

## ***Trends and Practical Applications of Energy Storage Solutions in the Military***

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earlier publications:

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**Abstract:** Energy storage solutions for defense needs are crucial for enhancing military operational efficiency, aligning with the growing emphasis on energy efficiency and resilience in military operations. These solutions cover a wide range of applications, from powering sensing systems or individual soldier needs to supplying energy for military platforms. This paper provides a brief review of the development of battery energy storage systems and examines their application across various military sectors. It evaluates the advantages of existing and implemented solutions, as well as unresolved challenges. The findings are supported by expert opinions from professionals in the field of defense energy.

**Bottom-line-up-front:** The existing energy storage solutions offer new opportunities for the military to enhance efficiency and resilience, thereby strengthening defense capabilities. With the growing emphasis on resilience, national defense forces now have a feasible and real opportunity to accelerate the implementation of energy-saving solutions on a broader scale.

**Problem Statement:** Energy, as a critical factor, is often undervalued during the upgrading of existing defense capabilities and the investment in new ones. Where should investments be made in advanced energy storage solutions for both current and future military capabilities? This research aims to explore advanced energy storage solutions and their potential applications across a range of military sectors.

**So what?:** It is recommended that national defense planning and capability development organizations assess the impact of advanced energy storage solutions on operational effectiveness and resilience. These solutions should be integrated into the upgrade of existing defense capabilities, and new energy requirements should be established to align with energy storage needs.

With the increasing demand for energy in the security and defense sector and the development of new energy technologies, including energy storage technologies, significant development opportunities are emerging in both the civilian and military sectors. Battery-based energy storage systems applied in the security and defense sector have not only improved operational and energy efficiency but have also enhanced operational resilience (Jha, 2012). Energy, as a critical enabler, plays a key role in all defense-related areas and is essential for military operations (Lucchese, Canha, & Brignol, 2020). Over the past three years, during the Russian Federation’s attack on Ukraine, the importance of energy supply and storage has highlighted the urgent need to improve energy storage capabilities (Marqusee, Olis, Li, & Oddleifson, 2023). Currently, energy storage—particularly battery-based solutions—has been implemented in various defense-related areas, including: i) Sensors, such as intelligence, surveillance, and data management systems (sensing layer), ii) Energy for soldiers and portable systems (communication, sensors, portable equipment, individual gear), iii) Energy storage for small-scale autonomous equipment (drones and other autonomous systems), iv) Energy storage for both tactical and non-tactical vehicles, v) Energy storage for military installations, particularly forward operating bases, vi) Energy storage for various military platforms, and others. For each of these areas, different energy storage solutions can be tailored to specific needs. However, advanced battery solutions, tailored to the requirements of these application areas, should be considered a priority.

This research analyzes the specific requirements for battery-based storage and presents an overview of already implemented solutions in the military sector.

The feasibility and desirability of these energy storage solutions are assessed through consultations with selected defense energy experts from EU member states.

In conclusion it has to be stated, that

The demand for advanced energy solutions in security and defense is growing as more energy is required for both current and future defense capabilities. In many critical cases, existing energy storage solutions are not integrated into defense systems due to a lack of understanding of their necessity.

An analysis of the existing energy storage solutions demonstrates that they are available and can be incorporated into systems, provided that capability planning bodies establish clear requirements for energy storage.

Energy storage solutions will not only enhance the efficient use of energy but also improve the resilience of military systems and units.

#### Literature

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