15 - KITE-E

KITE-E (Kite Integrated in Truck Electrical Energy) nullifies the carbon emission of mobile energy generation. A quick transition from fossil fuels to electrical and hydrogen solutions is necessary to meet the Paris Climate Accords. Limiting the CO_2 emissions of fossil fuel based industries is easier said than done. KITE-E introduces an airborne energy generation system that can be placed on an electric pickup truck. By reeling out the kite from a winch, electrical energy is generated. Contrary to all other DSE projects, which consume energy, KITE-E generates energy. This method of energy production creates no by-products and does not emit any greenhouse gases. It does not need any external power source. Consequently, it is a fully energy-autarkic system, thus providing unlimited freedom to the user. The KITE-E system has several applications; it can be used for remote exploration, disaster relief, and humanitarian peace missions.

Mission Objective

Design, with 10 students within 10 weeks, an airborne wind energy system with a cost and mass budget of €45,000.- and 500 kg, that can be fitted to the Rivian R1T for self-charging and is to be used as a mobile renewable power plant.

System Design

KITE-E is designed to be integrated into the Rivian R1T. This integration imposes constraints with respect to mass, volume, and cost of the system. The ground system of the kite has to fit on the truck bed. When not in operation, the airborne system is stored in the truck and on the truck bed. The system has a weight of 400 kg, thus satisfying the mass budget with a 25% margin.

The system produces 20 kW during nominal operations, fully charging the pickup truck battery in under 7 hours. It is designed to be capable of being operated for 3 months, or 2232 flight hours, generating 44640 kWh in the process. This power can either be directed to the battery of the truck, or to an external power grid. At a current kWh price of €0.6/kWh, the system produces more than €26000 worth of electrical energy before the bio-based tether needs to be replaced. This means the system will already be profitable, before the second tether needs replacement.

The optimised and self-designed kite has a better aerodynamic performance than TU Delft's V3 kite. It allows for a higher wing loading, and thus a smaller kite. Combining this with a compact bridle system, the kite has better steerability. Furthermore, the pulley system is fully optimised, using only one wheel, leading to a smaller reel-out system with full operational capabilities.

The system is at least 85% recyclable. Sustainable options were preferred in the design procedure, even if alternatives would result in a lower cost. For example, this resulted in choosing a bio-based tether, bio-based bridle lines, and a recyclable and highly innovative kite material called ALUULA.

In the following two weeks, recommendations that were written down during the process will be reported. In addition, the manufacturing of the subsystems and the system as a whole will be worked out in more detail. The current design can be seen in the figure below.