

- Designing the Future "Smart Camp": Strategic Challenges for Out-of-Area Military Logistics

Energy is no longer a mere support function; it is a force multiplier that will define technological advantage in the conflicts of the coming decade. A New Era for Military Energy: The European defense sector currently relies on imports for over 60% of its energy, creating significant vulnerabilities to supply chain disruptions and hybrid attacks. SENTINEL addresses this by developing interoperable, smart-energy technologies—such as on-site production, AI-enabled load management, and hybrid storage—to ensure that operational bases remain functional and independent even under duress.

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The Historical Burden of Energy in Warfare



From Napoleonic campaigns to the mechanised warfare of the 20th century, logistics has always been the "Achilles' heel" of any army. While the priority once shifted from fodder for horses to fuel for tanks, today's challenge lies in **energy density** and **network resilience**.

Historically, Forward Operating Bases (FOBs) have relied almost exclusively on diesel generators. During the conflicts in Iraq and Afghanistan, fuel transport represented a primary vulnerability: it is estimated that a high percentage of coalition casualties occurred during logistical convoy escorts.

The **SENTINEL project** (EDF-2024) was established to break this dependency, transforming the battlefield into an intelligent energy ecosystem. The project has officially launched, marking a major strategic

¹ AOS is an Independent company registered in Belgium since 2012. It delivers technical, engineering, operational and management support for defence and security sector at national, European & transatlantic levels. In systems engineering & programme management for the development of complex & innovative projects. In last 5 years, AOS has carried out more than 80 NATO studies and EU projects in interoperability, emerging technologies, air defence, energy management, UAVs, & dual-use solutions. AOS team consists of senior managers & engineers from Belgium, the Cz. Rep., France, Germany, Italy, Luxembourg, Portugal & Spain with extensive experience in defence industries, Ministries of Defence, and EU institutions

milestone for European defense. This ambitious initiative aims to transform how military operations manage energy, shifting from a fossil-fuel-dependent model to a resilient, smart-energy framework.

Defining the Smart Camp Concept

A "Smart Camp" is not merely a base equipped with solar panels; it is an integrated weapon system where energy is managed as tactical information. The design of these modern outposts rests on three pillars:

1. **Technological Foundations:** The core hardware and scientific advancements.
2. **Integrated Systems:** The seamless merging of hardware and software.
3. **Operational Performance:** The end goal—the ability to act in hostile environments with maximum effectiveness.

Moving Beyond Diesel

The core of the energy transition involves diversifying sources and improving efficiency.

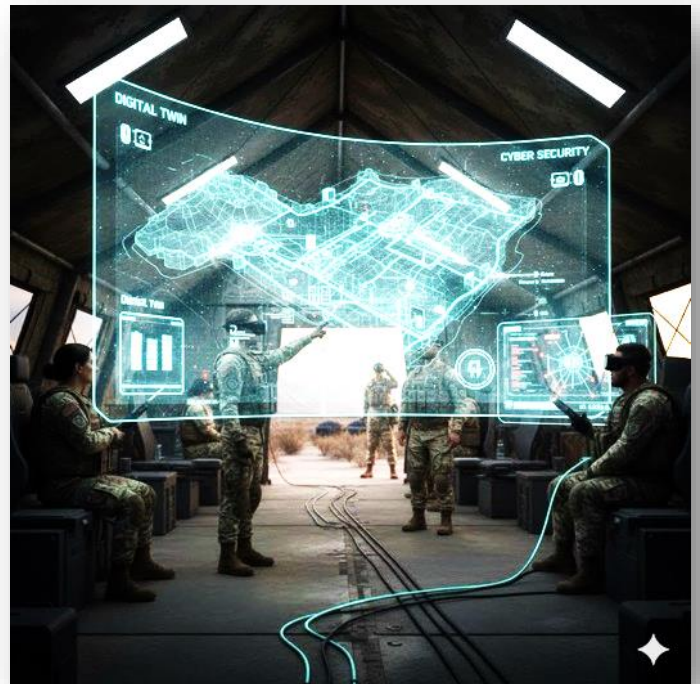
The Evolution of Power Generators: Traditional generators operate at constant speeds, wasting enormous amounts of heat and fuel when the load is low. Next-generation **variable-speed hybrid systems** allow for fuel savings of up to 60%, drastically reducing the need for external resupply.

Renewable Integration: Utilising flexible photovoltaics integrated into tents and mobile wind turbines allows forces to harvest energy from the environment. This not only cuts costs but also lowers the **thermal and acoustic signatures** of the base, making it less visible to enemy sensors.

The Hydrogen Frontier and Synthetic Fuels: Hydrogen represents the future of operational silence. Through field electrolyzers, it is possible to produce

energy carriers from water, powering fuel cells for "stealth" operations. Furthermore, "Waste-to-Energy" technology allows for the conversion of camp refuse into synthetic fuels, turning a logistical liability (waste disposal) into a critical resource.

The Camp as an Intelligent Hub



Modern mobility design moves beyond the vehicle as a simple transport tool, treating it as an active node within the network.

The Legacy of Mechanised Logistics: Historically, operational success depended on the speed of fuel tankers. The Smart Camp breaks this paradigm through **Hybrid and Electric Vehicles**. The introduction of hybrid tactical vehicles provides "Silent Watch" and "Silent Drive" capabilities—allowing for surveillance and movement without engine noise or heat signatures, exponentially increasing troop survivability.

Vehicle-to-Grid (V2G) Integration: One of the most radical innovations is the ability for vehicles to exchange energy with the camp. During peak demand or generator failure, tactical vehicle batteries can power critical systems like communications or

field hospitals, making the entire infrastructure fluid and resilient.

The Digital Backbone: Digital Twins and Cyber Security

The transition from an analogue electrical grid to a digital "Micro-Grid" is what truly defines a modern military settlement.

Planning and Digital Twins: Before a mission even begins, digital simulations can predict energy requirements based on terrain and climate. During operations, a **Digital Twin** monitors every kilowatt produced and consumed in real-time. This allows commanders to make informed decisions: for instance, if energy is scarce, the system can automatically cut air conditioning in living quarters to prioritise radars and defence systems.

The New Frontier of Cyber Defence: A connected camp is a vulnerable camp. If an adversary manages to shut down the power grid remotely, the base is neutralised without a shot being fired. Advanced camp design must integrate intrusion detection systems and encrypted energy data flows to ensure the micro-grid is as resilient as physical armour.

Efficiency and Human Well-being

Military effectiveness ultimately depends on personnel readiness. A soldier suffering from heat exhaustion has reduced cognitive abilities.

Thermal Efficiency and Heat Recovery: Modern tents and shelters are now designed as high-efficiency buildings. Integrating systems that recover waste heat from generators allows for water and space heating at zero additional cost. This reduces the need for massive air conditioning units, which historically consume up to 70% of a base's total energy.

Augmented Maintenance: The complexity of these systems requires specialised technicians. Through

Extended Reality (XR), personnel can perform complex repairs by following instructions projected directly onto the machinery or receiving remote assistance from experts at home, reducing downtime and the number of specialists required on-site.

Strategic Cooperation and the Role of AOS

SENTINEL is a platform for massive cross-border cooperation, uniting **42 partners from 16 countries**. While the project is supported by major defense players from Germany, France, Spain, and the Netherlands, it also highlights the vital contribution of specialized SMEs.

Notably, the **Belgian company AOS** is a key participant in the consortium. AOS stands out as the only SME entrusted with the leadership of an entire **Work Package**, specifically dedicated to the **definition of operational requirements and validation criteria**. This role is central to the project's success, as it ensures that the technical concepts developed by the partners align perfectly with the real-world needs of military end-users.

Energy as a Force Multiplier

The transition to these advanced energy strategies is not just an ecological choice; it is a strategic necessity. A Smart Camp ensures:

1. **Greater Autonomy:** Fewer logistical convoys mean fewer soldiers exposed to danger.
2. **Tactical Superiority:** Silent operations and reduced thermal signatures.
3. **Resilience:** A self-healing grid capable of withstanding both physical and digital attacks.

"Modern defense systems are more energy-intensive than ever," recently stated the Slovenian Minister of Defense. "Smart energy is not just beneficial; it is mission-critical".