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Policy Brief

From Detection to Depletion: Sustainability Constraints in Counter-Drone Defense

(Based on EPINOVA–2025–01–RR)

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1. Key Judgment

In the Russia–Ukraine war, air defense is not failing because drones cannot be intercepted, but because defenses struggle to remain economically and operationally sustainable under continuous saturation.

Metrics focused on shoot-down rates systematically overstate effectiveness and underestimate structural exhaustion.

The decisive question for policymakers is no longer "Can we intercept?" but: "Can we preserve critical national functions at an acceptable cost over time?"

2. What Has Changed

Low-cost, mass-produced, expendable drones—combined with AI-assisted sensing and targeting—have transformed air defense into a high-frequency endurance contest. This shift has exposed not only capacity limits, **but deep mismatches between offense and defense across technology, doctrine, and decision processes.** Under sustained pressure:

- **Physical limits emerge:** low-altitude clutter, weak radar and infrared signatures, reduced observability;
- **Temporal limits bind:** sensor refresh, data fusion, authorization, and interceptor timelines lag behind drone maneuver and attack cycles;
- **Resource limits dominate:** magazine depth, replenishment speed, and fiscal burden;
- **Technological and doctrinal mismatches persist:** defensive systems optimized for fast, high-signature platforms confront slow, low-signature, mass threats;
- **Operational procedures and decision guidance lag battlefield reality:** legacy engagement rules, target-classification standards, and human-centered authorization chains remain calibrated for manned or high-value threats, rather than swarms of low-cost, expendable systems.

As a result, intercept rates can remain high even while sustainability collapses, masking structural exhaustion driven by force-structure misalignment and outdated operational assumptions rather than immediate tactical failure.

3. What the Data Show (2023–2025)

The following findings summarize baseline observations and stress-tested patterns observed between 2023 and 2025. Using a **Minimum Viable, Auditable (MVA)** framework grounded in public data:

- **Cost per Loss Avoided (CPLA)** and composite cost–loss indicators consistently **deteriorate before intercept rates decline**, providing an **early-warning signal** of structural stress.

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- Under saturation, **force-structure choices dominate outcomes**:
  defenses relying heavily on expensive surface-to-air missiles experience sharply rising marginal costs.
- **Low-cost terminal layers** (guns, EW, interceptor drones), when properly cued, **flatten cost curves** and preserve mission outcomes more robustly—even under counterfactual stress.

Bottom line: Tactical success can be sustained—**but only at accelerating and eventually unsustainable cost** unless force structure adapts.

These patterns hold not only in observed data, but also under counterfactual stress testing, indicating that force-structure effects are robust to degradation rather than artifacts of baseline conditions.

4. Why Intercept Rates Mislead

High shoot-down ratios can coexist with:

- Rapid magazine depletion;
- Rising marginal defense costs;
- Increased dependence on scarce interceptors; and
- Long-term erosion of readiness.

Counting interceptions answers the wrong question: What matters is whether **electricity, fuel supply, and other critical functions remain operational** without exhausting defense resources.

5. Policy-Relevant Metrics

Decision-makers should prioritize:

- **CPLA (Cost per Loss Avoided):** How much does it cost to preserve one unit of critical function?
- **CER*** (Composite Cost–Loss Indicator): Are cost pressure and residual loss worsening together?
- **KAPS (Key Asset Preservation Score):** Are core national functions actually being preserved?

These indicators detect sustainability failure **before visible operational collapse**.

6. Actionable Policy Implications

(1) Adopt Mission-Based Defense (KAPS-First)

Accept incomplete interception outside priority zones. Concentrate protection, hardening, and rapid recovery on power, fuel, and other critical assets.

(2) Rebalance Toward Low-Cost Terminal Layers

Shift engagements against slow, low-signature drones away from high-end interceptors, supported by revised engagement rules and faster authorization pathways.

(3) Invest in Detection and Track Continuity

Improving “engageability” often yields more benefit than adding interceptors, provided engagement authorities and decision guidance are adapted to permit timely use of low-cost defenses.

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(4) Treat Counter-UAS as an Endurance Capability

Plan for stockpiles, production throughput, maintenance cycles, and surge capacity—not just peak performance.

Recommended decision rule: Minimize CPLA subject to maintaining KAPS above a defined mission threshold across plausible stress scenarios.

7. Why This Matters Beyond Ukraine

The dynamics observed in Ukraine are **portable**.

Any state facing low-cost saturation threats—air, maritime, or mixed-domain—will confront the same trade-offs.

Future air defense effectiveness will be defined by sustainability, not interception counts.

8. Bottom Line for Decision-Makers

Optimizing for shoot-down rates leads to rising costs and declining endurance.
Optimizing for sustainability and mission preservation enables defenses to absorb saturation while remaining effective over time.

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