SEMS: RESEARCH PROJECT DESCRIPTION

1. Project Background and Description

Sustainable composite materials for wind energy

Wind power installations have been significantly increased in UK and globally to produce clean energy and mitigate global warming. It is expected that their growth will escalate in the next decade with 323 GW of new wind energy projects, that will be installed in the EU by 2030. The offshore exhibit tremendous wind energy potential, particularly deep-water areas (below 50 meters) due to strong and consistent wind speeds, which has sparked global interest in developing offshore floating wind turbines (OFWT).

In service, the OFWT blades continuously experience extreme weather conditions, such as dry/wet weather, high/low-temperature cycles, UV radiation exposure and erosion. All these factors have a detrimental effect on the mechanical performance of wind turbine blades (WTB), particularly the combined effect of temperature/moisture ingression and fatigue loading is considered as the most crucial for the long-term durability of offshore WTB. Current wind turbine blades are mostly made from glass fibre reinforced polymer composites, which are difficult to recycle or not economically viable to recycle. Consequently, they will produce up to ~ 550,000 tons of composite waste by 2050, and it will become a major environmental problem within a few years. With the greater potential for environmental degradation, OFWT blades must be designed more robustly to reduce their maintenance costs and assure long-term durability. Therefore, the development of sustainable WTB is crucial to support economic benefits, climate mitigation and ensure their long-term performance under extreme weather conditions. Thus, the key objective of this project is to develop new sustainable composite and unravel their degradation mechanisms subjected to hygrothermal ageing and to develop a new computational framework to predict their long-term fatigue performance under a harsh marine environment.

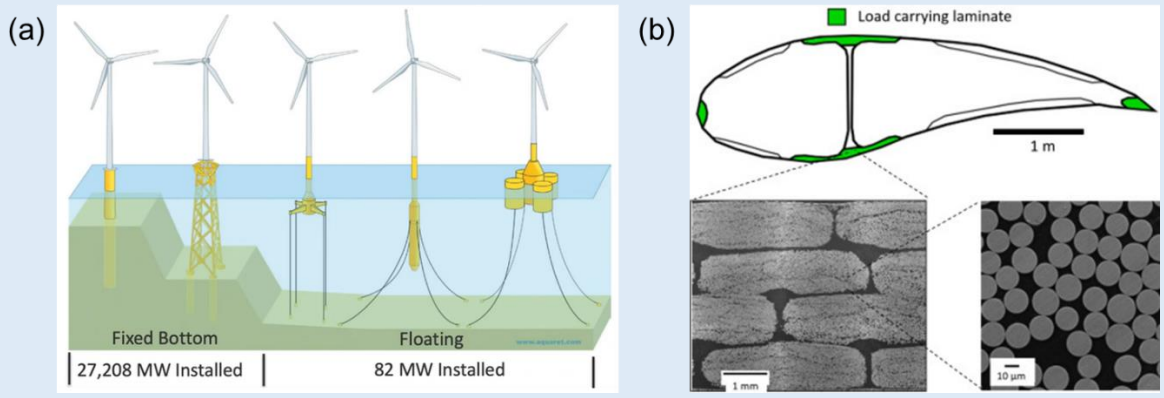

Figure 1. (a) Offshore wind turbines with fixed bottom structures and floating wind turbines (b) Load-carrying composite laminates in wind turbines

2. Project Scope

- To manufacture and characterise the mechanical properties of resin-infused composite laminates.
- To conduct impact or fatigue tests on the composite coupons and miniaturised composite turbine blades and explore the failure mechanisms under hydrothermal ageing conditions.
- To develop an analytical or computational model to predict the failure behaviours of sustainable composites in wind turbine blades under harsh marine environment.

3. Desired Skills from the Student

- Engineering background in relevant disciplines (Mechanical Engineering, Materials Science and Engineering, Aerospace Engineering, etc.)
- Solid knowledge in mechanics of materials, mechanical tests, failure of solids, or finite element analysis.
- Desirable skills: Finite element modelling (ABAQUS, COMSOL, etc.) and
- Excellent English communication and writing skills.

4. Supervisory Team

Primary supervisor: Dr. Wei Tan, Lecturer in Mechanical Engineering

Second supervisor: Prof. James Busfield, Professor in Materials