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# Smart Energy Optimization for Autonomous Delivery Drones : Insights for E-Commerce Applications

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**Abstract:** *Last-mile delivery is expensive, slow, and getting harder to scale. E-commerce volumes keep climbing, and the logistics infrastructure underneath them is struggling to keep up. Autonomous delivery drones offer a way out of that bottleneck, but battery range keeps getting in the way. Most commercial drones fly for 20 to 45 minutes before they need to land and recharge, which makes anything beyond a short urban hop logistically awkward.*

*This paper reports on a series of controlled flight experiments designed to find out how much energy can be saved through smarter operational choices without changing the hardware at all. We varied payload weight, cruise speed, flight altitude, and route distance across 120 flight trials and tracked battery discharge, effective delivery range, and energy consumed per kilogram of cargo.*

*The short version: flying at the right speed and altitude, with loads consolidated where possible, cuts energy use by up to 34% compared to default operations. We also propose a three-module Smart Energy Management Framework (SEMF) that puts these findings into a practical structure e-commerce operators can actually implement..*

**Keywords:** Autonomous Drones, Battery Optimization, Energy Efficiency, E-Commerce Logistics, UAV, Last-Mile Delivery, Smart Energy Management



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