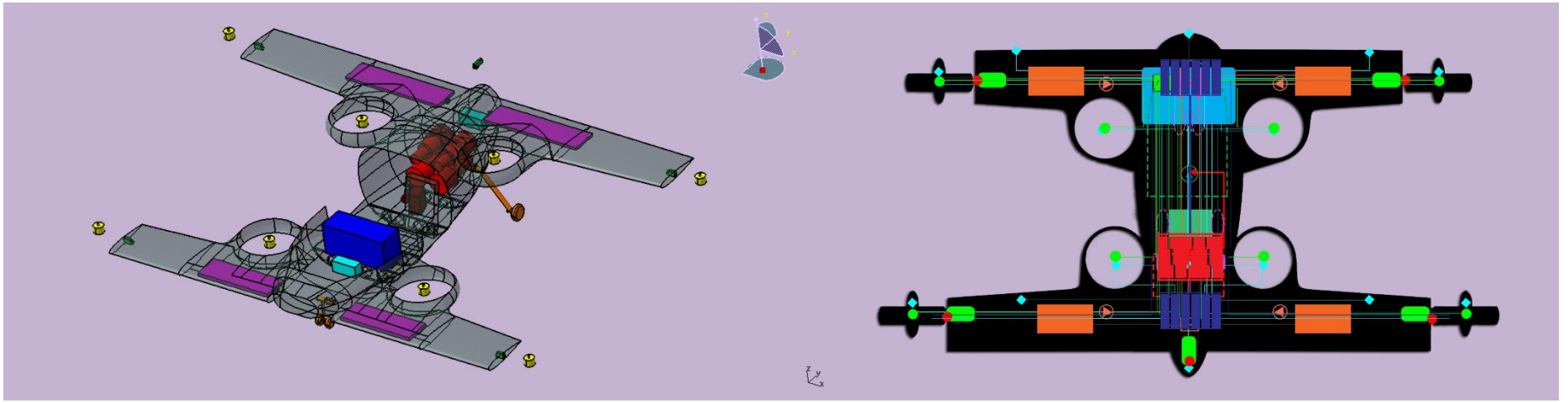
MINI-BEE: ON BOARD SYSTEMS INTEGRATION



Team POLITO:
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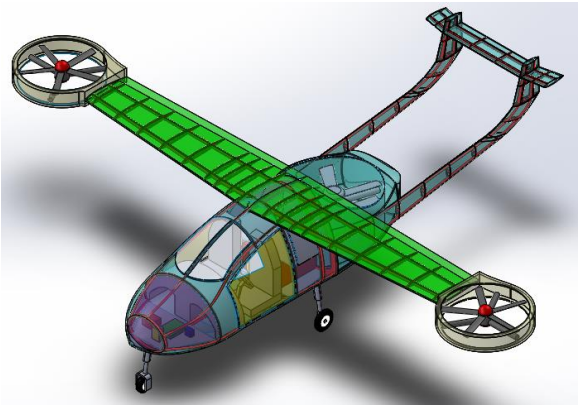
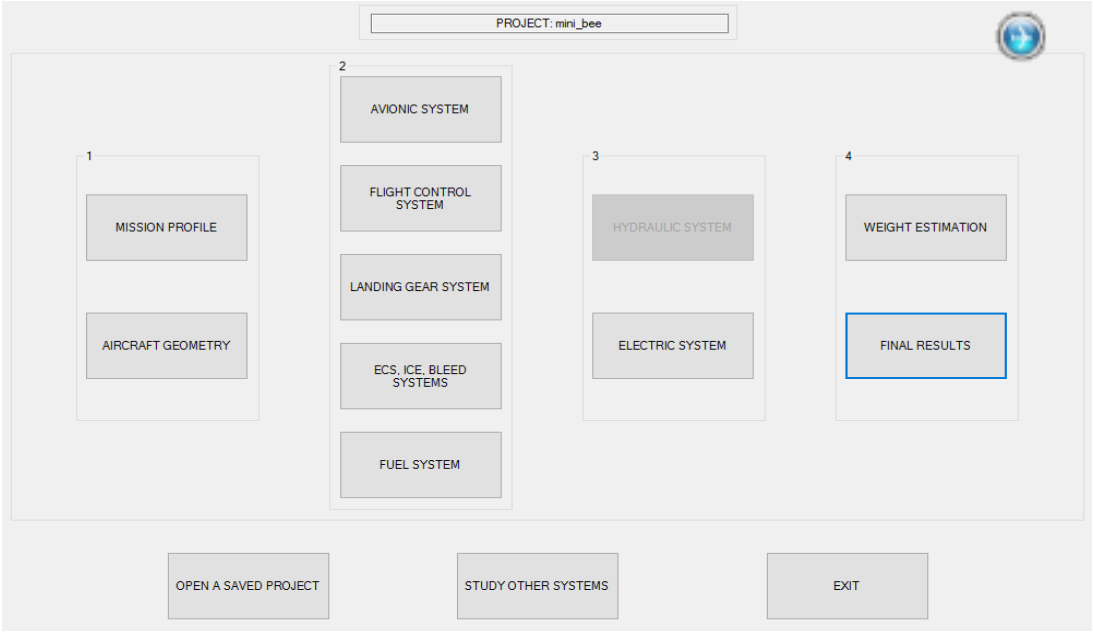
Francesco Viglione
Martin Samake
Alessio Vitali

Advisor:
Prof. Viola Nicole
Davide Ferretto
Roberta Fusaro

FIRST APPROACH

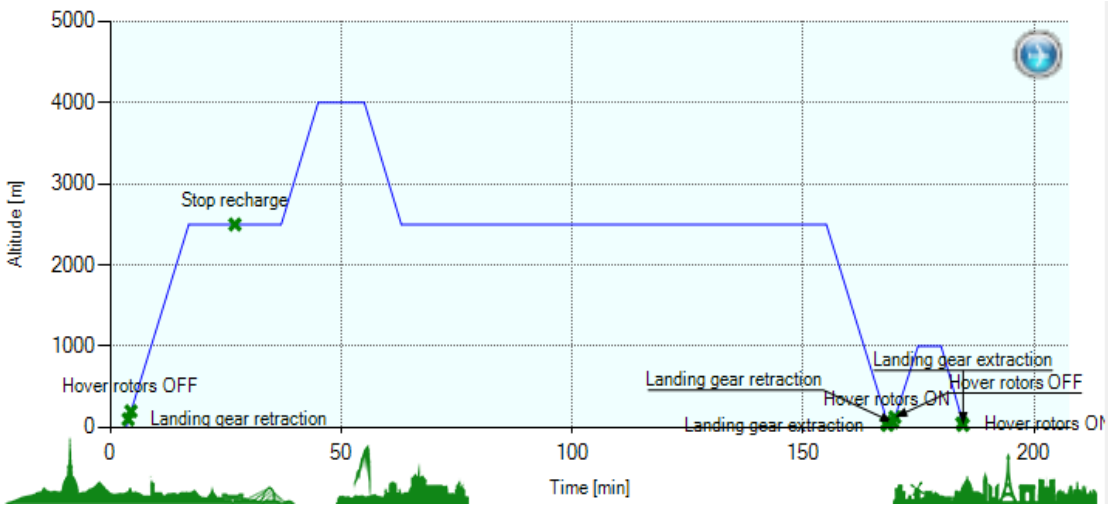
- Focus on on-board systems integration
- Alternative configuration
- Software used: SolidWorks & CATIA, ASTRID, X-Plane
- ASTRID =





REQUIRIMENTS AND MISSION PROFILE

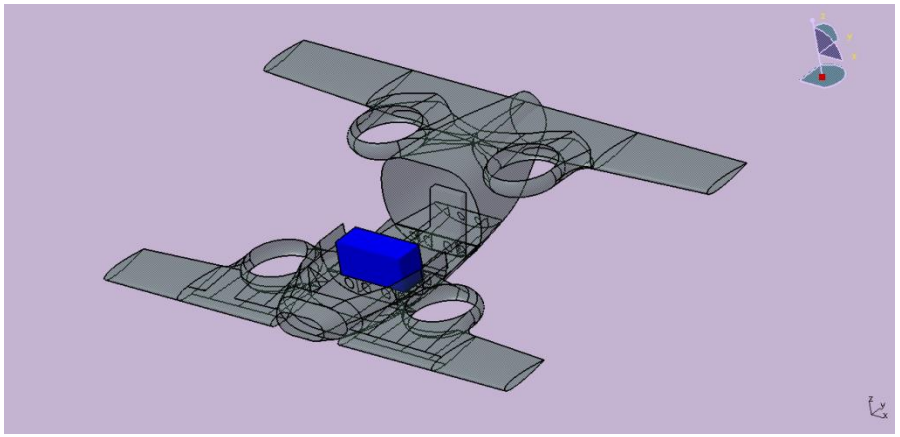
- Range: 600 km + 50 km
- Cruise Speed: 220 km/h
- Max Speed: 300 km/h
- Passengers/pilot: 2, 220kg
- VTOL & Hybrid Propulsion
- All-electric systems architecture

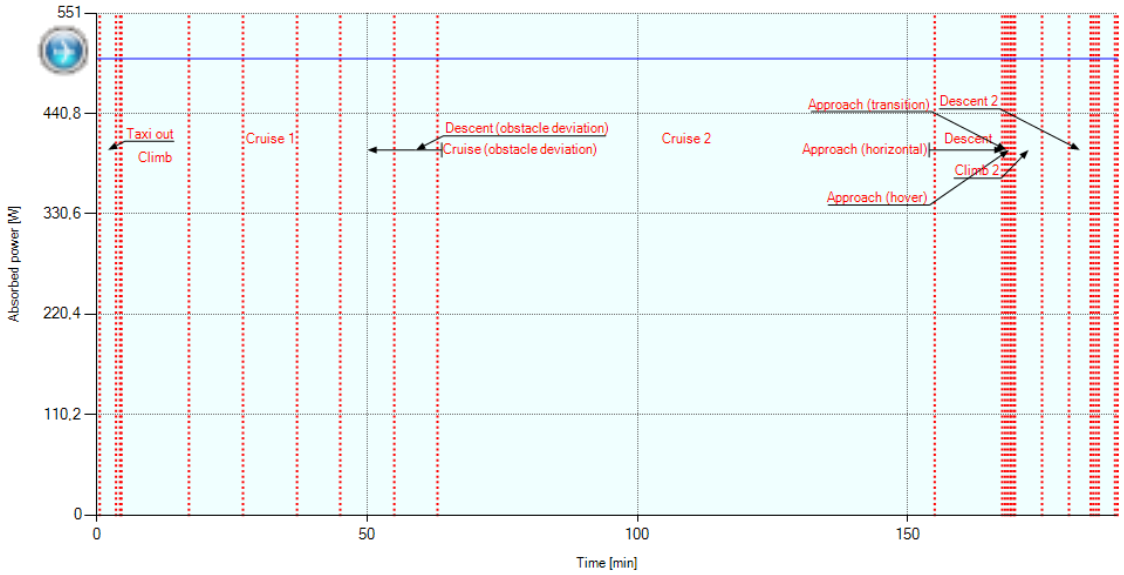


PLACIS

AVIONIC SYSTEM 1

- **Garmin G 1000**
- HUD **SAAB Aviguide**
- FCC: **Athena 311** by **Rockwell-Collins**
- Mass: **50 kg**
- Power used: **500 W**
- Volume: **0,11 m^3**





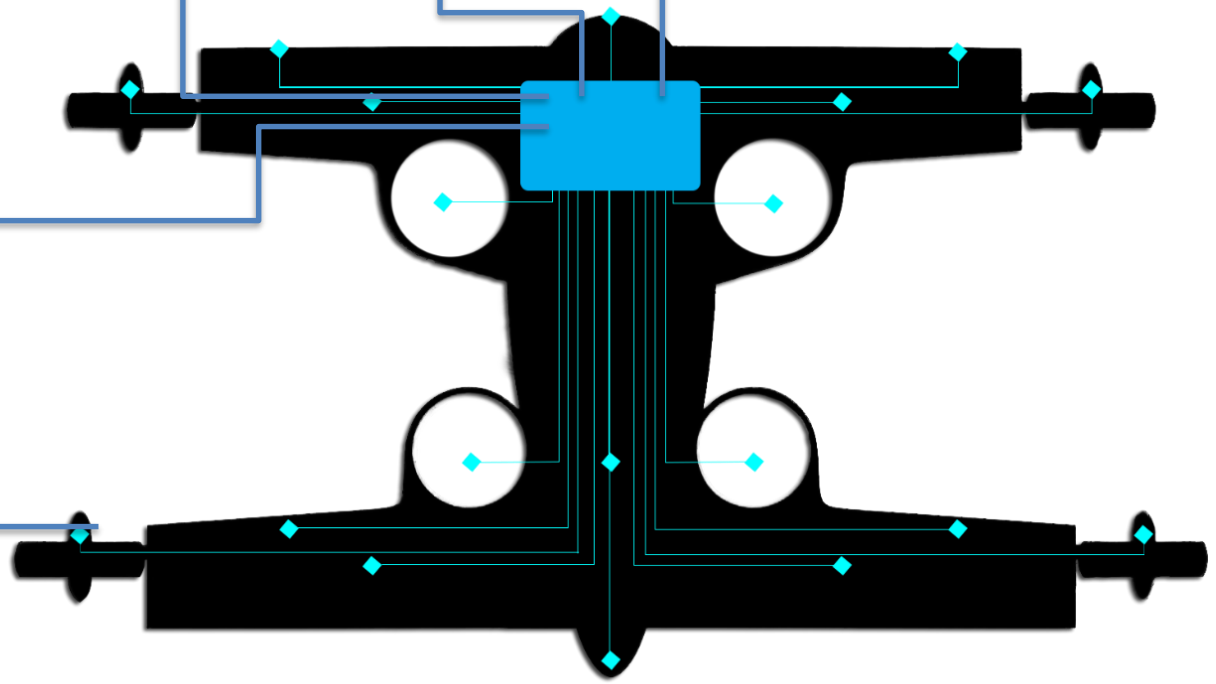
AVIONIC SYSTEM 2

G 1000

HUD Aviguide SAAB

3 x FCC Athena 311

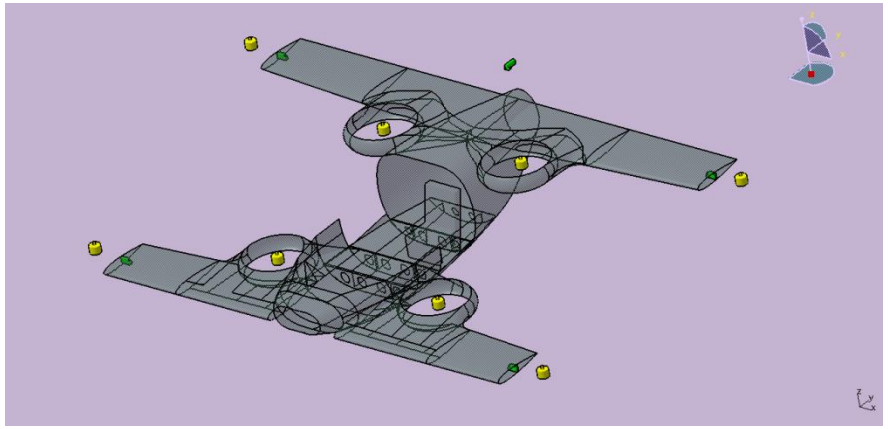
Sensors (G1000)

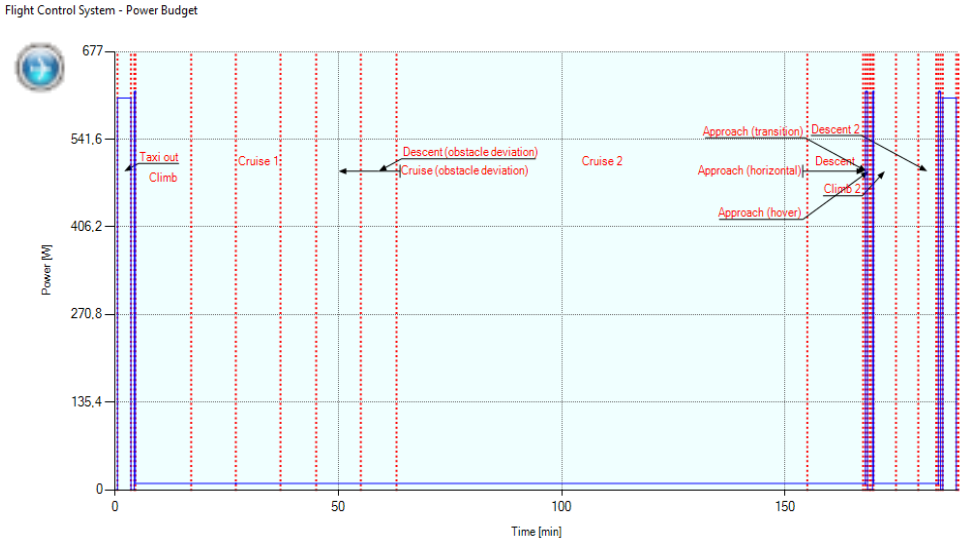


FLIGHT CONTROL SYSTEM 1

- Tilt rotors actuation:

  MOOG 965
- Rudder actuation: **CEF Industries 8618M80-mb**
- Mass: **31,76 kg**
- Power used: **605 W**
- Volume: **0,029 m^3**
- Optional: **MOOG 801** for blades adjustments

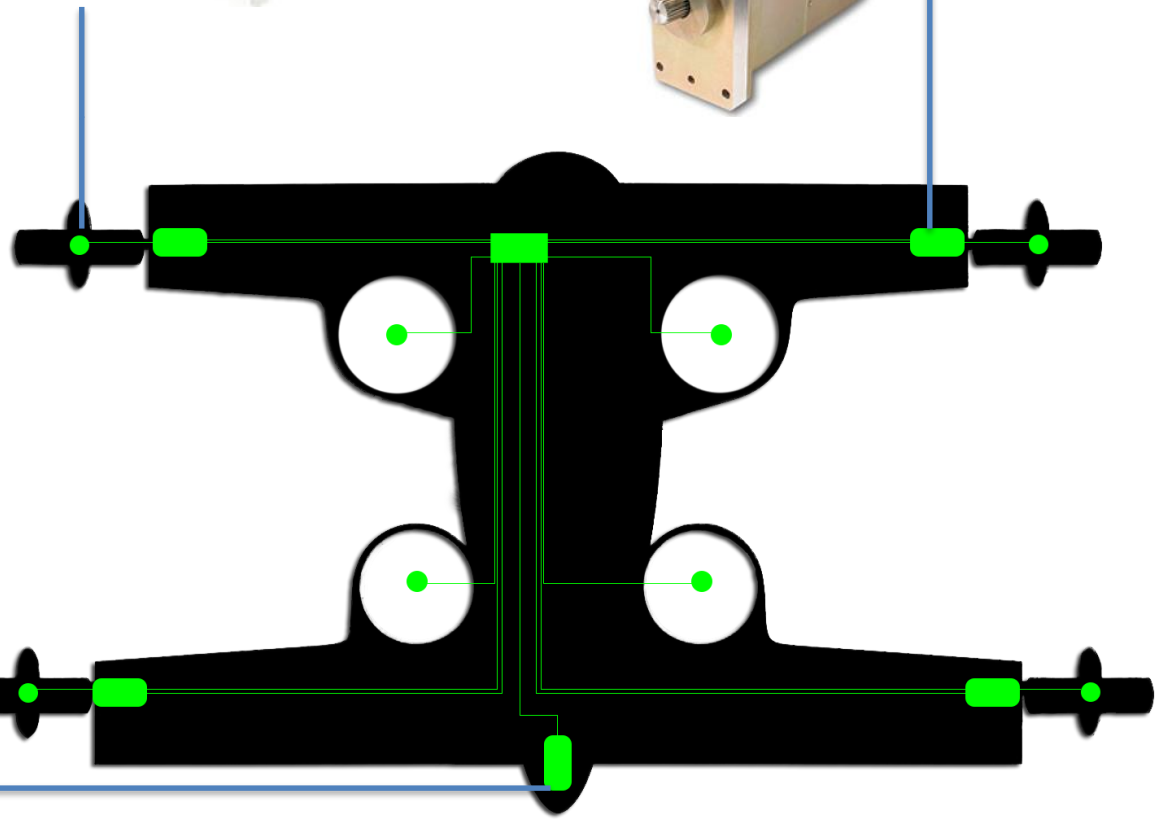




FLIGHT CONTROL SYSTEM 2

(Optional: 8 x MOOG 801 for blade adjustments)

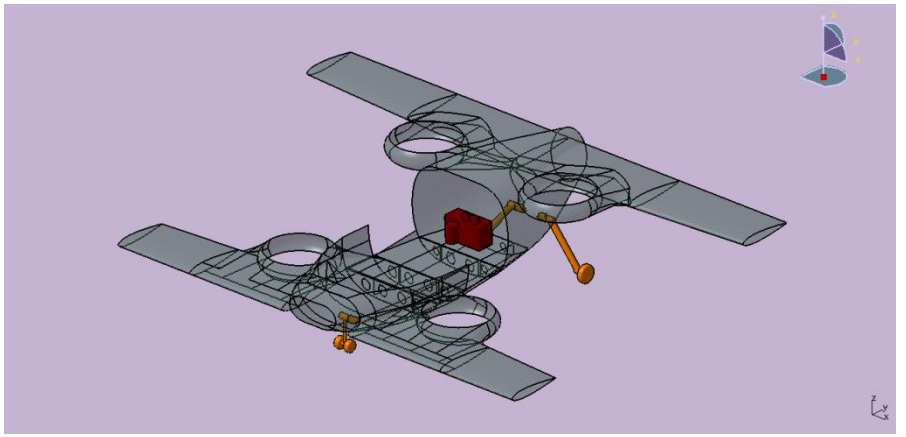
8 x MOOG 965



2 x CEF Industries 8618M80-mb

ECS, ANTI-ICE AND LANDING GEAR SYSTEMS 1

- ECS: **Kelly Aerospace Thermacool** Electric Air Conditionig System with **Vapor-Cycle, not Sub-Freezing CAU**
- Mass: **22,23 kg**
- Power used: **924 W**
- Volume: **0,2 m^3** (integrated with Garmin G 1000)
- **Anti-Ice**: Electric Resistances for tlit rotors and rudder hinges by **PYROMAX**
- Power used: **880 W**

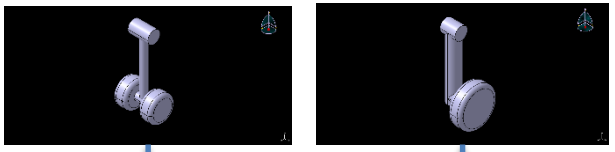


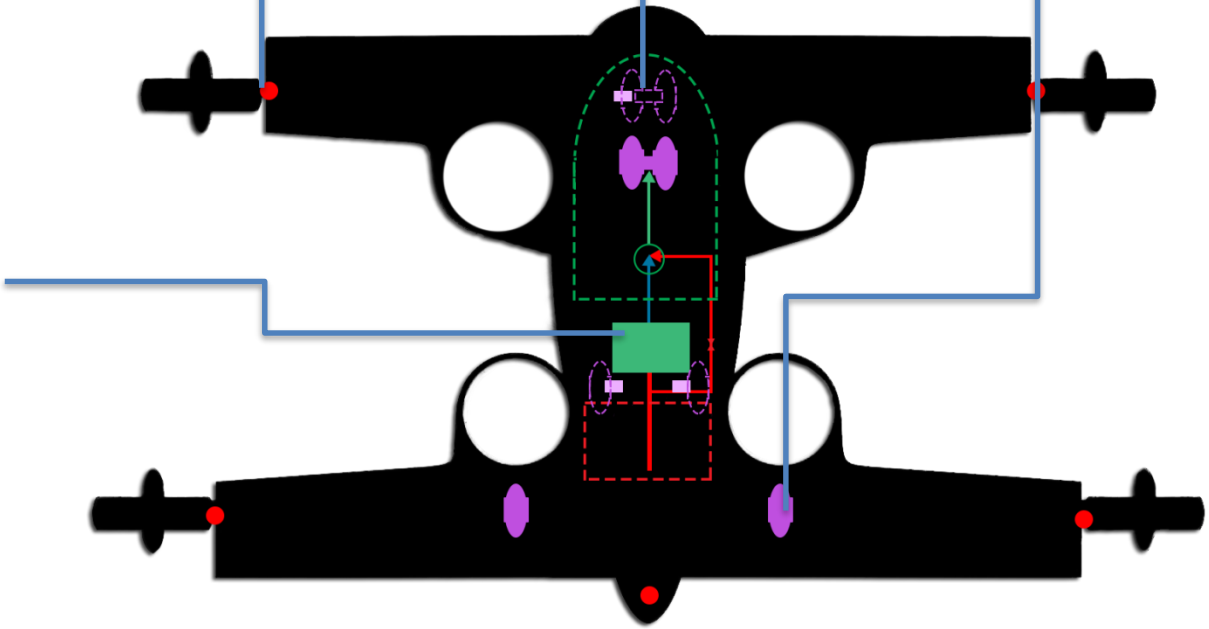
- Landing Gear: **Retractable tricycle** configuration with low breaking power
- Mass: **36,54 kg**
- Power used: **625 W**

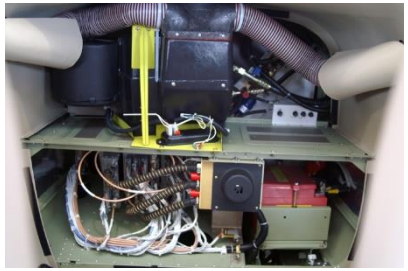
ECS, ANTI-ICE AND LANDING GEAR SYSTEMS 2

Series of Metallic Heating Elements (PYROMAX)

Landing gear: Front and main with their own actuators



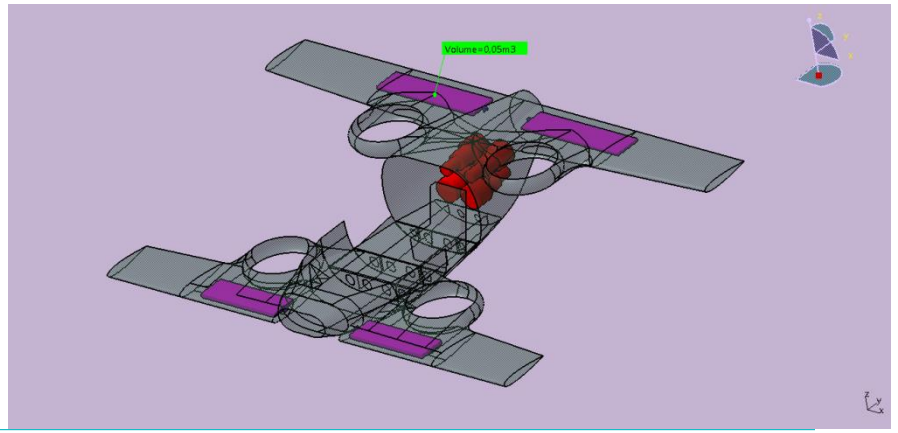


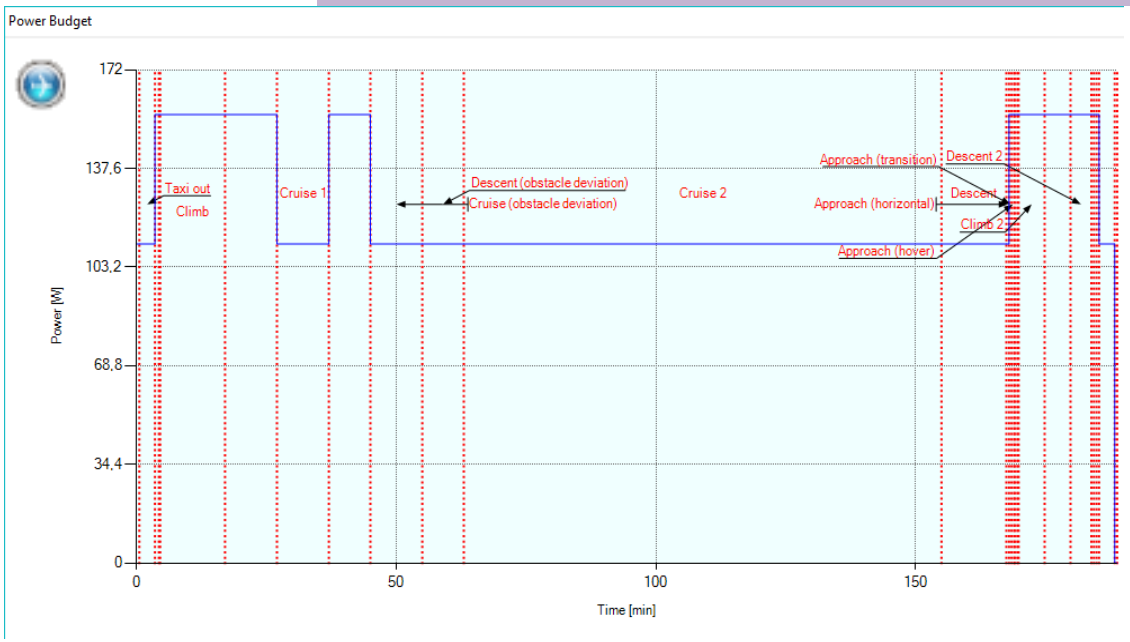


Thermacool Electric Air Conditionig (Kelly Aerospace)

FUEL SYSTEM 1

- 4 Tanks: **200 l** of fuel
- 8 Solid State Electronic Fuel Pump: **Facet Cube**
- Mass: **12 kg**
- Power used: **320 W**
- Volume: **0,17 m^3**
- Tanks are integrated with the airframe



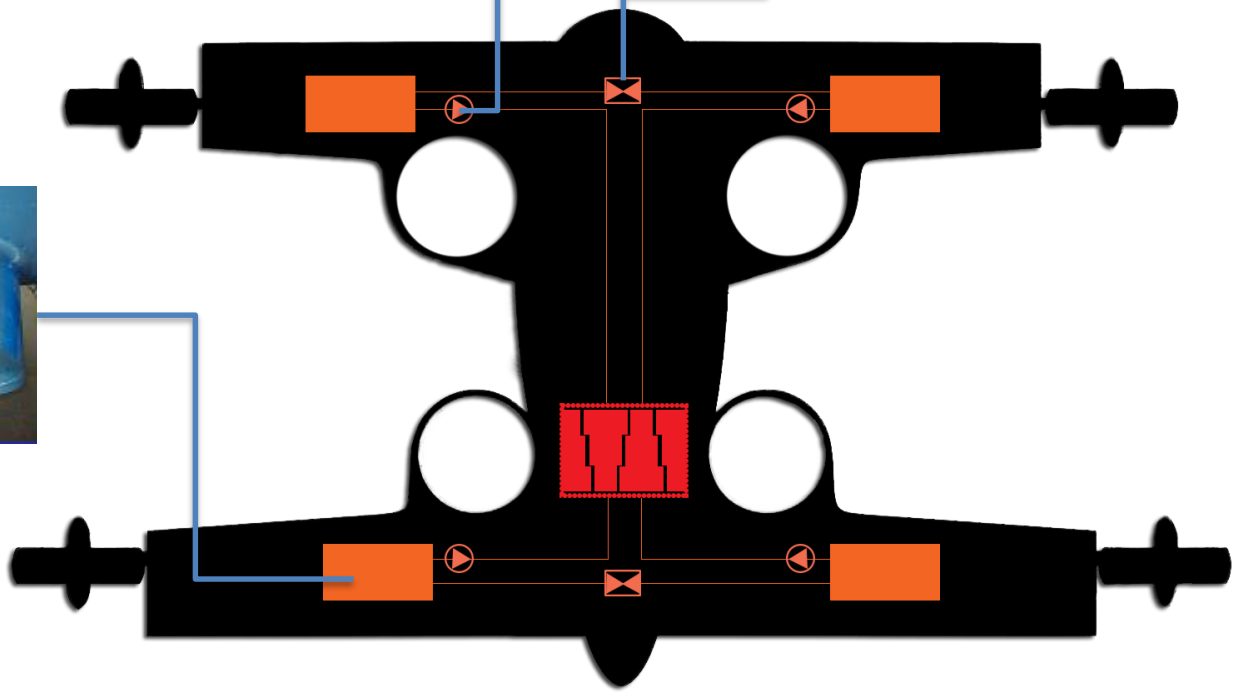


FUEL SYSTEM 2

8 x Solid State Electronic Fuel Pump (Facet Cube)

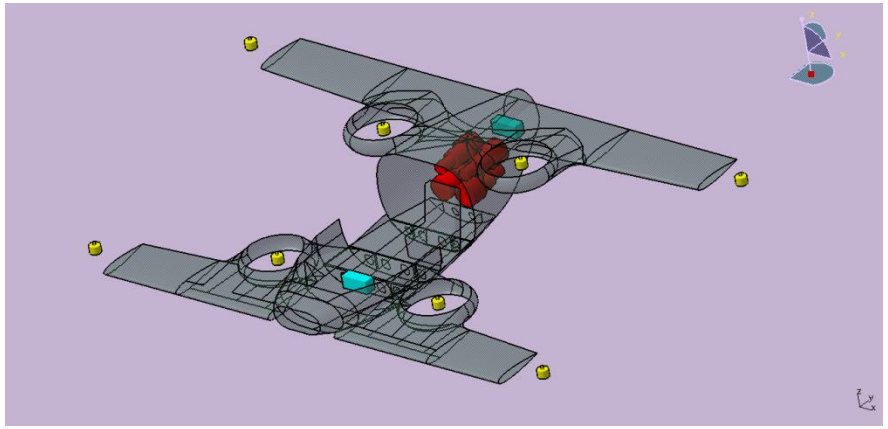
2 x Cross-Feed valve (SCOTT 4600)

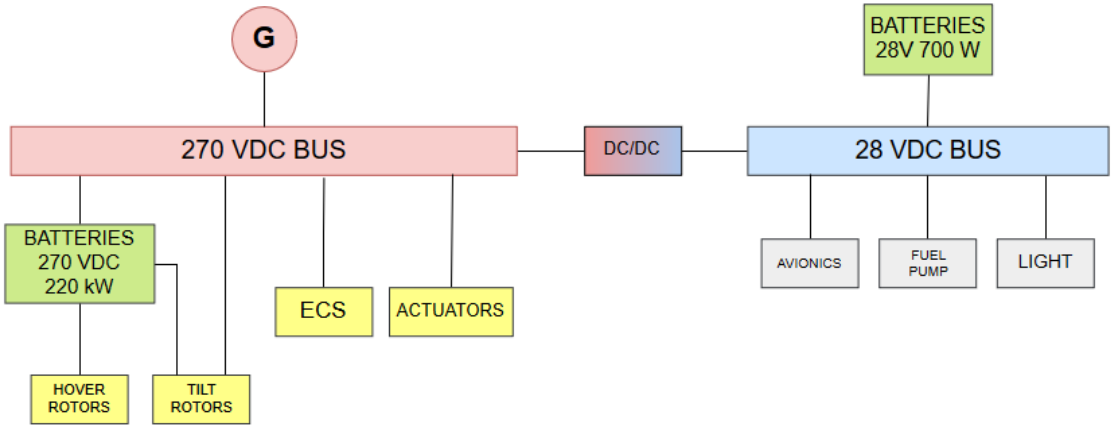
4 x integrated fuel tank



POWER GENERATION AND ELECTRIC MOTORS

- Li-ion batteries: 55 kg & 0.24 m^3
- 4 Engines: **Turbotech** Turbo Generator 160 kg
- 8 rotor electric engines: **Siemens DA36 eStar** 88 kg
- DC/DC converter
- Mass: **307 kg**
- Power installed: **440 kW**
- Volume: **0.78 m^3**

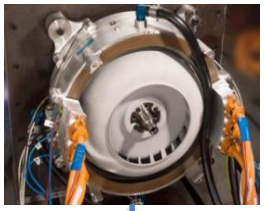




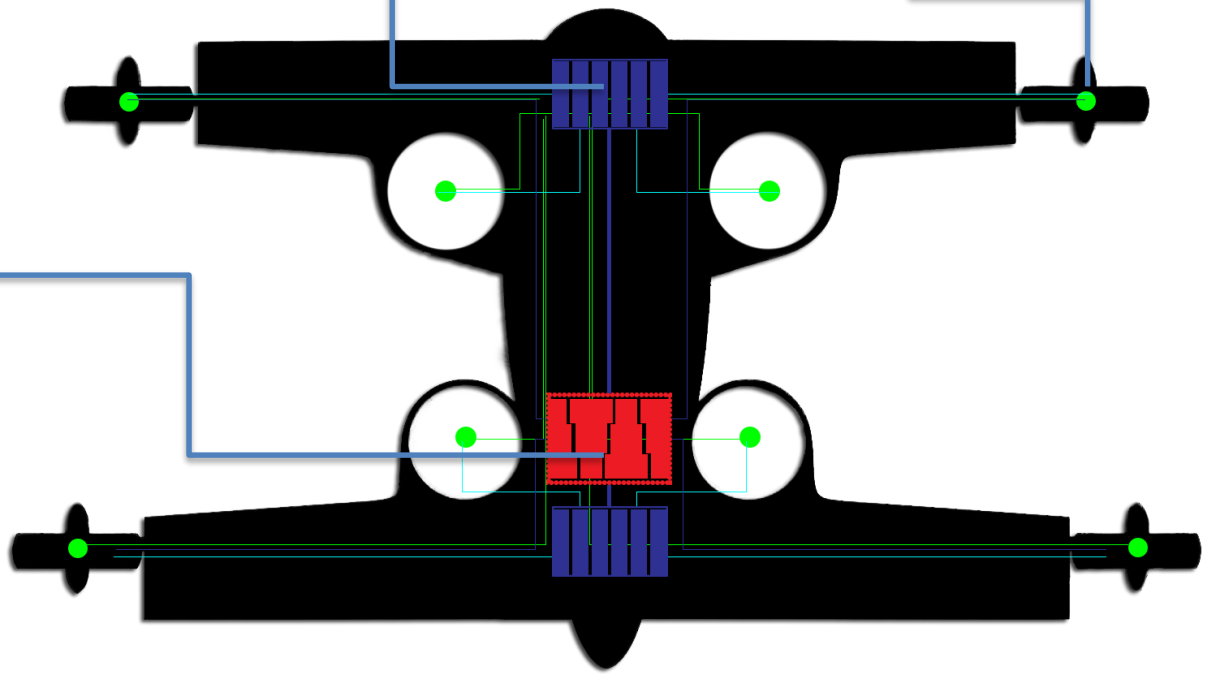
POWER GENERATION AND ELECTRIC MOTORS

55 kg of Li-ion batteries

8 x Siemens DA36 eStar engines

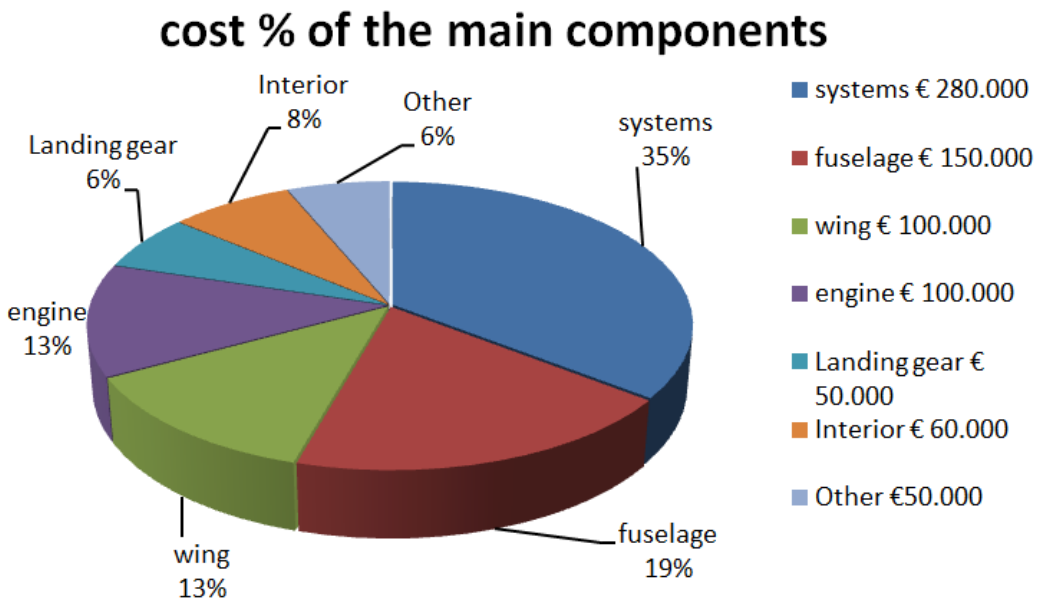


4 x Turbotech Turbo Generator



COST & RAMS

- Purchased price estimated [$] (from statistical data): **$ 798.720,00**
- Failure rate λ [failures/1000h]: **0,88**
- MMH/FH: **0,74**



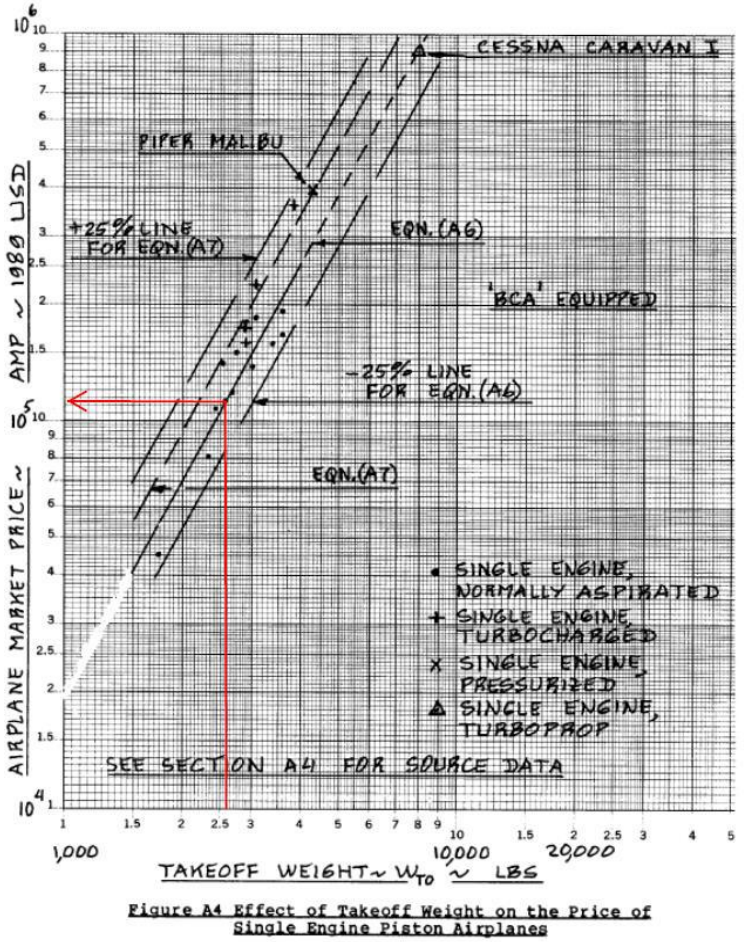
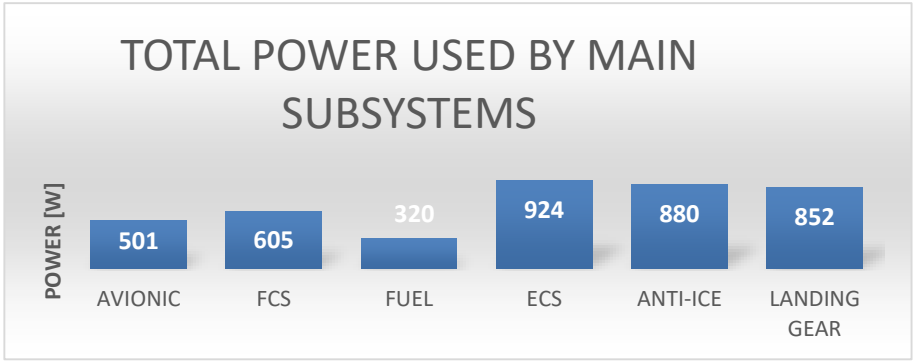
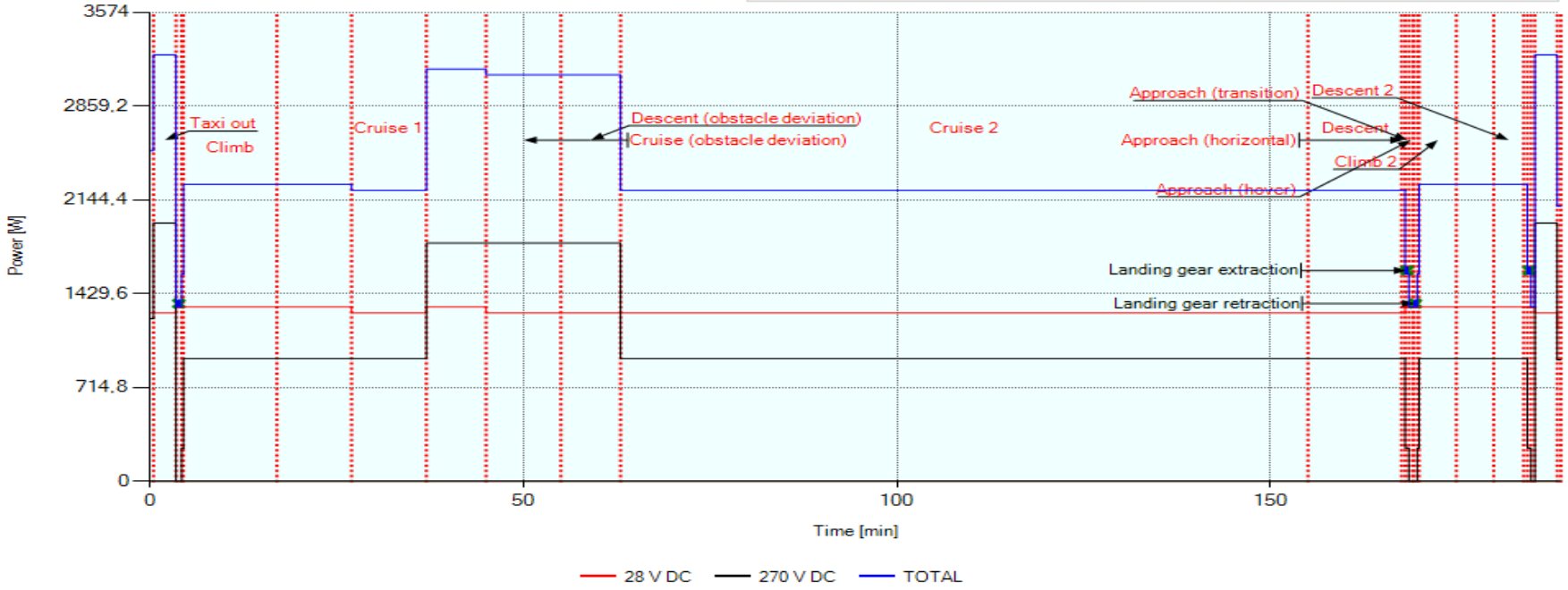


Figure A4 Effect of Takeoff Weight on the Price of Single Engine Piston Airplanes

FINAL RESULTS – SYSTEM POWER BUDGET

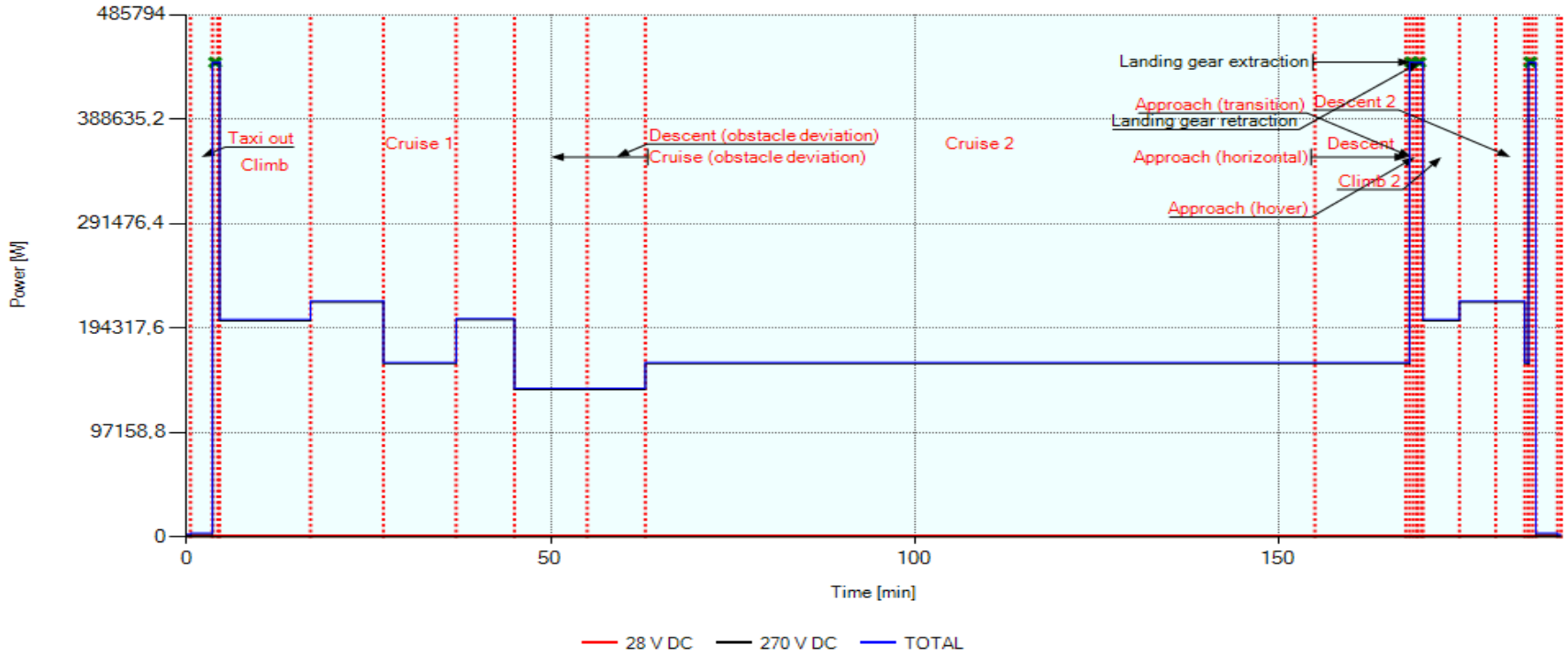
- Maximum required power by systems: **3.25 kW**





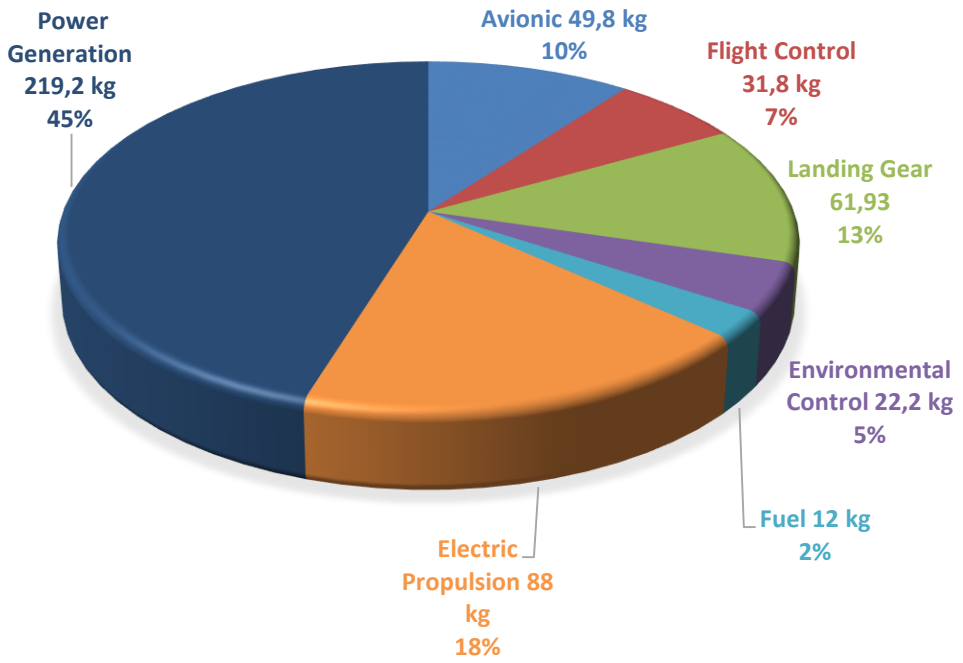
FINAL RESULTS – TOTAL POWER BUDGET

- Peak power: **441.5 kW** during transition from hover to horizontal flight
- Power used during cruise: **162 kW**
- Power used during recharge: **220 kW**

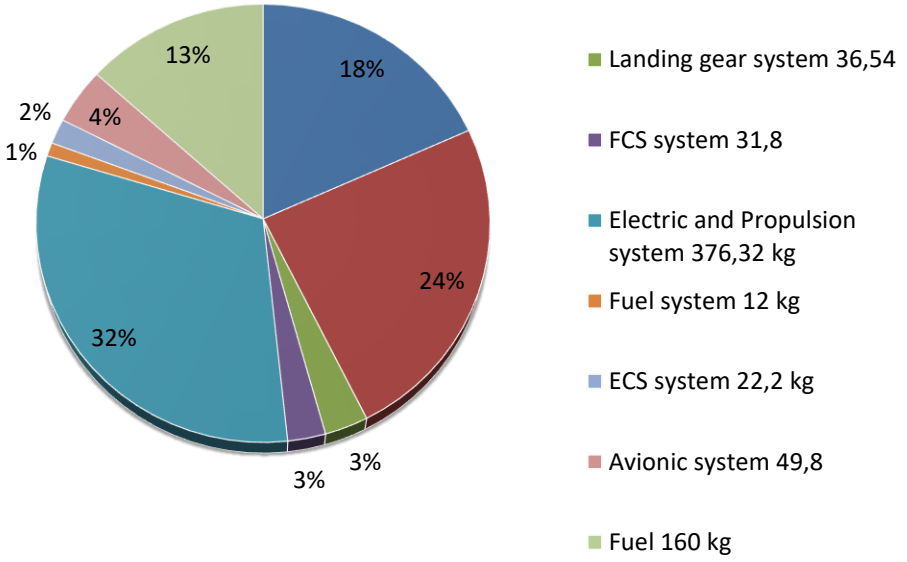


FINAL RESULTS – MASS BUDGET

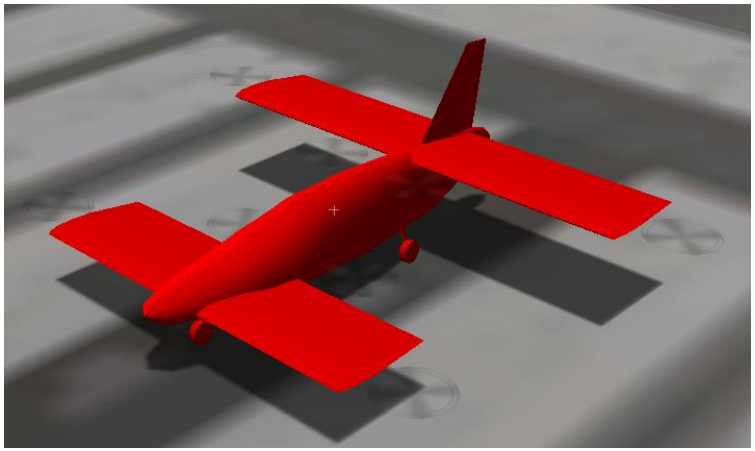
Systems mass breakdown



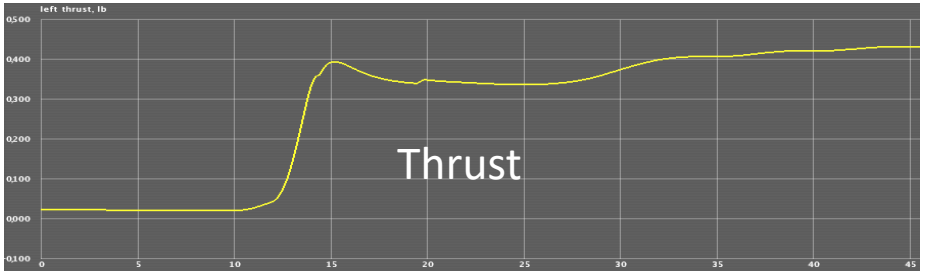
Overall aircraft mass breakdown

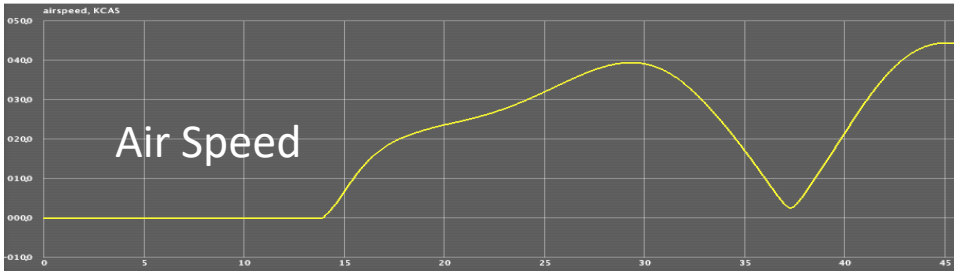


SIMULATION VIA X-PLANE



- Mock-up implementation
- Panel layout
- VTOL requirements verification





REMARKS

- Future improvements:
  - **Air intakes** should be considered; the sizing will be affected by:
    - Fuel generators requirements
    - Cooling system
    - Air conditioning unit
  - **Fixed/variable blade pitch tradeoff**

    (traditional control surfaces?)
  - **Aircraft layout configuration tradeoff**

    (More power for reaching 300 km/h)
  - Future **RAMS estimations**

    (Influenced by real operative scenario)

ANY QUESTIONS OR REMARKS?