eVTOL Battery Power Density & C-Rate Estimate

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eVTOL Battery Estimator v1.0

Case: Passenger eVTOL baseline · vertical takeoff and hover screening

1. Inputs

Max takeoff mass `MTOW` **600.0 kg**	Rotor efficiency η_R **7.0 g/W**	Battery mass fraction k_B **33.3%**
Thrust-to-weight ratio `T/W` **2.0**	Energy density e_{sp} **300 Wh/kg**	Usable capacity factor η_u **1.00**

2. Key results

Required power density

> 857.1 W/kg

Recommended engineering target ≥ 860 W/kg

Required C-rate

2.86 C

Based on e_sp = 300 Wh/kg, recommend 2.9 C or above

3. Calculation basis

$p_{sp} > 1000 \cdot (T/W) / (\eta_R \cdot k_B) = 1000 \times 2.0 / (7.0 \times 0.3333) = 857.1$ W/kg

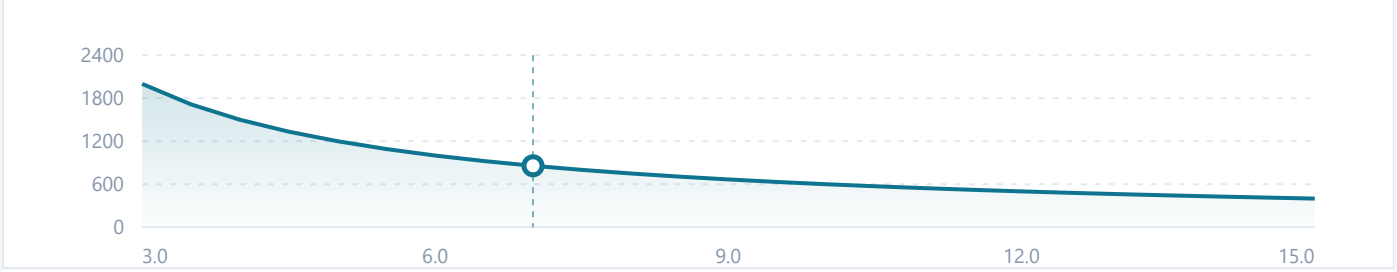
$C_{req} = p_{sp} / e_{sp} = 857.1 / 300$ Wh/kg $= 2.86$ C

$t = k_B \cdot e_{sp} \cdot \eta_u \cdot \eta_R / 1000\ (T/W=1) = 42.0$ min | $P = 1000 \cdot (T/W) \cdot MTOW / \eta_R = 171$ kW

4. Candidate comparison

Name	e_{sp} (Wh/kg)	C	Effective power density (W/kg)	Margin	Verdict	Endurance (min)
High-rate cell A	280	4.00	1120.0	+30.7%	Pass	39.2
High-energy cell B	330	2.60	858.0	+0.1%	Marginal	46.2
Low-cost cell C	250	2.00	500.0	-41.7%	Fail	35.0

5. Sensitivity



X axis: Rotor efficiency (g/W); Y axis: required power density in W/kg.

6. Conclusion

At thrust-to-weight 2.0, battery mass fraction 33.3% and rotor efficiency 7.0 g/W, the battery must exceed 857.1 W/kg (recommended engineering target 860 W/kg). With a cell of 300 Wh/kg energy density, its continuous discharge rate must be at least 2.86 C (recommend 2.9 C or above). This corresponds to about 200.0 kg of battery, peak battery power of about 171 kW, and a hover-only endurance limit of about 42.0 min. The power density requirement is met by 1 of 3 candidates, with another 1 in the marginal band (margin below 10%).

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This tool is for preliminary sizing only and covers power density / C-rate demand in vertical takeoff and hover. Climb and forward-flight power, temperature and SOC effects on usable C-rate, wiring and inverter losses, and redundancy or failure cases are not included. Use measured data and a full power-profile simulation for final design.