Group 17 – Functional Strandbeest Structure

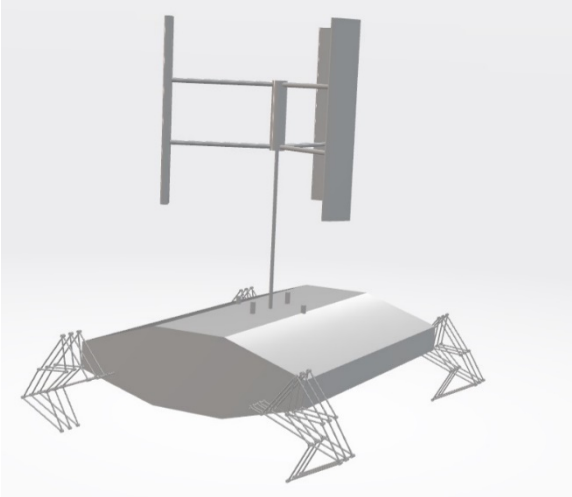
The Paris agreement and increasing awareness of the dangers of fossil fuels are pushing governmental bodies to transition to renewable energy. Wind energy, being one of the largest sources of renewable energy, is expected to account for a quarter of Europe's total electricity production by 2050 [1]. This is an 82% increase from current production levels which requires an increased production of larger wind turbines to accommodate the demand. This expansion, in return, is predicted to generate approximately 325,000 tonnes of wind turbine blade (WTB) waste annually [2]. Current wind turbine blades are made with synthetic fibres reinforced by thermoset-based resins. Due to the inability of the thermoset resin to be remoulded, the current recycling solutions for these blades are highly inefficient and energy intensive. This results in the WTBs often being burned or placed in landfill [3].

To address this issue, plentiful research is being carried out on how to reduce the impact of the WTB at the end-of-life. One of the options is the development of natural fibre reinforced thermoplastic composites to manufacture a next-generation of wind turbine blades. The key difference being the replacement of thermoset resins with thermoplastics capable of remoulding.

To validate that this new material can be sustainably recycled into functional structures, the objective of the project is stated as the following: "*To demonstrate the viability of repurposing next-generation WTBs at the end of their life into an autonomous wind-powered structure capable performing a societally impactful function on the beach that shows embodied intelligence* ".

To ensure that the design is a recycled product from the potential future wind turbines, the vast majority of the structural components is manufactured from the natural fibre reinforced thermoplastic composite. The composite that is chosen consists of the coPOM polymer, reinforced with natural flax fibres.

The design takes inspiration from Theo Jansen's strandbeests, which are wind-powered structures that demonstrate an organic walking motion. However, the structure will be capable of operating autonomously on the beach and additionally fulfilling a function. There are several options for such a function such as waste collection, desalination or providing entertainment and it will be powered with the energy that the BFG does not use for motion.



The main source of energy is a vertical axis wind turbine mounted on top of the structure. It is supplemented by solar panels to account for times where the wind conditions do not allow for enough energy production from the wind turbine.

In the final two weeks of the design process, the final design will converge through an iteration, detailed design of critical components will be performed and the design will be verified and validated.

[1] European Court of Auditors. Special report 22/2023: Offshore renewable energy in the EU– Ambitious plans for growth but sustainability remains a challenge. 2023. url: https://www.eca.europa.eu/en/publications?ref=SR-2023-22.
[2] Lichtenegger G. et al. "Offshore and onshore wind turbine blade waste material forecast at a regional level in Europe until 2050". In: Waste management 106 (2020), pp. 120–131.
[3] Shuaib N. Ai. and Mativenga P. T. "Energy demand in mechanical recycling of glass fibre reinforced thermoset plastic composites". In: Journal of Cleaner Production 120 (2016), pp. 198–206.