AN AIRBORNE TURBINE CONCEPT FOR POWER GENERATION ON VENUS

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Motivation:

Mission Enabling: As the projected life of lander concepts extend from hours to months providing power to a Venus lander becomes a challenge.

Science Return: Wind speeds within the Venus boundary layer are relatively unknown. Obtaining measurements of the Venus boundary layer could be the key to measuring the planet's moment of inertia.

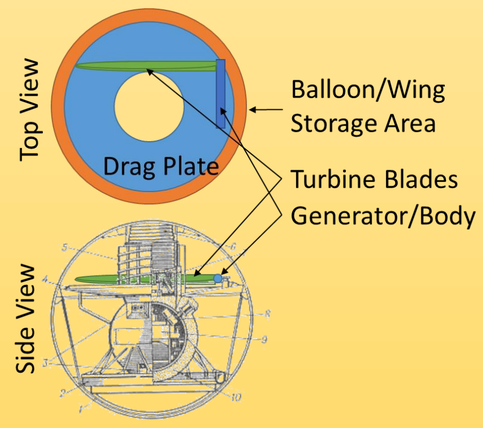
Power on Venus:

Power generation for a Venus surface mission has been proposed through solar panels, RTG's, and wind turbines.

- Solar panels require large surface areas due to less than 2% of solar energy reaching the surface and do not operate during 60-day nights.
- RTG's designed for Venus temperatures would require expensive investments and would not have the multi-mission justification other RTG's do.
- Ground based wind turbines may be obstructed, may reach lower velocity wind, and require towers.
- An airborne turbine may produce the most consistent power source and would measure the boundary layer.

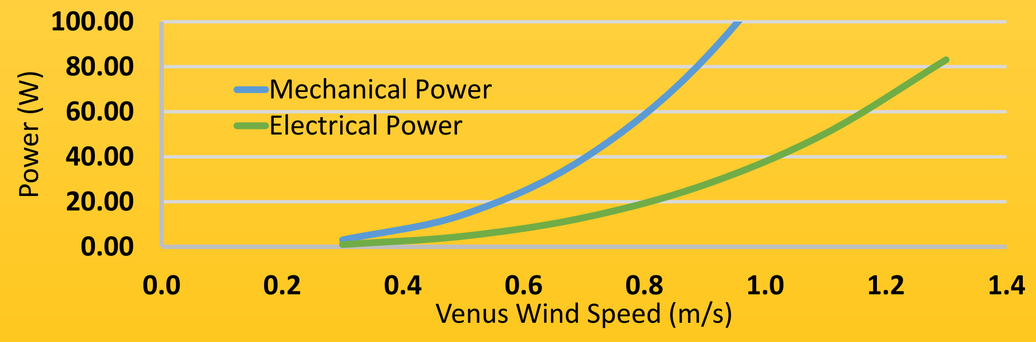
Design Considerations:

Size Limitations: The turbine and elevating mechanisms would be designed to fit within 1/4 of a Venera style lander. Blades would be stored across the drag plate to enable a 3.3 meter turbine.



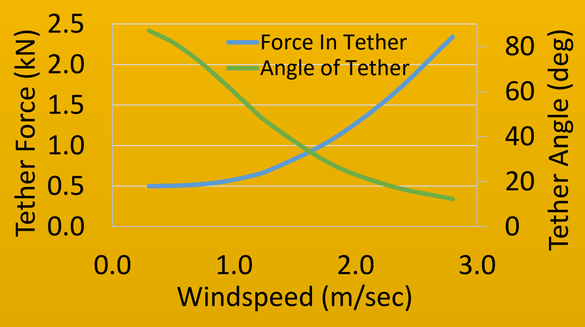
Turbine Design: A single bi-blade turbine is baselined for the design. Such a turbine would have a coefficient of performance of 0.40. 40% of the wind power would be converted to mechanical energy.

Generator: The Honeybee Robotics motor can be run backwards as a generator. Honeybee is currently investigating using the motor as a generator. A conservative efficiency of 33% from mechanical power to electrical power was estimated.



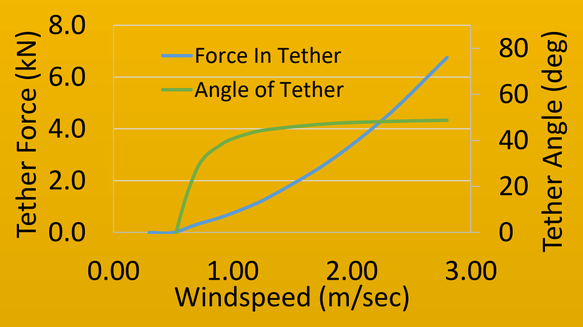
Architecture 1: Balloon Only

- A 1 x 3 meter cylindrical zero pressure balloon.
- Balloon maintains lift.
- No reliance on wind speed.
- Risk of losing lifting gas.



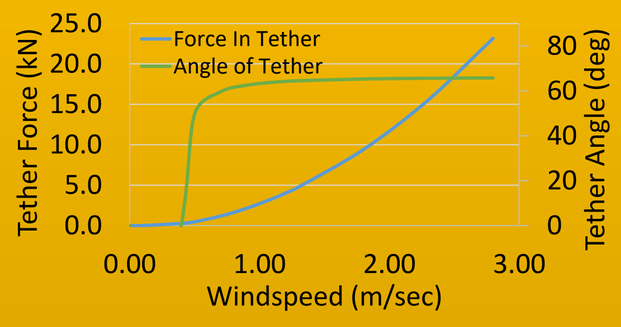
Architecture 2: Wing Only

- Requires large deployable 7m rigid wing span w/ landing gear.
- Would only fly at Venus wind speeds of 0.55 m/s or greater.
- At lower wind speeds would remain on the ground



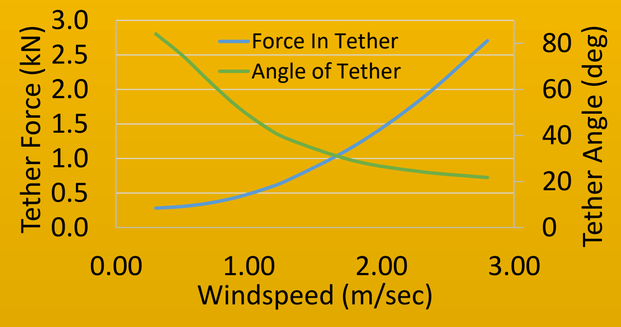
Architecture 3: Balloon w/ Para-wing

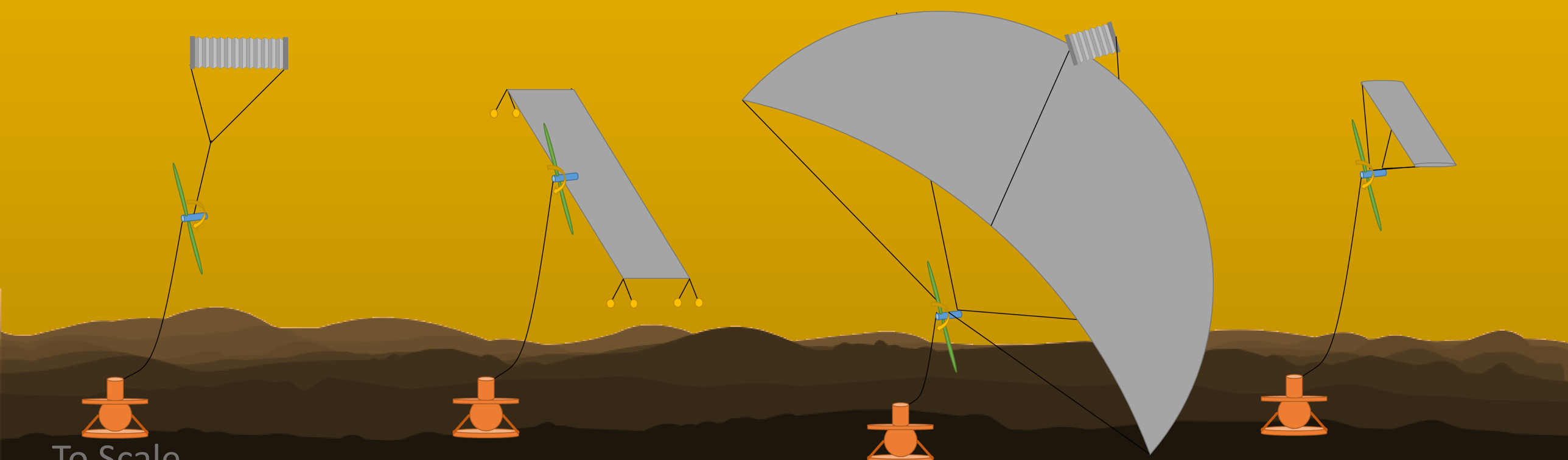
- Turbine is elevated by a balloon, which also deploys a 18x6m para-wing.
- Para-wing is "inflated" by wind and maintains altitude at 0.4 m/s regardless of buoyancy loss.



Architecture 4: Buoyant Wing

- Wing is inflated with a buoyant gas to provide both aerodynamic and lift effects.
- Results in high lift with minimal drag





To Scale
Except Tether

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