2024_13_Civil_CW: Environmental and health risks related to the recycling of waste wind turbine blades

Supervisors: Dr Chao Wu (mailto:c.wu@imperial.ac.uk); Professor Terry Tetley, Faculty of Medicine, National Heart & Lung Institute

Department: Department of Civil and Environmental Engineering

The UK is a global leader in wind energy which is the key to achieve Net Zero. Half of the country's electricity will be made by wind power by 2030. There are currently 2,555 wind turbines installed in UK waters, and 8,625 turbines installed onshore (Jensen et al. 2020). However, the fast-growing wind energy industry is facing an imperative challenge from waste turbine blades. They are made of composite materials with continuous fibers (mostly glass fibers) embedded in thermoset polymers like epoxy. These blades are inherently tough and strong making them extremely difficult to recycle at the end of service life. Unfortunately, effective recycling methods are not yet available. According to a recent study by the UK National Composite Centre, the blades are being landfilled in the UK and many other countries. This creates huge environmental problems, because the blades not only occupy valuable land space, but also degrade with time and release micro plastic and fibres that pollute the soil. On the other hand, there is ongoing research to recycle the blades through mechanical shredding, and the recycled powders and short fibres can be used in other applications like as fillers in road pavements. However, this process inevitably generates dust that is hazardous to human health. A health and safety guideline is urgently needed in the industry to carry out the recycling practice.

This project investigates the environmental and health risks related to recycling waste wind turbine blades. It aims to address three key research issues: (a) the nature of the release of micro plastics and fibres in the soil when landfilled. This requires a complete understanding of the material degradation when in contact with the soil. Laboratory testing will be conducted simulating the landfill environment and quantifying the concentrations of micro plastics and fibres in the soil with time. Accelerated lab testing with increased temperature will be used to speed up the leaching process, and the reliability will be validated with testing in ambient condition. (b) putative toxicity of inhaled airborne micro plastics and fibres within the respiratory system. Toxicity studies will be carried out using human lung cell models in vitro which mimic the air-tissue interface, a likely target of inhaled particles. Pulverous dust will be collected from wind blade manufactures and its physicochemical composition will be fully characterised before toxicity testing. The relationship between particle dosage, physicochemistry and toxicity/health risk will be established. (c) mitigation methods will be proposed to reduce the environmental and health impact based on the results in (a) and (b). Ventilation system will be designed and key parameters will be recommended. Personal protective equipment (PPE) for handling the dust will also be recommended. The research outputs will be very useful for understanding the environmental and health hazards of similar pulverous materials like cement.