Project: Solutions for end-of-life WINd turbine blades in a Circular Economy (WIN-CE)

Project type: cSBO 3 years – Catalisti (lead cluster) & Blauwe Cluster ,
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Context

Offshore wind energy is becoming increasingly important for the Belgian electricity supply. In 2021, 8% of the total electricity demand was supplied by Belgian offshore windfarms. Although wind turbines are designed for a long lifetime operation (20-25 years), a massive number of installations will need to be decommissioned soon requiring efficient recycling procedures. Currently, 80-90% of the turbine has solid and long-established recycling routes, as it consists mostly of steel. The remaining 10-20% is linked to the blades which are mostly made of glass fiber composites and have currently no valorisation path with high material value preservation. In the blade, the fibres and the thermoset polymer are bonded at a microscopic level, which results in optimal lightweight properties and high energy efficiency, but also poses challenges for efficient material recovery and reuse. In a previous study, it was estimated that the composite waste from offshore wind turbine blades will reach 12 ktons in Belgium by 2040. From onshore turbines, a significant flux will be released from 2025 onwards reaching 3000 tons/year in 2030. In Europe, volumes are 50 ktons (2022), increasing to 43.5 Mtons worldwide by 2050. The current installed wind turbine blades in Europe represent approximately 1500 ktons of glass fibre, impregnated with 500 ktons of epoxy or polyester resin. As the currently used methods of landfill (phase out) and co-processing to cement clinker fails to exploit the residual value of the composite waste, there is a need for innovative solutions to recycle these blades into high value materials for a circular approach. Mechanical grinding technologies, whereby the refined blade-composite is incorporated in products as a replacer of filler or fiber, is currently extensively been investigated. This approach has reached higher TRL, but has the disadvantage that only partial replacement is possible (~10%) and results in a downcycling preventing real circularity. Thermal recycling, on the other hand, has primarily been focusing on the recovery of low value glass fibers whereby the intrinsic value of the composite is lost. Moreover, the required high temperatures result in a severe reduction of the fiber strength (50-90%) and do not allow the re-use of the resin fraction.

Project idea

To address these issues, this project aims to **develop a scalable (thermo-) chemical methodology that enables the fiber/resin recovery at significantly lower temperatures as compared to the state of the art**, thereby targeting the recovery of fibers with high strength as well as a resin-based fraction suitable for re-use. Two promising technological approaches will be developed and compared on their technical performance, environmental impact, scalability and economic feasibility, one is based on (catalytic) solvolysis and one on catalytic microwave assisted pyrolysis. Major focus will be put on the evaluation of the **product quality of the recovered fiber and resin fractions**. It will also include resin synthesis and materials formulation (proof-of-concept level) to **assess the functional properties of the fractions for renewed use in various composite materials**. This will form the basis for follow-up (industrial) projects to further develop and industrialize these technologies combined with the development of modified and new composite manufacturing processes based on recycled materials.