S. McDonald and E. Oterkus, "Dynamic structural design of offshore direct-drive wind turbine electrical generators", in Ocean Engineering, Elsevier Series, 161, 1-19, 2019. T. Oye, N. Gupta, K. Goh and T. Oye, "Development of Sustainable Indoor Air Quality for Air-Conditioning System Using Smart Control Techniques", in Environmental Management and Sustainable Development 11(1):1. R. Balakrishnan and Sung-Ho Hur, "Maximization of the Power Production of an Offshore Wind Farm", in Applied Sciences, 12(8):4013, April 2022. Y. Reddy and Sung-Ho Hur, "Comparison of Optimal Control Designs for a 5 MW Wind Turbine", in Applied Sciences, 11(18):8774, September 2021
Enquiries	For informal enquiries about this PhD project, please contact Dr Pablo Jaen Sola on p.sola@napier.ac.uk
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