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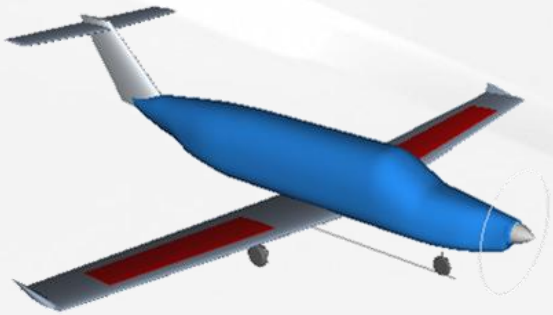
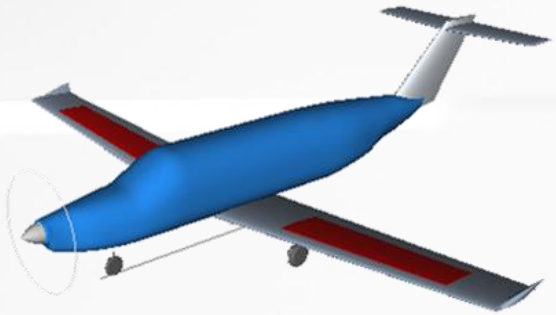




# MiCoVol

# Team: *Le Plewb Project*

*Harshini AICH, Shourya SARKAR, Shouvik BANDHOPADHYAY*

# DESIGN MISSION


**Milan Malpensa (LIMC)**

- 304.8 m above MSL
- 49 km from city

Milan-Malpensa Airport

SRN

Cortina d'Ampezzo Airport

San Vito (Approach Point)

**Cortina d'Ampezzo (LIDI)**

- 1200 m above MSL
- 4.5 km from city

Flight Path Distance: 300 km



90 km

N

# SUITABLE MODELS

- CS-23 certified aircraft
- < 10 passengers

*Pilatus PC-12*

*Cessna Grand Caravan*


*Daher Kodiak*

*Beechcraft King Air 90*

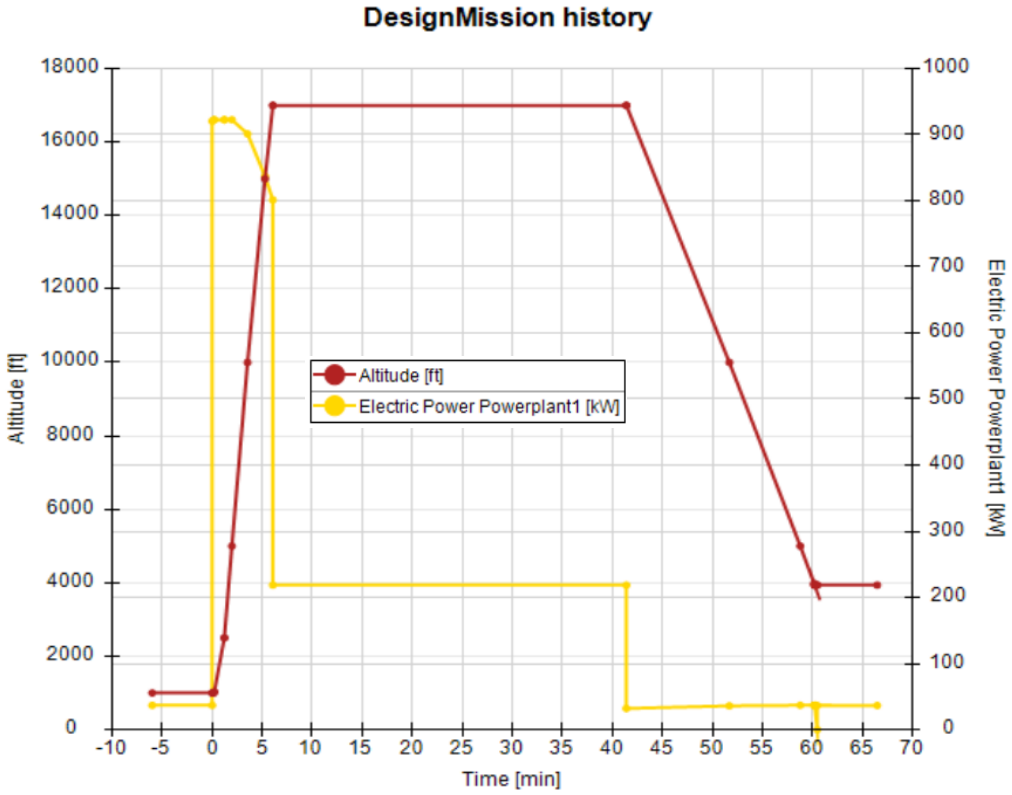
# AND THE WINNER IS...

- 9 passengers
- 4740 kg MTOW
- Range of 3400 km
- Template available in PACELAB APD

*Pilatus PC-12*

# KEY ASSUMPTIONS TAKEN

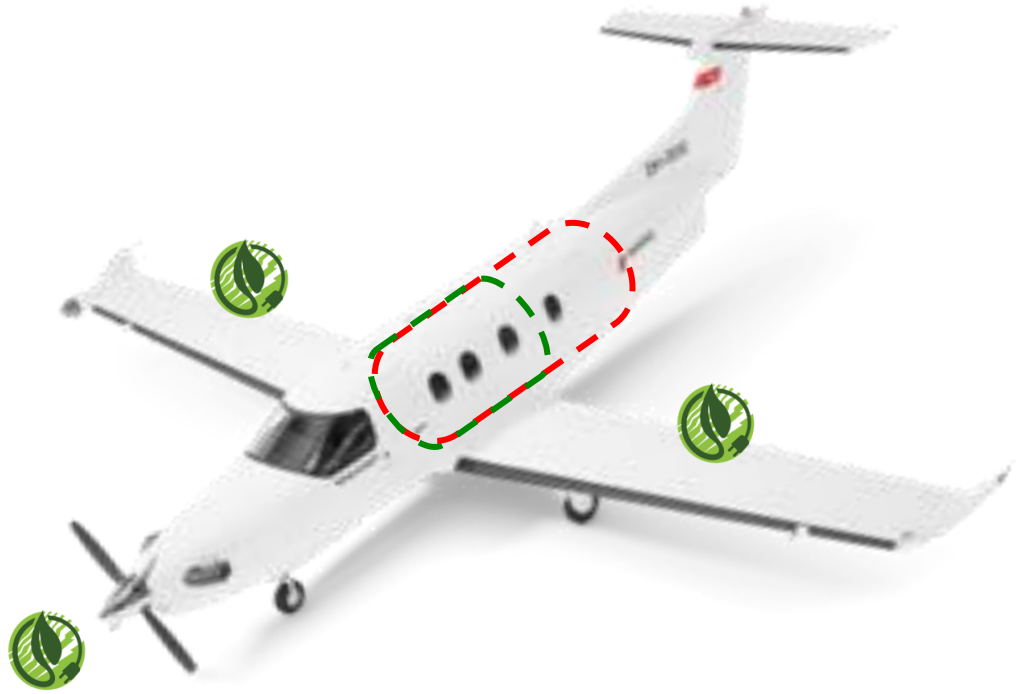
- 2022 technology energy levels considered[1]
- Default flight profile analysed:
  - Take-off, climb, flat cruise, descent, landing and taxi
- Sizing done for Milan (LIMC) to Cortina d'Ampezzo (LIDI)
  - Charging/battery swapping facility available
  - Round trip flight not considered




[1] http://pace-contest.euroavia.eu/regulations/

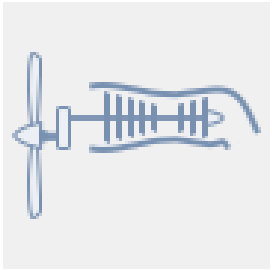
# MODIFICATIONS TO FLY ALL-ELECTRIC

1. Change powerplant type
    - Turboprop → Electric prop
2. Remove fuel tanks
3. Add battery compartments
4. Reduce payload
    - 9 seats → 4 seats



# CHANGING THE POWERPLANT TYPE

Turboprop
P&W
PT6A-67P

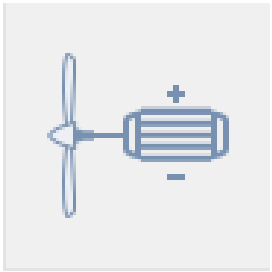


790 kW [1]

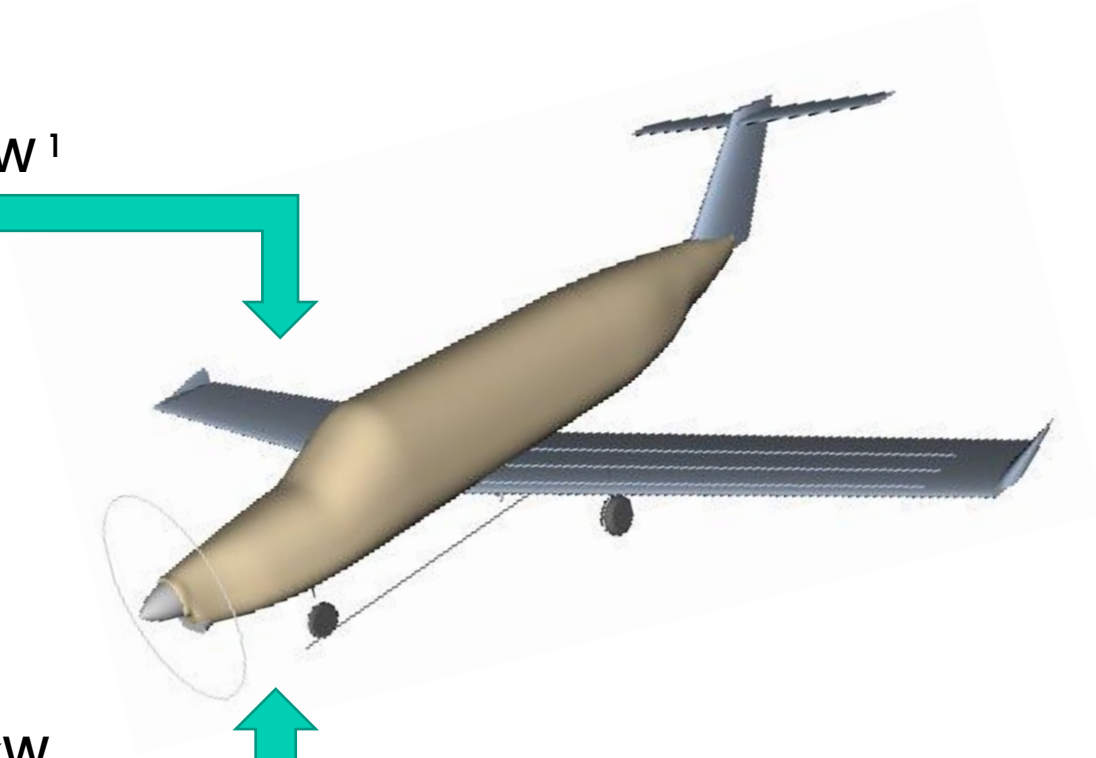
Factors considered for conversion to electric:

- System losses
- 20% margin for battery safety

Electric
Motor

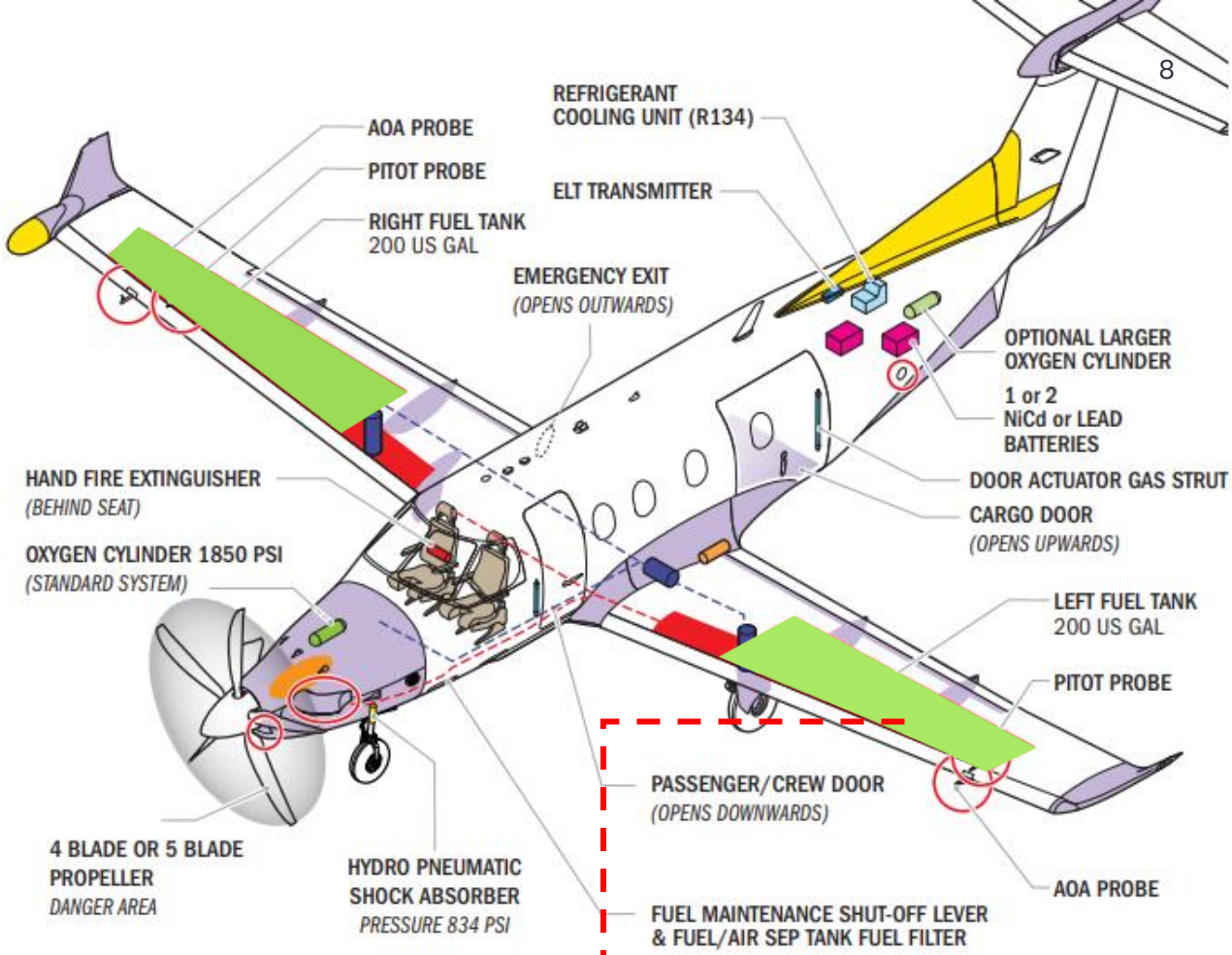


1157 kW



[1] https://www.pilatus-aircraft.com/en/fly/pc-12

# PLACEMENT & WEIGHT OF FUEL TANKS ON THE PC-12




Single tank fuel weight: **613 kg** [1]

[1] https://www.pilatus-aircraft.com/en/fly/pc-12
[2] Pacelab APD PC-12 Template Mass Breakdown

# BATTERY PLACEMENT

## Exact locations as the fuel tanks

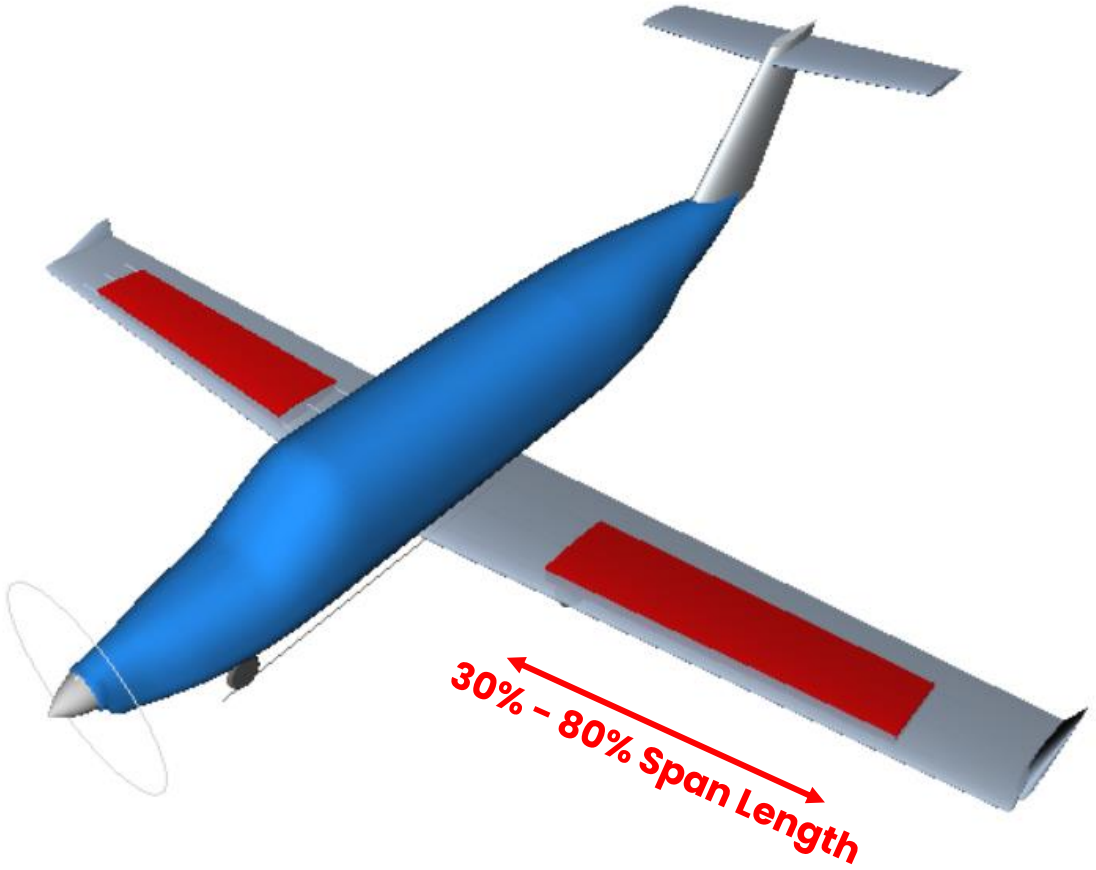
To place loads where the wing structure expects loads

## Avoid Main Landing Gear Compartment

Minimal interference with rest of aircraft structure & systems

## Battery Specifications @ 2022 Technology Levels

Specific energy = **210 Wh/kg**
Specific power = **1.365 kW/kg**




## Free Variables

**Nominal energy (kWh)**: design input
Battery mass (kg): design output

# CONVERGED DESIGN

Objective Design Solution

Key:

**Output**
***Optimised Output**
**Constraint**
**Iteration Variable**

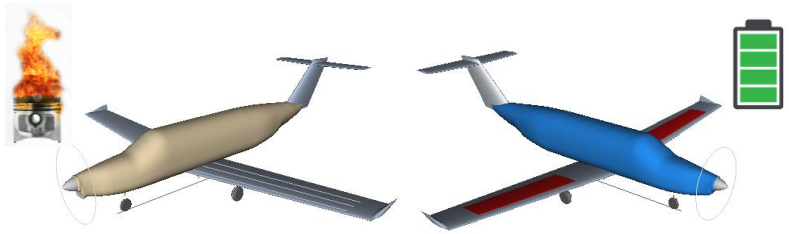
| Quantity | Converged Solution |
|---|---|
| MTOW* | 4930 kg |
| Mission Range | 300 km |
| Cruise Mach | 0.275 |
| Flight Time | 1 hr 4 mins |
| Single Battery Weight | 848 kg |
| Single Battery Nominal Energy | 148 kWh |

- Battery end state of charge 20% — Safe battery operation
- MTOW within CS23 limit of 5.76 tons — Meets MTOW constraints
- Return trip range = 305 km — Less demanding than LIMC → LIDI
- Cruise altitude = 13,000 ft — Meets ground clearance requirement

# MASS BREAKDOWN COMPARISON

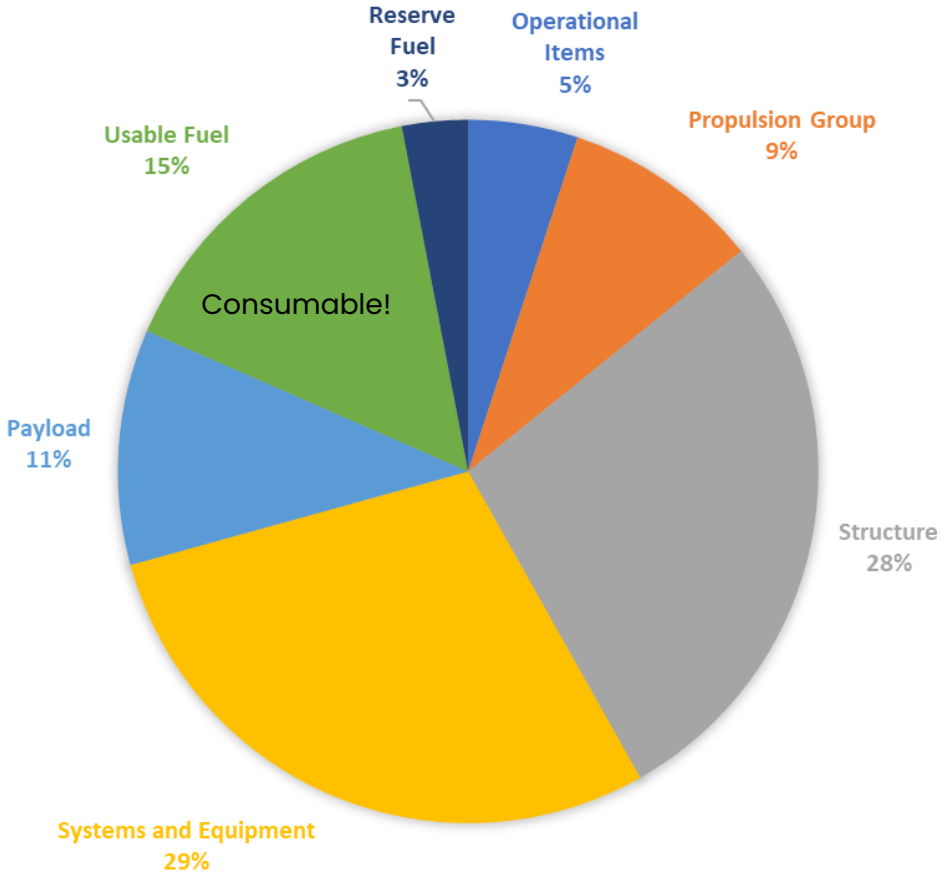
*PC-12*

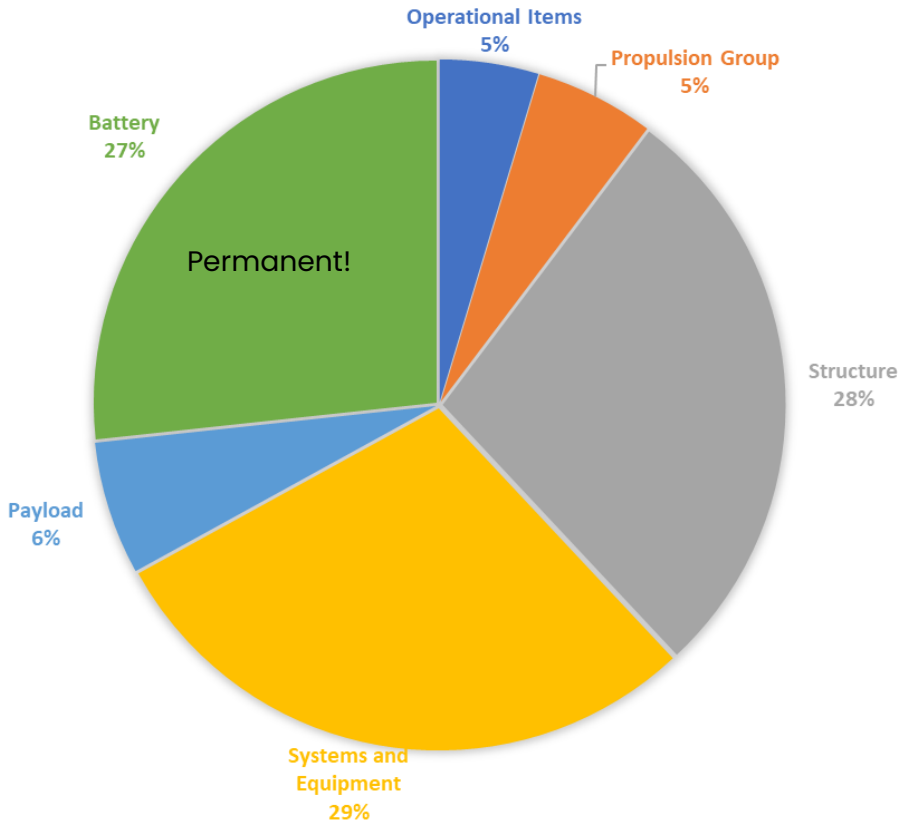
Converged MTOW: **4760 kg**



*MiCoVol*

Converged MTOW: **4930 kg**

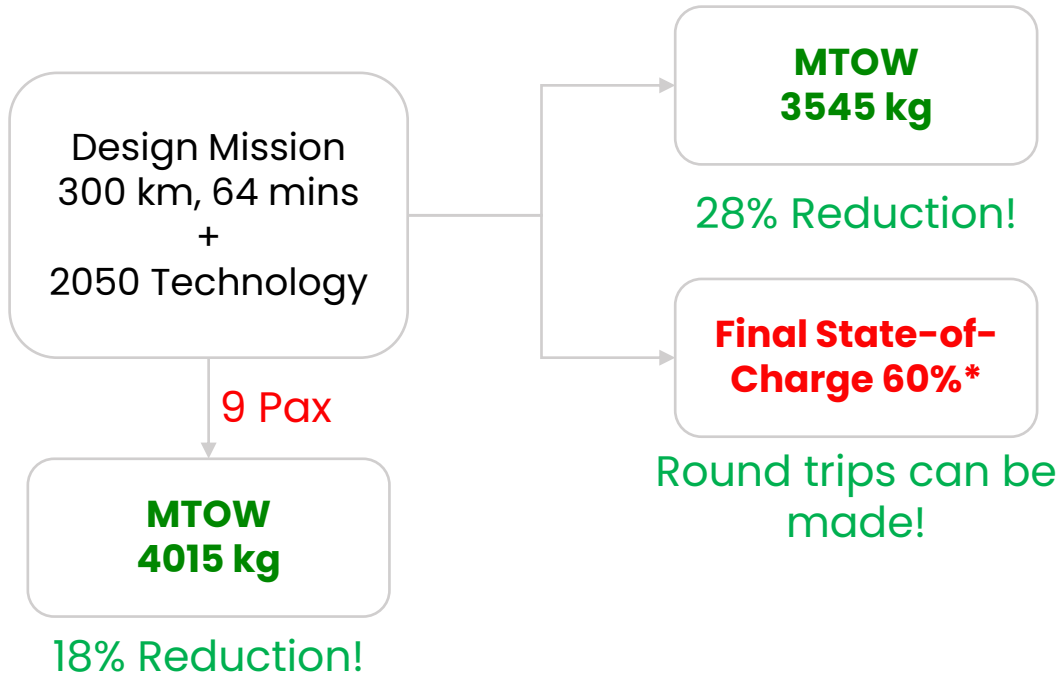


# CREATIVE DESIGN

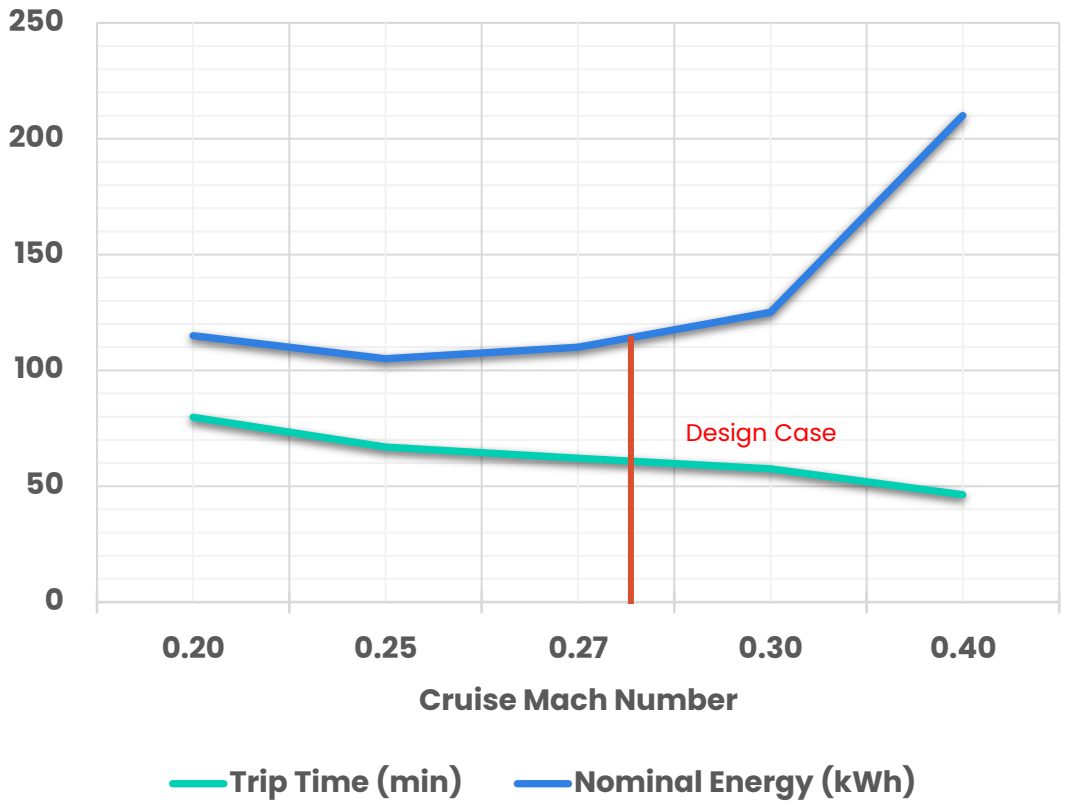
# IMPROVED BATTERY PERFORMANCE

- Objective design was done at 2022 battery and motor technology levels
- What happens if we use expected **2050 technology levels**?
- With this improved battery performance, what if the payload capacity is increased to 9 seats?



# OTHER TRADEOFF STUDIES

- Increase in **cruise altitude** 13,000 ft → 17,000 ft
  - Increases range by 4 km
  - But higher strain on battery, motor
- Variation in **cruise speed**
  - Faster cruise means shorter flights
  - Increase in battery nominal energy (and thus, MTOW)
  - Balance between lighter aircraft and shorter flight times



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# THANK YOU!