#23 - Airborne Wind Energy System on Mars

Life on other planets has been a dream for humanity since their discovery. As a result of today's level of technology, it is possible to not only visit outer space or send unmanned vehicles to other celestial bodies but also to start planning a way of creating habitable areas beyond Earth, coming to a step closer to the once impossible dream. Mars is one of the most promising locations for this, being a terrestrial planet with sufficiently hospitable conditions. The Rhizome project of the European Space Agency is tasked with designing a habitat on Mars. Rhizome not only needs to provide a habitat, but also supply energy to the mission. It must be powered by renewable energy in several complementary ways, including an automated airborne wind energy system. Following this mission need statement, the project Airborne Wind Energy System on Mars (AWESOM) was launched with the objective of designing an airborne wind energy system capable of covering the energy use of a Mars habitat which corresponds to 10 kW, assisted by a solar array to cover for the time periods with insufficient wind.

Using the Mars climate database created by Le Laboratoire de Météorologie Dynamique, the wind resources and atmospheric properties on Mars were evaluated in order to design according to the limits imposed by the adverse Martian climate. This evaluation proved that the thin atmosphere and high variability of the wind would push the design team to innovate and come up with an effective system. With this goal of innovation and our ambition, AWESOM was born.

The configuration of AWESOM consists of a semi-rigid swept-wing concept, controlled from the ground by two independent control tethers connected to the wingtips. Energy is harnessed via a ground-based generator which is spun using the reeling out of the tethers as a result of the lift force produced by the wing. This tether reels out a drum directly connected to the generator. To harness the full potential of the wind resource, the wing is controlled to fly crosswind in a figure of eight trajectory. This trajectory also defines the power cycle which has a reel-out period where the wing turns the drum and generates power, along with a reel-in period where the first position of the wing is restored for the next cycle. The energy necessary for the reel-in period is stored in a buffer storage consisting of supercapacitors, which also stores the energy required by the control actuators during operation. An additional long term storage is built and connected to a power distribution unit to deal with the fluctuations in the power output. This long term storage is charged when the wind speeds are high in winter so that the low wind speeds in summer can be compensated.

According to the computer model developed to simulate the system, AWESOM is capable of producing 122.5 MWh of energy in a Martian year, which is 0.8% more than the total energy required by the habitat and the system itself, ensuring sufficient power output for the habitat in any case, planned or unforeseen.