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Finabel
The European Land Force Commanders Organisation

FINABEL - THE EUROPEAN LAND FORCE COMMANDERS ORGANISATION

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1. Introduction

In October 2025, the US Department of Army launched the Janus Program, an initiative to provide US military installations with uninterrupted, reliable, and secure power. The project was marketed as underscoring "the Department of War's commitment to the warfighter ethos by ensuring uninterrupted energy for training, deployment, and combat operations" (U.S. Army Public Affairs, 2025, Program Details section). The project draws a direct link between operational energy (OE) and combat-readiness. This link is historically proven. In World War II, the lack of Petroleum, Oil, and Lubricants (POL) stymied General Patton's armoured advance towards Berlin. Historian Sir Basil Hart eventually called this "the best chance for a quick finish" to the war, which "was probably lost when the gas was turned off on Patton's tanks" (Samaras et al., 2019, p. 3). Hence, OE, which the North Atlantic Treaty Organisation (NATO) defines as "the energy required to train, deploy, operate, and sustain... forces across missions and operations" (UK Ministry of Defence, 2023, p. 10), has tactical and strategic implications.

The needs of modern OE are ubiquitous (Carpenter et al., 2021). From soldiers, to platforms, to bases, militaries must ensure a steady supply of secure and reliable energy to its forces to enable efficient warfighting. For example, the modern soldier carries up to 10 kilograms of batteries, including redundancies to power their array of electronic equipment[1] for a multi-day mission (Vergun, 2018). Platforms such as tanks, artillery batteries, and 5-ton trucks run on diesel, the amount of which depends on their fuel efficiency (Stoop et al., 2025). Military bases have relied on civilian grids to provide electricity, while those in Forward Operating Bases require reliable energy sources. Hence, OE is not simply about batteries or climate change; in fact, it is about how the military can marshal a particular type of energy (e.g., solar, wind) through a generator (e.g., diesel, solar panels) and into a grid (e.g., cables, underground) or storage (e.g., batteries, pumped storage), and eventually into appropriate facilities for compatible equipment (Carpenter et al., 2021).

Given this understanding of OE, this paper argues that Europe is in urgent need for a system-level shift towards finding alternative energy sources to power bases, platforms, and soldiers. Current policies have not sufficiently addressed serious issues such as dual-use grid infrastructure and hydrocarbon dependencies.

2. Issues in Operational Energy

OE is a key component of military logistics. However, there are several issues with how militaries deploy them. This section covers four problems: dual use grids, POL, oil and refinery capacities, and soldier weight.

1. For example, Night Vision Goggles, small-unit radios, large radios for communication with Higher HQs, etc.

2.1.Base Defense: Dual Use Grids

Dual-use grids are those used by both civilians and military end-users. Such arrangements are the norm in several countries. It is a logistically sound and affordable arrangement for civilians and militaries to plug into the same, commercially run grid that provides electricity for cheap, ceteris paribus (Curtis & Rocha, 2024). According to NATO, 75% of its electrical needs are derived from civilian grids (NATO, 2024). However, such arrangements create efficiency and security issues.

First, civilian power grids are "built to fail actually at peak demand" (Atlantic Council, 2025, 10:08). This design feature – or "load shedding" – protects the grid when there is a sudden surge in demand. A surge overloads power generating stations, which partially shut down as part of load shedding so that they can continue providing power to essential parts of the grid (Sympower, n.d.) Militaries plugging into civilian grids in times of war will substantially increase electricity demand, potentially causing grid failure (Atlantic Council, 2025). Hence, civilian grid design features are incompatible with the on-demand energy required to ensure effective warfighting. Second, Europe's adversaries have resorted to critical infrastructure attacks as part of hybrid warfare. For example, in Ukraine, Russia orchestrated a series of strategic attacks on Ukraine's electrical grid. The first step degraded oil production facilities near frontlines, hindering vehicles and other platforms from moving. The second step featured distributed drone attacks on power stations, substations, and transformers with follow-on attacks to kill repair technicians and destroy spare parts. The final part was a campaign of systematic attrition consistently preventing Ukraine from repairing its now destroyed electricity grid. Some reports estimate that critical materials required for repairs would take up to two years to be delivered (Knapp et al., 2025). Disrupting hardware and software at commercial power stations or at distribution hubs makes energy supply unreliable and insecure. Indeed, Ukraine was subjected to rolling blackouts, with military facilities enduring the same fate (Knapp et al., 2025). Such blackouts reduce warfighter efficiency in both the short and long term.

2.2. Platform Issues: Petroleum, Oil, Lubricants

Land platforms like tanks and artillery require diesel for mobility (Stoop et al, 2025). Consistent advances over time will necessitate, at some point, battlefield refueling from logistics trains[2] that carry POL to the front line. Hence, Main Supply Routes (MSR) feature in all battle plans, where logistics trains provide ammunition, POL, food, and water. In contemporary conflicts, MSRs – from logistics hubs to logistics trains themselves – have come under threat as troops navigate complex terrain in a drone-biased environment. For example, Russia and Ukraine have both attacked important logistics hubs of their adversary, seeking to disrupt the supply of POL, ammunition, and other essentials to front line troops

2. Not the literal train, but a convoy of vehicles carrying sustenance required for troops.

(POLITICO, 2025; Zadorozhnyy, 2025). During the Iraq War, insurgents regularly targeted logistics trains. The attacks were so deadly and demanded such protection that more purple hearts were awarded to soldiers protecting logistics operations than those engaged in active conflict (Clark, 2025). Hence, energy requirements compel logistics trains that require protection.

2.3. Platform Issues: Oil Dependency and Refinery Capacity

Europe and NATO armies are dependent on hydrocarbons. Indeed, its land platforms and air platforms are fueled by diesel and kerosene respectively (Stoop et al, 2025). War will substantially increase the fuel demands of militaries to the extent that it becomes comparable to civilian usage (Stoop et al.). Long-term considerations make the fuel dependency picture clearer; tanks and aircraft acquired today are expected to be operational for the next 60 to 70 years, extending fuel dependencies at least until 2085 (Hobhouse, 2025). Hence, fuel logistics are important for Europe and NATO combat operations.

However, Europe and NATO countries are net importers of hydrocarbons. Even worse, some import sources may proverbially “turn off the tap” during conflict. For example, Europe imports a large amount of its crude oil from the United States and Kazakhstan (Stoop et al., 2025, pp. 11 – 12). While the former is revising its defense commitments to Europe, the latter is under the influence of Russia. Additionally, transportation infrastructure between Europe and some of its exporters in the Middle East, Russia, Kazakhstan, and the Caucuses region is subject to supply instability because of potential conflict, armed attacks, or trade disputes (Stoop et al., 2025, p. 11). Hence, a large portion of Europe’s hydrocarbon sources cannot guarantee supply during war.

Even if Europe can secure its supply of crude oil, its next challenge is having enough capacity to refine it. Several refineries have closed because of “energy transition headwinds”, reducing demand for gas and oil in Western Europe (Norways, 2024), and increased competition from renewable energy. In January 2025, the European Fuel Manufacturers Association accused the European Commission of not paying enough attention to the closure of oil refineries in the case of conflict (EFMA, 2025), alleging that political decisions have resulted in a financial pivot towards renewable energies without giving a chance for hydrocarbon refineries to adapt. The result has been the closure of refineries.

Since 2024, Europe has lost 400,000 million barrels per day worth of crude oil byproducts due to policies unfriendly to hydrocarbons (Argus Media, 2025). Such closures have a negative impact on military readiness where stability of supply is crucial. Hence, the progressive reduction of refining capacities in Europe is counterproductive to ensuring military capabilities. Indeed, it is telling that refining demand shot up upon the commencement of the war in Ukraine in 2022, before stabilizing to long-term averages after some time (Norways, 2024).

2.4.Personnel Problems: Excessive Battery Load

A significant portion of a soldier's load is batteries. For example, an average rifleman in the US military carries an average of 12 watts of power in the form of AA-batteries, translating to roughly 7.5kg of batteries for a standard 3-day mission (Vergun, 2018). Such weights adversely impact soldier performance, affect alertness, marksmanship, and agility. Studies found that loads decreased accurate marksmanship timings by approximately 0.1 seconds. Soldiers also took 0.7 more seconds to finish a 5-part task, demonstrating weight's adverse impact on decision making (Fish & Scharre, 2018). Weight can also affect combat effectiveness. For instance, British troops stationed in Afghanistan in 2011 struggled to approach their enemy due to their heavy loads (King, 2017). Thus, increased loads negatively affect soldier performance and, in some cases, mission success.

3. What is Europe doing to resolve these issues?

Conventional thinking dictates that the problems listed above might be easily resolved by reducing hydrocarbon demand and increasing non-hydrocarbon supply. Pairing this change with more resilient distribution networks might be what armies require to deliver OE efficiently during conflicts. However, there are several factors to consider when providing OE, including energy density, costs, and operational effectiveness.

3.1. Base Defence: Smart Microgrids and Alternative Energies

Militaries can protect their own critical infrastructure with the installation of smart microgrids. Microgrids are air gapped from civilian grids and are isolated from the latter's potential infrastructure failures. Militaries may even implement nanogrids for critical functions within a base, such as command and data centres. "Smart" microgrids may provide further efficiency through "grid balancing, network reconfiguration, fault detection, isolation and restoration" (EUJRC, 2023, p. 44). Hence, smart microgrids and nanogrids can provide continuity in crisis.

European militaries have taken some steps to incorporate smart grids into their energy planning. For example, the Slovenian Armed Forces has developed a hybrid mobile microgrid, powering bases while disconnected from the public grid (SiEnE, 2025). On the other hand, other armies have only promulgated strategies or conducted studies on microgrids. In particular, the German Bundeswehr has studied how to build a fault-tolerant infrastructure for electrical networks (Brückner, n.d.), while the French Army recommended that an “intelligent micro-network” should manage renewable energy production and multiple energy storage solutions (French Ministry of the Armed Forces, 2020). However, these studies are only in their proposal stage, in contrast to Slovenia, which has already implemented such solutions.

Small Modular Reactors (SMRs) or Micro-Modular Reactors (MMRs) can power bases resiliently and securely. New innovations in reactor technology have resulted in simpler reactors that are easier to run and maintain. Further, these reactors are factory sealed with their local supply of fuel that only needs refuelling over decades, with on-site waste storage (Andres & Breetz, 2011). The solution is operationally effective and facilitate the energy transition. However, Europe is slow to capitalise on such technologies, despite being a nuclear powerhouse itself. While there is a recognition of the potential of SMRs (Jeannin, 2024), there are significant operational, political, and reputational risks (Jeannin, 2024; French Ministry of Armed Forces, 2020). Hence, it will take time before Europe allows for SMRs or MMRs into power bases.

3.2. Powering Platforms: Non-hydrocarbon fuels

On the one hand, Sustainable Aviation Fuels (SAFs) are good alternatives to kerosene because of their similar energy densities[3]. In 2022, The UK trialled a 100% SAF flight with a military variant of the Airbus A330, while the French Air Force tested SAFs with its NH90 helicopter without fuel modifications in 2023 (Morris, 2024). The UK and Sweden have also trialled SAFs with the F-35 and the JAS 39 Gripen (Stoop et al., 2025). SAFs could reduce Europe’s dependency on hydrocarbon imports. However, costs, supply chain concerns, and technical uncertainties limit their rapid adoption. First, SAFs are twice to ten times more expensive than hydrocarbons (O’Malley, 2025), exerting upward pressure on military budgets (European Parliament, 2023). Second, SAFs are heavily dependent on feedstock availability (PwC, 2023), which introduces supply chain uncertainties that are incompatible with the large and rapid needs of the military. Third, militaries are likely to take time to implement SAFs because of the uncertainty around their performance in extreme environments, such as high-altitude, low-temperature terrain (Herbert, 2022).

On the other hand, there are no realistic non-hydrocarbon alternatives that can power other land-based platforms such as tank and artillery systems. While there might be a role for fully electric vehicles that are lighter and have specific mission profiles, fully electric drivetrains are “impractical” for armoured ground vehicles because of their limited range, long recharging times, and unreliable charging infrastructure in war zones (Committee on Powering the U.S. Army of the Future et al., 2021; Villalobos & Simulcik, 2023). Finally, batteries cannot endure harsh conditions and will increase the weight of vehicles, which in

3. Similar amounts of kerosene and SAFs generate the same amount of energy.

turn affect battlefield performance (Trakimavicius, 2025). Hence, hybrid vehicles are preferable to fully electric ones. Yet, projects such as the Main Armoured Battle Tank of Europe (MARTE) may have a hybrid drivetrain (Brünte, 2025). Though the project is still in the development phase, the initiative to explore hybrid drivetrains reflect the political and military will to reduce hydrocarbon usage for land platforms.

3.3. Lightening the Warfighter: Compact Battery Technologies

National militaries are researching batteries that are energy dense, can be distributed better across a soldier, and can harvest energy from the environment and soldier movement. For example, in 2017, Saft Batteries manufactured a battery variant that offers a 50% increase in energy output at the same weight, contributing to a decrease in soldier weight, ceteris paribus. Such innovations allow soldiers to carry less batteries for the same amount of energy. Second, companies have explored the possibility of a conformal wearable battery: a lightweight battery that can be worn or carried according to the needs of soldiers. Bren-Tronic's CWB even allows for soldiers to hot-swap batteries that need charging (Guest, 2024). Finally, EU and NATO are researching a lightweight, wearable energy system that can generate power from the environment. In 2024, for example, the European Defence Fund contributed €4 million to the Harnessing Adaptive Renewables: Versatile Energy Supply Technology (HARVEST) project. The project aims to create a "lightweight, wearable energy system with reduced weight and increased operational duration" (European Defence Fund, 2024, p. 1). The system is meant to generate power from heat, operator motion, and solar radiation (European Defence Fund, 2024). Hence, there are several initiatives from both the public and private sectors to support reducing battery loads for soldiers. This include making batteries more efficient, centralising a wearable battery that can charge soldiers' electronics, and harnessing energy from other sources, such as movement.

4. Conclusion

Armoured Infantry soldiers who wake up for an early morning close-terrain route march in a dense forest may not fear heavy loads, as more efficient CWBs have reduced their battery load. Similarly, the CWBs are smart and can charge soldiers' devices based on the latter specific activities and needs. When training mounted activities, may feature contactless chargers in the trooper's compartment, where they can lay their battery packs or weapons to charge. The vehicle itself might be a hybrid-drive AFV or a fully electric AFV, with ranges similar to their hydrocarbon counterparts due to advances in battery technology that allow it to be light and energy dense. This AFV – due to its lack of combustion – is silent and stealthy. Finally, SMRs fuel the military bases and help them remain unaffected during harsh weather, cyberattacks, and network issues since their domestic power source remains uninterrupted under these conditions.

Such a future will require a clearer policymaking from the European agencies. States must move away from the current system of hydrocarbon reliance and increase research and investments into microgrids, SAFs, and battery technology that will insulate military grids from cyberattacks, reduce fuel dependencies on unstable sources, and minimise soldier loads to improve their performance. This way, national militaries can ensure operational energy during war.

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