

[UAV Battery Efficiency Estimator — Quick Start Guide](#)

Unicode safe PDF • Updated to match current app behavior • 2025 10 23

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[WHAT THIS APP DOES](#)

- Estimates dispatchable endurance, distance, thermal T , and detectability for various UAVs.
- Models battery/fuel draw with atmosphere, gusts, terrain, stealth loadout, and mission mode.
- Supports ICE (MQ 1/MQ 9) with BSFC and optional Hybrid Assist; battery fixed wing and rotorcraft branches.
- Includes AI/IR Detectability Alert, LLM Mission Advisor (with graceful fallback), and Swarm Advisor.
- Exports individual results and scenario summaries as CSV/JSON; includes mission playback + waypoint exports.

[INSTALL & RUN \(local\)](#)

- 1) Python 3.10+ recommended.
- 2) Install dependencies:
`pip install streamlit matplotlib pandas`
(Optional LLM client): `pip install openai`
- 3) Save the script as: `Final_Full_App.py`
- 4) Run:
`streamlit run Final_Full_App.py`

[FAST START \(first demo\)](#)

- Model: “ Quantum Systems Vector ”
- Flight Mode: “ Forward Flight ”
- Battery Wh: default from profile
- Speed: 30 km/h Wind: 10 km/h Gust: 2
- Altitude: 0 m Temp: 25 ° C
- Stealth & Terrain: leave defaults
- Click “ Estimate ” to view Endurance, Ranges, Thermal, Detectability and Details. Try “ Swarm Advisor ” and the playback slider.

[UI MAP](#)

Top — Digital green title + caption — Debug toggles (optional): Debug Mode, Battery Override (guarded)
Model Section — Drone Model selector (full profile list) — AI Capabilities + base weight, max payload, power system, type
Flight Modes — Fixed wing: Forward Flight, Loiter, Waypoint Mission — Rotor: Hover, Forward Flight, Loiter, Waypoint Mission
Main Form — Battery Capacity (Wh) [clamped unless debug override] — Payload (g) [validated against max]
— Speed (km/h), Wind (km/h), Temperature (° C), Altitude (m), Elevation Gain (m)
— Flight Mode (see above) — Cloud Cover (%), Gust Factor (0 10), Terrain Complexity (× 1.0–1.5), Stealth Drag Factor (× 1.0–1.5)
— Failure Simulation (checkbox)

[ICE PANEL \(MQ 1/MQ 9 only\)](#)

— Fuel Tank (L), C_{D0} , Wing Area S (m²), Wingspan b (m), Oswald e , Propulsive η_p
— BSFC (g/kWh), Fuel Density (kg/L)
— Hybrid Assist: fraction 0.05–0.30, duration 1–30 min (battery substitution)

[SWARM & STEALTH](#)

— Swarm Advisor enable, size (2–8), rounds (1–5)
— Stealth Ingress mode, Threat Zone radius (km)

[WAYPOINTS](#)

— Enter “ x,y; x,y; ... ” (km). Example: 2,2; 5,0; 8, 3

[MODELING HIGHLIGHTS](#)

Atmosphere & Aero — ISA density; density ratio / displayed.
Fixed wing power uses the drag polar with hotel and installation losses (as implemented in code).
Rotorcraft — induced power $\sim 1/V^3$ (hover/low speed) + empirical parasitic power $\propto V^2$ in forward flight (as implemented).
Penalties & Mission Effects — Gust penalty scales with gustiness and wind; sensitivity varies with configuration and wing loading (heuristic).
Energy & Reserves — Battery usable 85% and fuel usable 90%; dispatch reserve 30% (defaults; editable).
Climb/Descent — Battery climb energy uses ideal $m \cdot g \cdot h$ Wh; descent applies a capped 20% regeneration (as implemented).
Thermal & Detectability — Thermal T from convection + radiation sink; reduced by cloud cover and hybrid assist (when active).

[HYBRID ASSIST \(ICE\)](#)

Substitutes a fraction of shaft power for a limited duration; saves fuel and reduces T .

[WORKFLOW \(RECOMMENDED\)](#)

- 1) Select a UAV profile — choose a realistic payload (max).
- 2) Set mode and environment (speed, wind, gusts, cloud cover, terrain, stealth factor).
- 3) For ICE platforms, tune aero + BSFC; optionally enable Hybrid Assist for stealth ingress.

- 4) Click “ Estimate ” . Review atmospheric data, detectability alerts, and detailed performance metrics.
- 5) Use AI Mission Advisor for quick tips.
- 6) Enable Swarm Advisor iterate rounds review actions.
- 7) Use Mission Playback slider; export Playback CSV and Waypoints CSV.
- 8) Export Scenario Summary (CSV/JSON) and Individual UAV Detailed Results (CSV/JSON).

TIPS FOR REALISM

- Keep payload within profile limits.
- For fixed wing endurance checks, use Loiter (the app uses a heuristic $0.6 \times$ input speed to emulate a lower power setting).
- High gustiness may sharply raise penalties for light/low WL platforms.
- Stealth Drag Factor increases draw; use sparingly when endurance is critical.
- Hybrid Assist: 10–15% for ~5–10 min inside threat zones reduces T without exhausting battery support.
- Upwind range approaches zero as headwind approaches airspeed (groundspeed 0).

TROUBLESHOOTING

- “ Payload exceeds lift capacity. ” Reduce payload_g.
- Unreal endurance Check mode, speed, gusts, and multipliers.
- Fast battery drain Confirm Wh after temp derate + climb energy cost.
- ICE L/h mismatch Current model uses shaft + hotel as a conservative proxy for engine load.
- Waypoint parse error Use “ x,y; x,y ” format.

EXPORTS

- Individual UAV Detailed Results: CSV + JSON
- Scenario Summary: CSV + JSON (includes T & detectability)
- Swarm Playback: CSV (per timestep agent states)
- Waypoints: CSV (if provided)

LIMITS & SAFETY

- Educational/estimation tool only.
- $\pm 10\%$ uncertainty band.
- LLM features optional, fallback enabled.

HOW TO ENABLE LLM FEATURES

- Set env var: OPENAI_API_KEY
- pip install openai
- Falls back to heuristic advice if unavailable.

ONE MINUTE SANITY CHECK

- Endurance drops with gustiness/drag
- T falls with cloud cover/hybrid assist
- Upwind range shrinks as wind airspeed.

CREDITS

Built by Tareq Omrani (2025). Streamlit + matplotlib + pandas.
Aerospace helpers: ISA, drag polar, convection, radiation, BSFC pipeline.