Solar UAS

Keane Garcia (ME), Arturo Rivera (EE), Andres Brooks (MAE), Tristin Jameson (MAE), Bryndan Gardner (AE)

New Mexico State University

NM STATE — BE BOLD. Shape the Future. College of Engineering

SOLAR UAS — NMSU CAPSTONE

Mission & Statement of Work

NMSU commissioned our capstone team to engineer a high-altitude, solar-powered UAV glider designed for climate research. The system was developed to deliver a long-endurance flight, modular payload capacity, and reliable atmospheric data collection under demanding environmental conditions.

The S.O.W included the following parameters:

- Integrate high-efficiency, solar-electric array
  - Power propulsion & onboard electronics
- Develop cost-effective flight platform
- Achieve sustained long-duration flight
- Enable multi-parameter climate sensing
  - Sensor selection (temperature, humidity, pressure)
- Optimize aerodynamic and thermal dynamics for high-altitude performance
  - Stability in various environments
- Conduct validation testing
  - Simulation-based performance evaluation
  - Solar cell performance evaluation

Our team successfully designed and fabricated a versatile UAV glider that not only meets but exceeds project requirements, positioning it as a valuable asset for future climate research.

Research

Wings:
High aspect ratio desired for high lift generation and large surface area for fitting more solar cells.

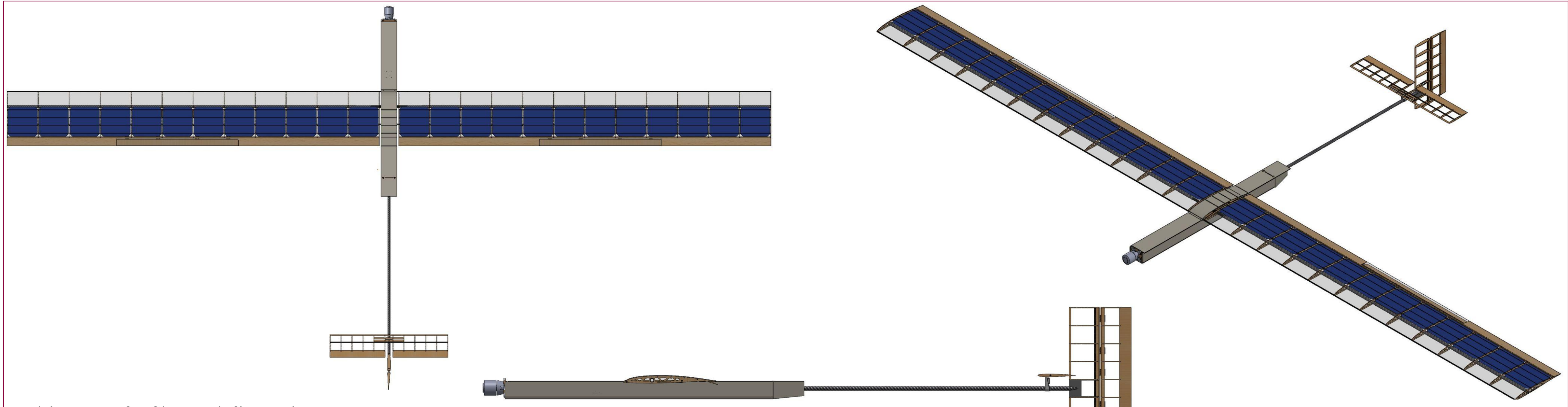
Other Solar Planes:
AtlantikSolar, SolLong Solar, and Airbus Zephyr.

Power Generation and Modularity:
Easily accessible and adjustable sensor package, high surface area for solar cells, high capacity battery and low energy sensor package.

RC Inspiration:
Heavy inspiration from RC aircraft to maintain flexibility, reliability, modularity, and adaptability for consumers.

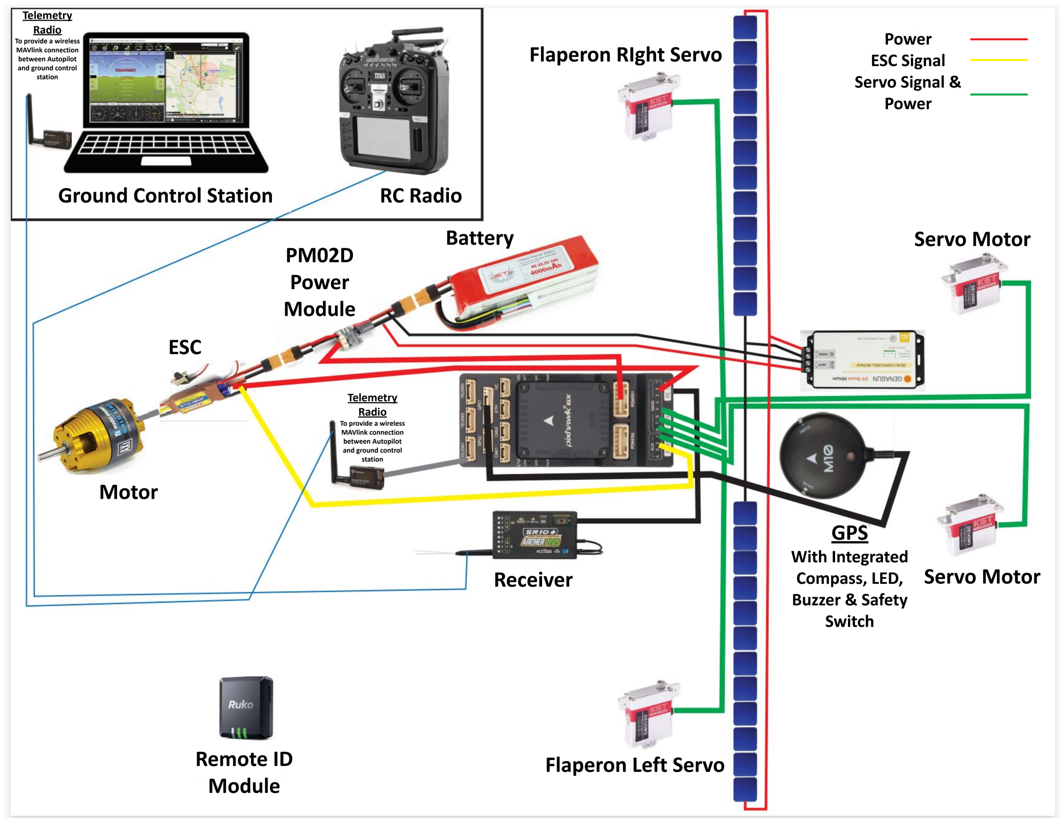
Solar Cells:
Solar cells need to generate high energy for their size, and have the necessary flexibility to endure flight forces.

Final Design



Aircraft Specifications

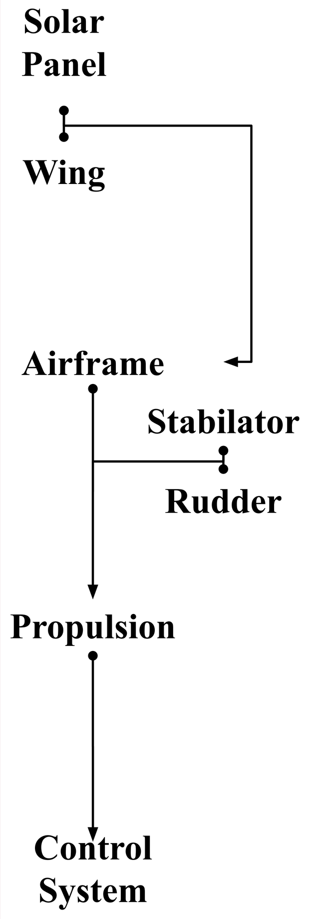
Wingspan:	4.2 m	Wing chord:	0.3 m
Length:	2 m	Weight:	3.8 kg
Cruising speed:	25 kt	Max Motor Power:	1250 W
Airfoils:	HQ258 (Wing)	Control surfaces:	Flaperons, stabilator, rudder
	NACA 0008 (Rudder and Stabilator)		
Solar cells:	24 (In Series)	Theoretical Flight Time:	4.0 Hr ± 30 min



Power and Control System

- Pixhawk 6x flight controller (autopilot and telemetry)
  - GPS, 3x redundant barometers and gyroscopes
  - Power module for battery voltage, amperage, amp hours
- FrSky Archer SR10+ receiver
- 5S, 35C, 4000 mAh battery
- AXI 4120/20, 465 Kv (rpm/V), 1150 W electric motor
- Jeti Advance Pro ESC, 70A
- 17 x 7 folding propeller
- Genasun GVB-8 (boost) MPPT solar charge controller
- (4x) KST digital servos

Design Flow



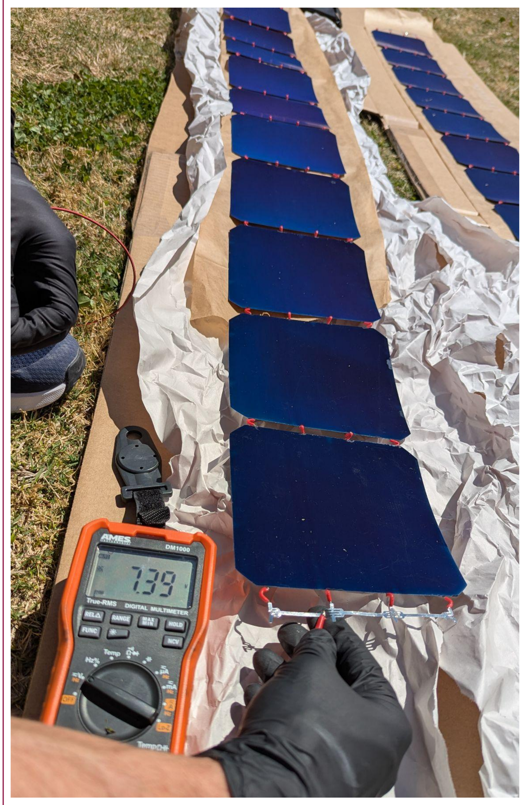
Solar panel design and specs determined the basis of the prototype; wing was designed around the cells.

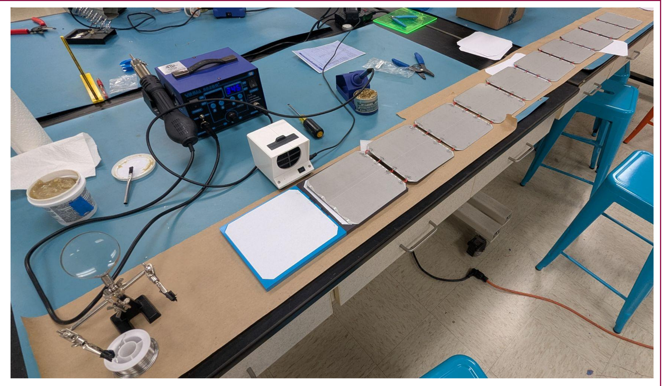
Wing design provided needed constraints to design aircraft dimensions and flight characteristics. Fuselage, stabilator, and rudder designs are derived from the design as a whole.

After the aircraft and designed flight domain were determined, propulsion could be found to suit the needs of the above design steps.

The control system is mostly tertiary and design-independent.

Solar Panel - Specifications & Performance





Sunpower Maxeon Gen 5 Solar Cell Array (24 cells)		
Ideal Max	Pmpp (Wp)	145
	Eff (%)	0.24
Max V MPPT should see	Vmpp (V)	14.6
Max I MPPT should see	Impp (A)	9.95
Open-Circuit (no load)	Voc (V)	17.4
Short-Circuit (max current)	Isc (A)	10.7
	Dimensions:	
	Cell Area (cm^2)	258.3
	Width (mm)	161.7
	Diagnal (mm)	211
	Weight (g)	278.4

Concept Development

Final Power System Simulation Results

Aircraft

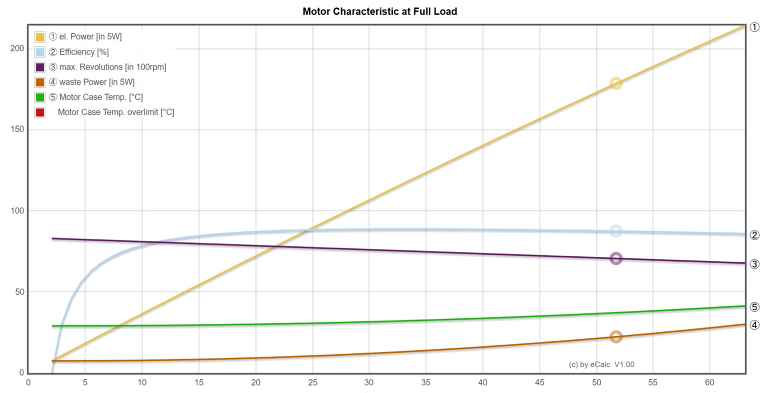
All-up Weight:	3800 g
Wing Load:	0.3 g/dm^2
Cubic Wing Load:	0.0
est. Stall Speed:	3 km/h
est. Speed (level):	11km/h
est. Speed (vertical):	3 km/h
est. Rate of Climb:	0.9 m/s

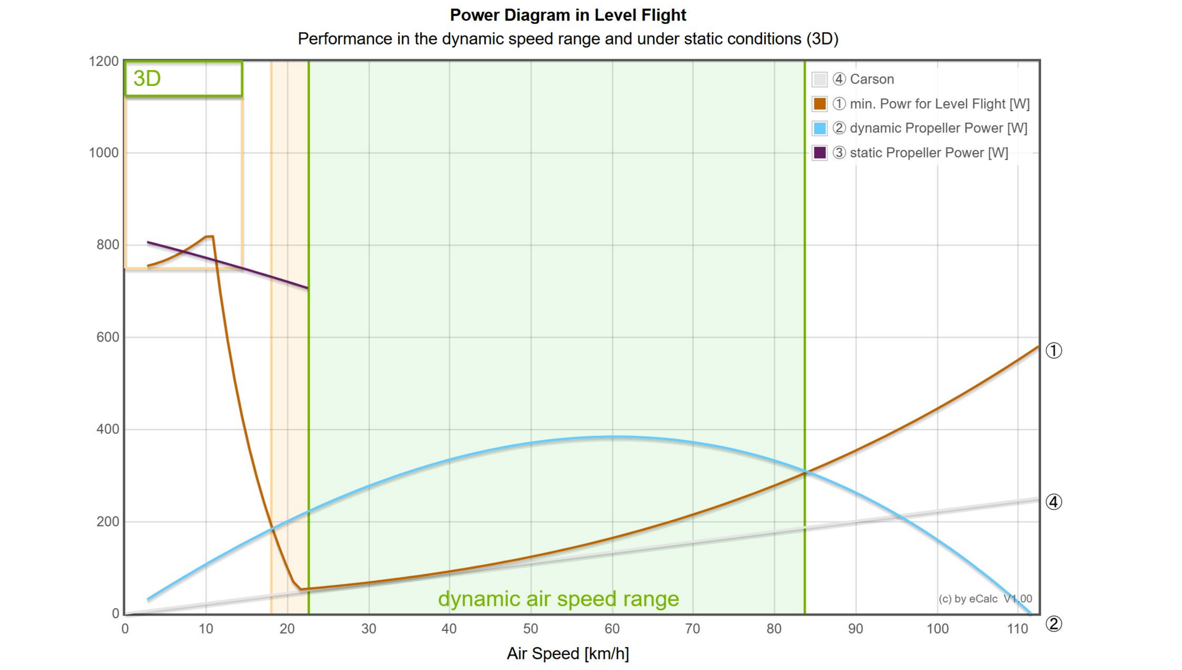
Motor @ Optimum Efficiency

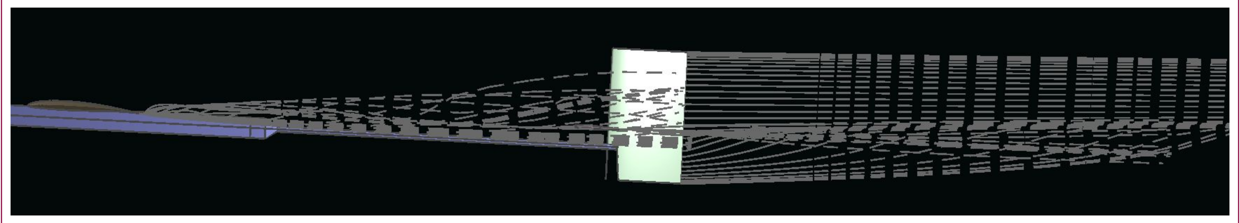
Current:	33.01 A
Voltage:	17.71 V
Revolutions:	7525 rpm
Electric Power:	584.5 W
Mechanical Power:	519.1 W
Efficiency:	88.8%

Motor @ Maximum

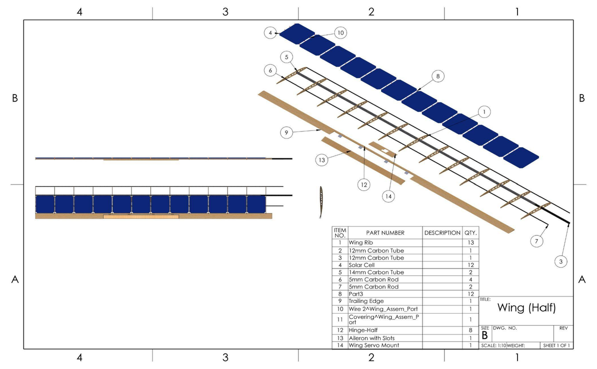
Current:	52.56 A
Voltage:	17.24 V
Revolutions:	7039 rpm
Electric Power:	906.0 W
Mechanical Power:	792.0 W
Efficiency:	87.4 %
Est. Temperature:	37℃

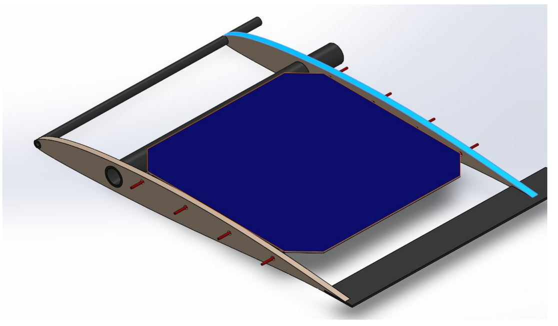






Solar Cell Mounting





Most design iterations occurred around the mounting configuration of the solar cells within the wing. The prototype features the cells connected with pre-bent wires resting on the wing ribs.

Design benefits:

- Wing bending isolation
- Vibration and thermal isolation
- Easy install and maintenance
- Does not interfere with wing covering

References

- www.atlantiksolar.ethz.ch
- www.maxeon.com/maxeon-solar-cells
- https://www.ecalc.ch/motorcalc.php
- www.research-collection.ethz.ch/handle/20.500.11850/265638
- www.atlantiksolar.ethz.ch/wp-content/downloads/publications/JFR_81hFlight_paper_final.pdf