

Sunrise - solar-powered thermal airship

Peter Lobner, updated 18 March 2022

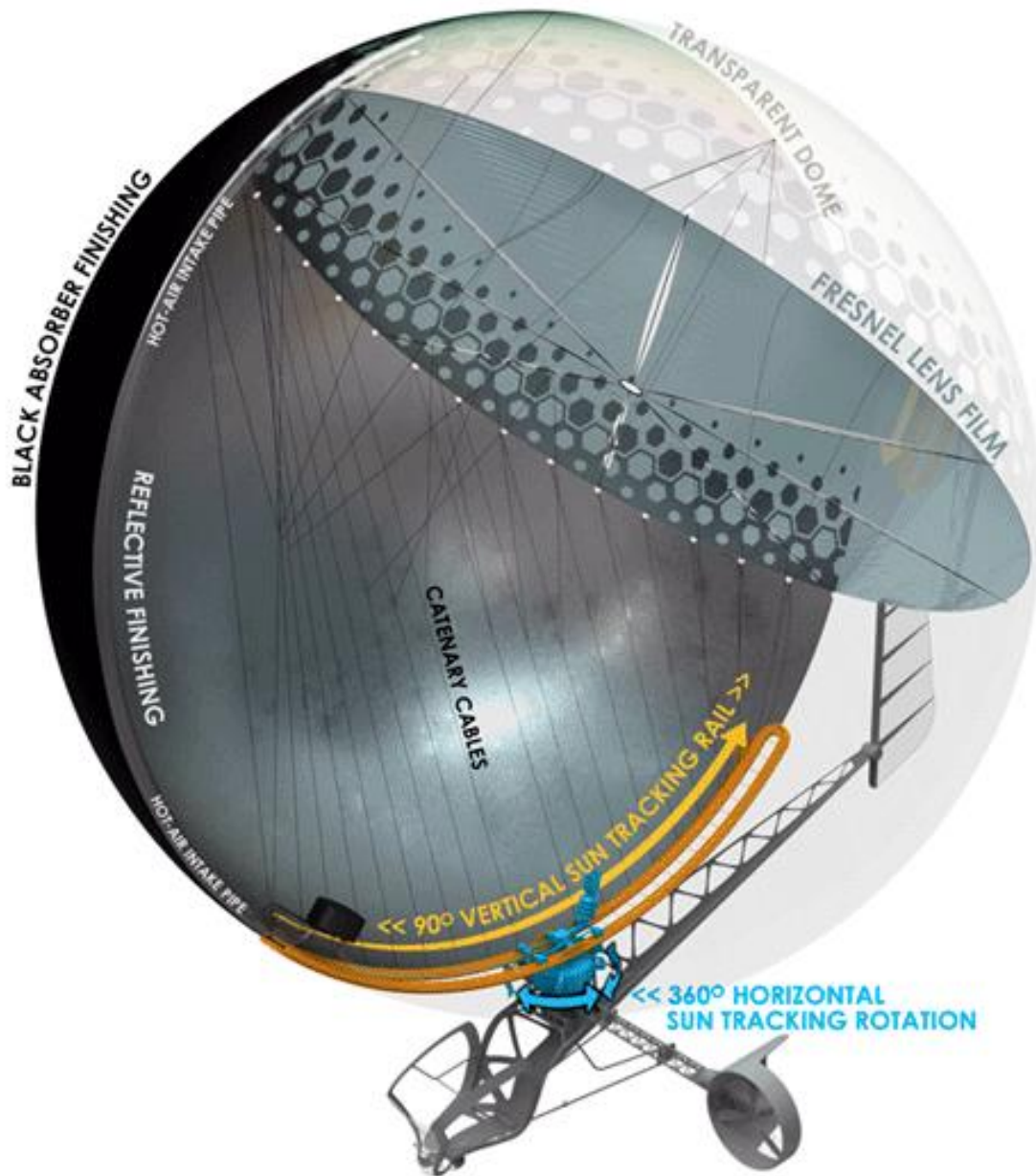
This unique airship concept, developed by Swedish designer Metin Kaplan in 2012, uses hot air as its lifting gas, trading off performance relative to using helium in exchange for dramatically reduced operating costs. The airship is designed for airborne missions conducted at low speeds and for long flight duration. As such, it may find applications for observations, expeditions, patrolling, filming, crop dusting or simply for recreation. The airship can be fitted with floats for amphibious landings. With the envelope removed, and some structures folded, the airship can be transported on a flatbed trailer.



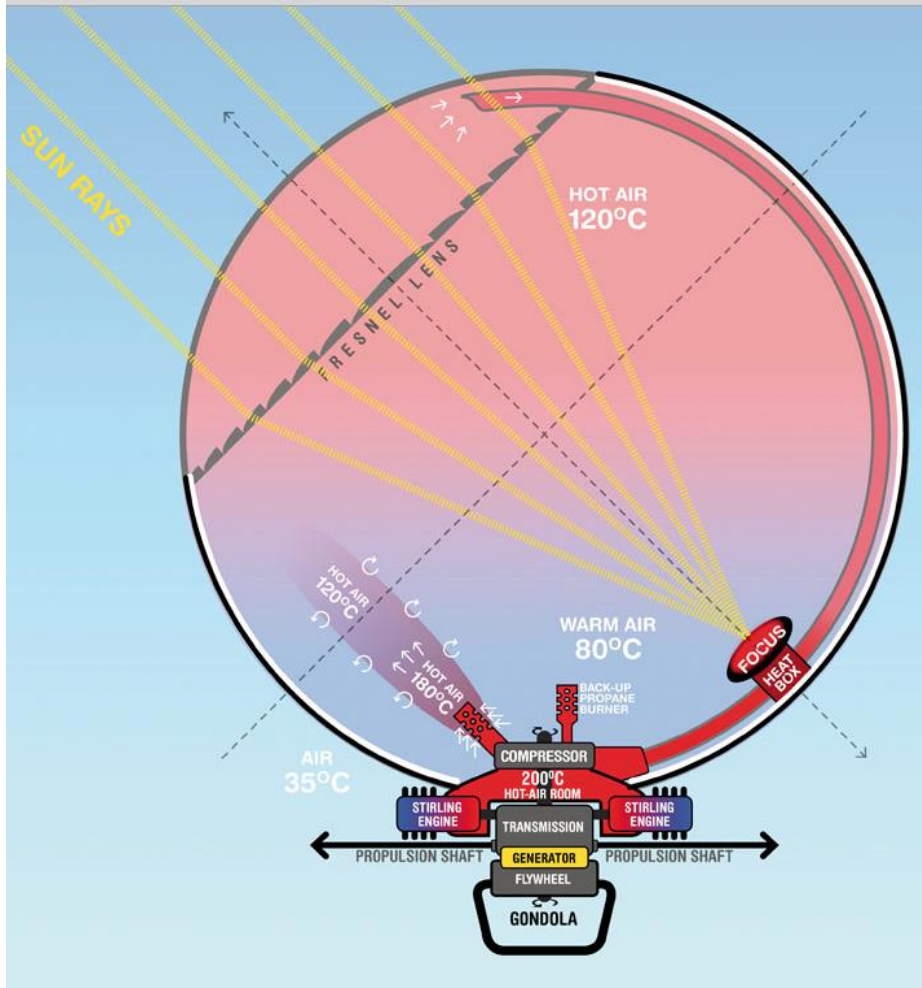
Sunrise solar-powered thermal airship. Source: Tuvie

Lift is produced by hot air inside a spherical, partially transparent balloon. A thin Fresnel lens behind the transparent front of the balloon concentrates the sunlight on a focal point at the back of the balloon where air is heated to produce aerostatic lift and a heat-powered Stirling engine provides power for propulsion. A 2-axis sun tracking system keeps the transparent part of the balloon and the Fresnel lens constantly facing the sun. Any extra energy from the Stirling engine is transformed into motion and stored in a flywheel as rotational energy for use later. The balloon is insulated and also stores thermal energy for use later. The operating principles are shown in the following diagrams.

To change altitude, the pilot rotates the two propulsion units up or down as needed. A propane-powered burner serves as a temporary backup source of power.



*General arrangement of the Sunrise solar-powered thermal airship.
Source: Tuvie*

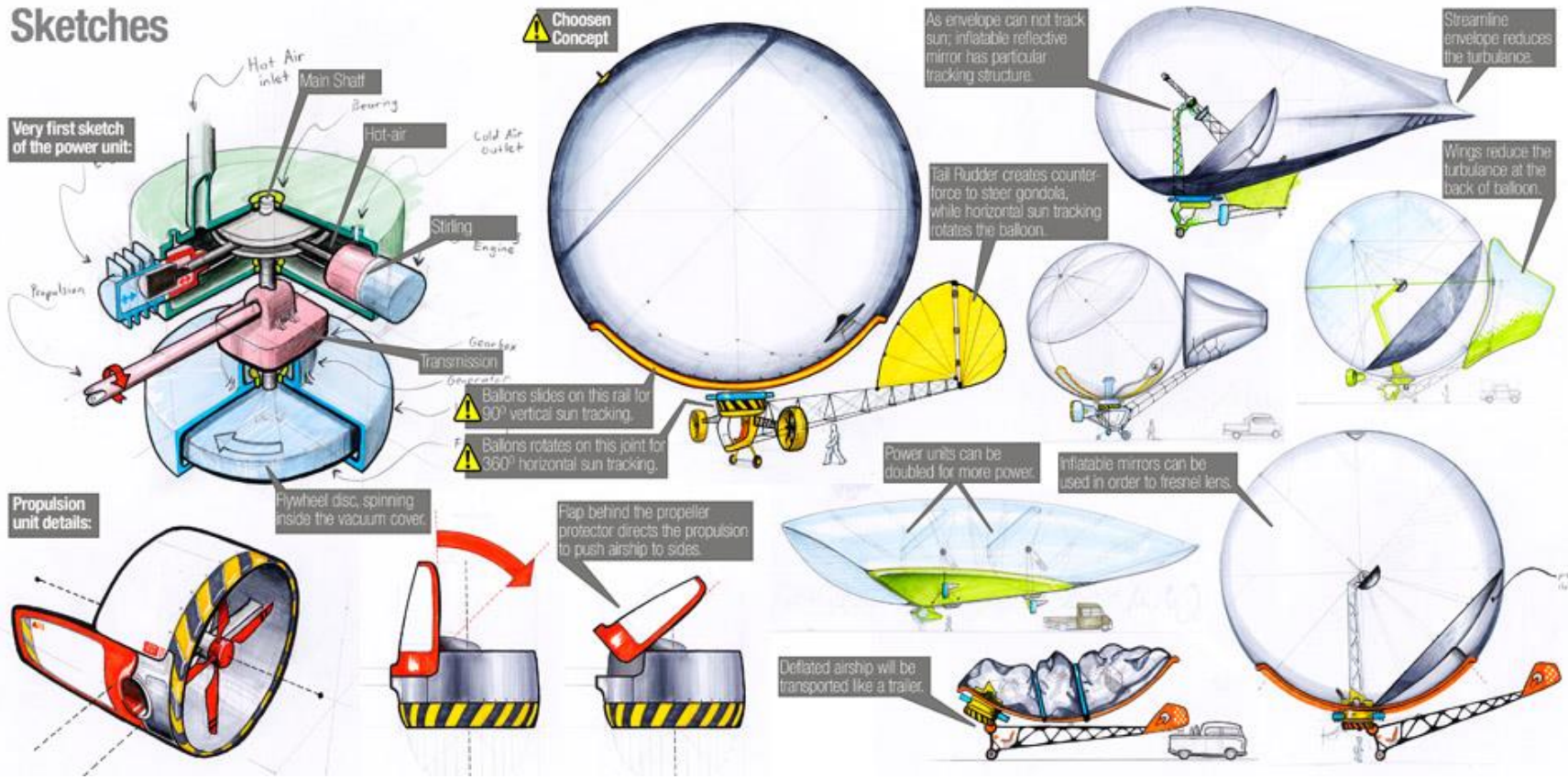


- 1) Solar radiation is concentrated on focus point by Fresnel Lens to create extreme heat.
- 2) A pipe will suck the 120°C hot air from top of the balloon where the hottest air always stays.
- 3) Pipe brings hot air into the heat box under the focus
- 4) Even more heated air (200°C) is carried from heat box to Power Unit by pipe.
- 5) Hot air moves around hot part of Stirling Engines to transfer its heat. Cooled down air is released to balloonet, mixing with warm air stored in the lower part of balloon. Hot-air goes back to its original temperature (120°C) and moves up to the balloon.
- 6) Stirling engines turn the main shaft inside the gearbox. Gearbox distribute the mechanical power into propulsion unit, electric generator and flywheel unit. Main shaft also powers the compressor that sucks air from the top of the balloon.
- 7) Flywheel stores the mechanical energy by spinning its disc in extreme rpm.
- 8) In case of system is out of energy, back-up propane burner is used for landing safely.
- 9) Circulation of hot-air inside the balloon, mix the cold and hot air and homogenize the temperature. This increase lifting efficiency, and reduce the heat stress of the balloon fabric.

Operation of the solar collector & Stirling engine

Source: Source: Tuvie

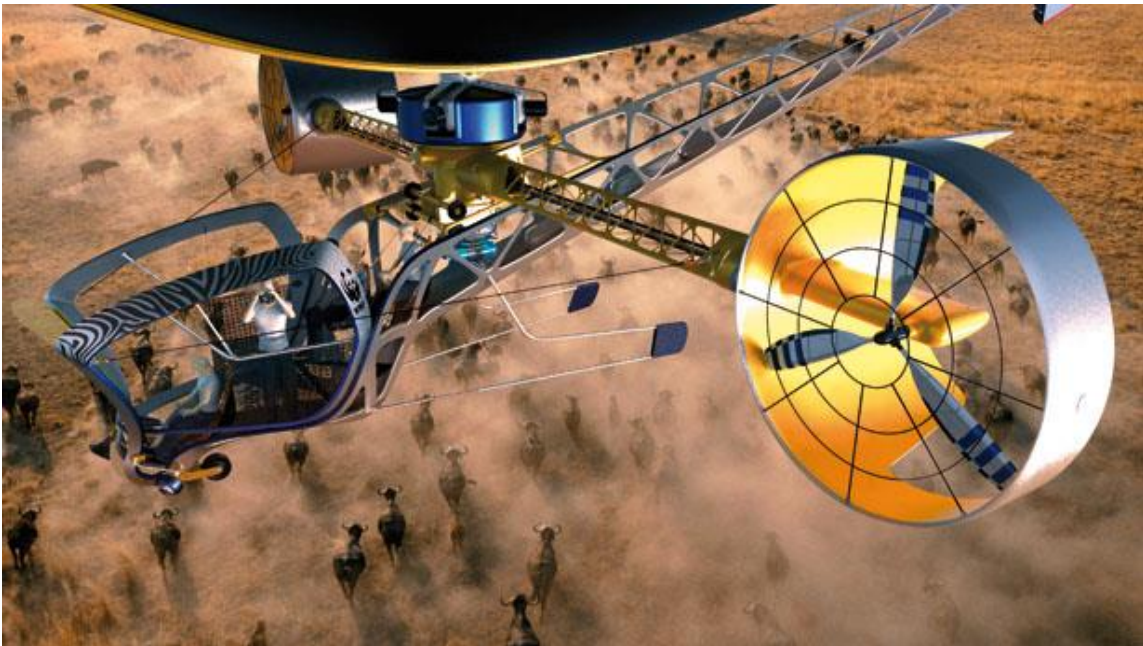
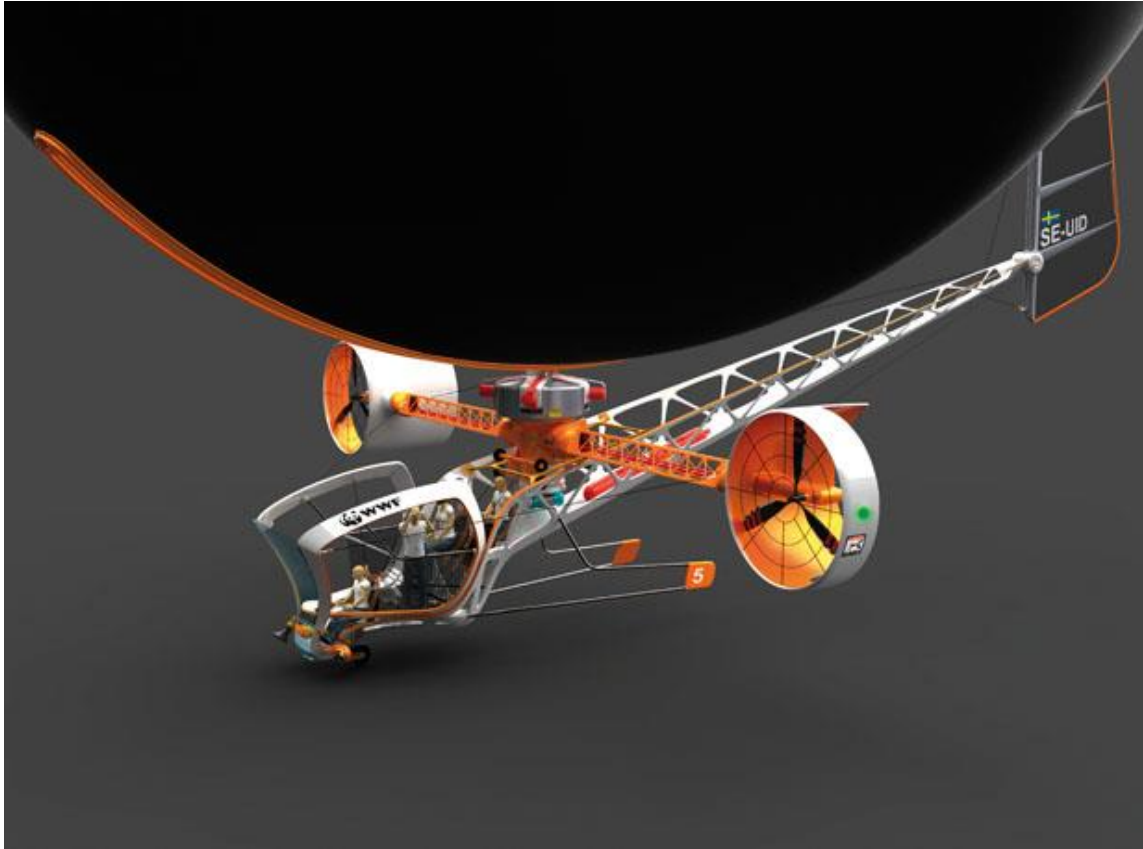
Sketches



Metin Kaplan's sketches of the Sunrise solar-powered thermal airship.
Source: Tuvie



Source, both graphics: Tuvie



*Sunrise fuselage and thrust-vectoring propeller configuration.
Source, both graphics: Tuvie*



Sunrise with the envelope removed. Source, both graphics: Tuvie

For additional information

- “Sunrise Solar Powered Thermal Airship Reduces Operational Costs and Allows You to Enjoy Longer Flight Duration,” Tuvie, 2012: <https://www.tuvie.com/sunrise-solar-powered-thermal-airship-reduces-operational-costs-and-allows-you-to-enjoy-longer-flight-duration/>

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 - Sterling solar-powered thermal airship