16 - Wooden Urban Air Mobility Vehicle

Personal mobility has become one of the pillars of modern society, giving people the freedom to travel and effectively expanding the edges of every individual's horizons. In fact, most of society heavily relies on transportation, with people routinely travelling thousands of kilometres per year. However, combining the need for mobility with the increasingly alarming climate crisis has proven to be very challenging due to the polluting nature of motorised transport. The Wooden Urban Air mobility Vehicle (WUAV) aims to bring society one step closer to sustainable transportation by producing a wooden electric Vertical Take-Off and Landing (eVTOL) aircraft that is able to replace short-haul private flights.

Mission Objective

The objective of the WUAV project is to design a private eVTOL air transport vehicle that is able to complete intra- and intercity flight while being more environmentally friendly than current options. In order to achieve this, two aspects were considered: on the one hand, the aircraft has to maximise sustainability. Net-zero operational carbon emissions are achieved by using a battery, and CO_2 sequestering wood is used as a primary structural material to minimise emissions during manufacturing and end-of-life operations. On the other hand, the recharging of the battery using sustainable energy sources must be considered. For this, a ground station was designed, comprising of a passenger waiting room, a landing pad and a charging port which charges the aircraft using gaseous green hydrogen; this hydrogen is stored in tanks on-site.

System Design

The design proposed for the WUAV consists of an aircraft with a tandem wing, selected after a concept trade-off. At the time of writing, a preliminary sizing of the aircraft had been performed; this sizing is presented in this section. The aircraft is designed to fly a range of 200 km at a speed of 250 km/h, cruising at an altitude of 1 km. To achieve this, the propulsion system is powered by a battery with a pack-level energy density of 300 Wh/kg, allowing for immediate development of the design with current cell technology. The thrust-to-weight ratio achieved by the propulsion system is 1.3, dictated by the eVTOL capabilities of the vehicle. The front wing houses six 1.75 m wide propellers and the back wing has four 2.99 m wide propellers. All propellers are tilt rotors and can rotate to produce thrust in variable directions, allowing the aircraft to fly horizontally and also take off and land vertically. The fuselage accommodates five passengers and a pilot, each weighing 100 kg (including carry-on luggage). The aircraft has two primary structural materials: Sitka Spruce and aluminium (specifically, AL-2024-T3). The wings are entirely made of Sitka Spruce, while the fuselage is made of aluminium. The aircraft selling price is estimated to be around 2 million EUR, while the ground station manufacturing cost is estimated to be around 1 million EUR. In terms of sustainability, the design substitutes carbon-emitting and difficult-to-recycle composites with CO_2-absorbing wood, vastly reducing the aircraft's carbon footprint. Also, the battery is charged at the ground station using two fuel cells powered by green hydrogen. In the final week of the project, the design will be iterated and finalised, ensuring that the aircraft maximum take-off mass is less than 3600 kg. Additionally, the use of wood in the structure will be maximised, aiming for at least 25 % of the structural weight to be wood. Then, a verification and validation of the design shall be performed, alongside a sensitivity analysis. In addition, compliance with project requirements will be checked, to ensure the result meets, and exceeds, expectations.