Armament Industry European Research Group

GREENING DEFENCE: FRAMING THE STAKES FOR INDUSTRIAL AND MILITARY CAPABILITIES

Value chains and security of supply for environmental and energy transitions-enabling technologies in the defence sector

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Armament Industry European Research Group

The Armament Industry European Research Group (Ares Group) was created in 2016 by The French Institute for International and Strategic Affairs (IRIS), who coordinates the Group. The aim of the Ares Group, a high-level network of security and defence specialists across Europe, is to provide a forum to the European armament community, bringing together top defence industrial policy specialists, to encourage fresh strategic thinking in the field, develop innovative policy proposals and conduct studies for public and private actors.

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ABSTRACT

The increase in defence spending in the last years has prompted new equipment acquisitions of defence equipment that European countries have primary focused to replenish inventories. In view of the European Union's 2030 Green Deal goals, what is the impact of the acquisitions on the environmental and energy transition in defence and what are the required critical raw materials (CRM)? This commentary investigates the geopolitical importance of critical raw materials (CRM) for defence and green transition and assesses how disruptions of the related supply chain can affect defence in Europe. After delineating the major European measures and activities implemented to ensure security of supply, the commentary concludes by arguing that steps taken for a wider use of alternative materials, sources, international partnerships and increased recycling of materials might not be enough to ensure both conventional defence production and environment and energy transition in defence.

Keywords: Defence production | CRM | Green transition | Europe

INTRODUCTION

The renewed emphasis on defence readiness in Europe since 2022 has highlighted structural dependencies that extend beyond military inventories and industrial capacity, forcing governments to rebalance long-term transformation goals with immediate security imperatives. Among these, the energy and environmental transition of the armed forces have struggled to keep momentum amid pressing operational demands. In this context, critical raw materials (CRM) have emerged as a key strategic issue.

As the volume of defence production increases in Europe, the volume of CRM needs will increase proportionally, compounded by the challenges linked to energy and environmental transition. Additionally, the armed forces' energy and environmental transition and their increasing reliance on digital technologies, electrification, and alternative energy solutions, will pose a stronger pressure on the demand for materials used for both sectors such as rare earth elements, lithium, cobalt, and graphite. Europe's access to these materials, however, is characterized by long-standing dependencies on third countries and highly concentrated global supply chains. Such dependencies pose direct risks to defence readiness and long-term sustainability objectives. Export controls, licensing regimes, and restrictions on processing know-how can disrupt the availability of components and technologies essential for both advanced weapon systems and cleaner defence capabilities.

After delineating the relevance of CRM for defence and defence energy and environmental transition, this commentary focuses on the material dependencies of European countries and analyses the European activities in place to mitigate these dependencies, arguing that the current efforts, while positive, do not allow for a stronger resilience of the supply chain by 2030.

ENERGY AND ENVIRONMENTAL TRANSITION IN THE ARMED FORCES

Since 2022, European countries have been increasing their investment in defence to equip their armed forces with the weapon systems required to ensure security in the region and rapid reaction capacity. Comparing procurement contracts in the periods 2018-2022 and 2022-mid2025, European countries almost doubled their total investment on procurement, that amounted to USD245.66bn in the latter period. Equipment categories like artillery, ground-based, air- and missile-defence contracts and armoured vehicles experienced the

higher increase in contracts, with artillery procurement rising by 570% compared to the period 2018-2022.[1]

These statistics highlight that a relevant proportion of defence investment went to replenish national inventories and increase capacity in conventional equipment mostly. This has partly affected the environmental and energy transitions of the defence sector, that has been more focused on improving production capacity, reducing delivery time, re-acquiring the technological expertise for defence systems and integrating new technologies in the military, rather than focusing activities on environmental and energy transition in the military.[2]

Efforts toward environmental and energy transition in the defence sector would support the European Union (EU) goal of reaching climate neutrality by 2050. The global defence sector is estimated to account for 5.5% of the world's CO2 emissions.[3] EU institutions are aware of the importance of environmental and energy transition in the defence sector, as evidenced by the 2020 Climate Change and Defence Roadmap, which delineated several action points to integrate energy and environmental considerations into capability development cycles, or by the 2023 new outlook on the climate and security nexus joint communication, that highlights the security risks caused by climate change.[4]

At national level, several countries have either defined their national defence strategies vis-à-vis the effect of climate change on the military, or have put in place policies to reduce the environmental footprint of their armies and implement energy transition. [5] An example of the latter is provided by the Eco Camp 2025 project of the French army, that aims to develop energy and water self-sufficient external operations camps. Other potential avenues for the

[1] International Institute for Strategic Studies, 'Progress and Shortfalls in Europe's Defence: An Assessment', Strategic Dossier, September 2025, https://www.iiss.org/globalassets/media-library---content--migration/files/publications---free-files/strategic-dossier/pds-2025/complete-file/iiss_strategic-dossier_progress-and-shortfalls-in-europes-defence-an-assessment_092025.pdf.

[2] Council of the European Union, 'Greening Armed Forces. Is a sustainable approach to national defence possible?', Research Paper, Analysis and Research Team, January 2024, https://www.consilium.europa.eu/media/69640/art_greening_-armies_web.pdf; Caspar Hobhouse, 'The lifeblood of the military: The energy transition and operational capacity', EUISS, Brief 16, June 2025, https://www.iss.europa.eu/publications/briefs/lifeblood-military-energy-transition-and-operational-capacity

[3] European Defence Agency (EDA), 'EDA and EU Commission Sign Grant for New Phase in Green Defence', 11 December 2024, https://eda.europa.eu/news-and-events/news/2024/12/11/eda-and-eu-commission-sign-grant-for-new-phase-in-green-defence.

[4] Council of the European Union, 'Climate Change and Defence Roadmap, 12741/20, 9 November 2020, https://data.consilium.europa.eu/doc/document/ST-12741-2020-INIT/en/pdf; European Commission and High Representative of the Union for Foreign Affairs and Security Policy, 'Joint Communication on Climate Change, Environmental Degradation, and Security', JOIN(2023) 19 final, 2023, https://www.eeas.europa.eu/sites/default/files/documents/2023/JOIN_2023_19_1_EN_ACT_part1_v7.pdf

[5] See for example: German Federal Ministry of Defence, Strategy on Defence and Climate Change, 2023, https://www.bmvg.de/resource/blob/5759520/5308c4904ff6fc0780061b6e424fc27e/strategy-on-defence-and-climate-change-data.pdf; German Federal Ministry of Defence, 'Sustainability and Climate Action Strategy for the Area of Responsibility of the Federal Ministry of Defence', November 2023, https://www.bmvg.de/resource/blob/5888798/e7464f041d62f71e45a079c8b93329e5/nhstrat-eng-langfassung-final-barrierefrei-data.pdf

sustainment of the environmental and energy transition in defence is provided by a wider use of virtual trainings.[6] Alternative fuels also constitute an additional way to advance energy and environmental transition in defence, provided that they do not compromise operational efficiency of the systems. As technological advancement and operational testing in still developing, while some countries are working towards the development of less polluting armies, others do not have the same priorities and will continue to use high-energy dense sources, potentially causing (unacceptable) disadvantages for those opting for a greener and more environmentally sustainable army.[7] As a testing phase, activities such as the use of biofuels for Defence business trips can be an intermediate approach to test and improve alternative fuel resources. An example in this regard is provided by the use of national biofuels by the Norwegian Army to cover at least 15% of the fuel requirement for defence's business travels,[8] or the test of blend fuels by the United Kingdom's air force to operate its Typhoon.[9]

THE STRATEGIC RELEVANCE OF CRITICAL RAW MATERIALS

Environmental and energy transitions in defence would provide the armed forces alternatives to dependencies on energy supply and on vulnerable strategic supply chains and geopolitical risks. These transitions entail several aspects, including investments on digitalisation, electrification, power storages, low carbon energy and propulsion systems, or integrated energy management systems among others.[10]

These technologies require critical raw materials (CRM) for their production, that adds to the amount of CRM needed for the production of adopted military systems. CRM are defined in the EU as raw materials of high economic relevance and with a risk of supply disruption that are costly to substitute in economic and performance terms.[11] Examples of materials that are highly used for both armament production, energy and environmental transition and

[6] Council of the European Union, 'Greening Armed Forces. Is a sustainable approach to national defence possible?', Research Paper, Analysis and Research Team, January 2024, https://www.consilium.europa.eu/media/69640/art_greening_-armies_web.pdf.

[7] *Ibid*.

[8] Norwegian Armed Forces, 'Norwegian Armed Forces Create Aviation First with Biofuels', https://media.uk.norwegian.com/pressreleases/norwegian-armed-forces-creates-aviation-first-with-biofuels-3308314.

[9] Royal Air Force (RAF), 'RAF Defends UK's Skies Using Sustainable Aviation Fuel', https://www.raf.mod.uk/news/articles/raf-defends-uks-skies-using-sustainable-aviation-fuel/.

[10] Other examples of how energy and environmental transition can be implemented and their impact on the operational effectiveness of the armed forces are provided by the consultation forum for sustainable energy in the defence and security sector (CF SEDSS) guided by the European Defence Agency (EDA). For more information please see: https://eda.europa.eu/news-and-events/news/2024/12/11/eda-and-eu-commission-sign-grant-for-new-phase-in-green-defence

[11] Please note that the EU list of CRM is periodically reassessed and updated to take into account the changes in strategic value and availability of the materials. For more information please see: https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en

semiconductors include aluminium, cobalt, copper, graphite, lithium, manganese, nickel, rare earth elements or silicon metal.[12]

Europe is highly dependent on third actors for its supply of CRM. This is partly a consequence of the uneven geographical distribution of these minerals, but also the result of past decisions. Mines and processing facilities were closed as environmental concerns strengthened and as the investment required to process these materials was higher than sourcing cheaper alternatives from abroad. Revamping or building new mines and processing facilities would take several years, thus not impacting the dependence on non-EU solutions and import from third countries in the short to medium term.[13]

Other international actors have instead continued investing in CRM processing or are now exploring ways to position themselves in the market.[14] With a production of roughly 70% of global rare-earth elements and control of about 90% of refining and magnet-making capacity, China currently holds a de facto monopoly on the supply of CRM, on which European countries rely for the vast majority of their required materials.

This situation exposes European countries to supply chain vulnerabilities that have been increasingly weaponised in the last years. Given their relevance and strategic importance across international markets and sectorial applications, raw materials have been more subjected to export control restrictions than other goods.[15] In 2023, export restrictions on CRM affected 24.9% of the CRM exports, compared to 14.6% in 2017.[16]

When it comes to materials exported by China, export restrictions peaked in 2025 with two waves in April and October 2025. The second wave of restrictions expanded the list of materials affected by export control; included requirements for companies using even traces

[12] EY, 'Critical Raw Materials for the Energy Transition', https://www.ey.com/en_bg/insights/energy-resources/critical-raw-materials-for-energy-transition; Laura Heidecke, Yoeri Dijkhof, Daniela Cinova, 'The critical link between Energy Security and the European Defence Industry', European Parliamentary Research Service, PE 780.411, December 2025, https://www.europarl.europa.eu/RegData/etudes/BRIE/2025/780411/ECTI_IDA(2025)780411_EN.pdf; The Inovation imperative, Bridging the Supply–Demand Gap for Critical Raw Materials by 2030, GLOBSEC GeoTech Centre, https://www.globsec.org/sites/default/files/2025-05/GLOBSEC%20Innovations%20In%20Critical%20Materials.pdf, p. 15.

[13] Andreas Goldthau and Simone Tagliapietra, 'The EU's Quest for Strategic Raw Materials: What Role for Mining and Recycling?', Intereconomics, Vol. 58, No. 2 (2023), https://www.intereconomics.eu/contents/year/2023/number/2/article/the-eu-s-quest-for-strategic-raw-materials-what-role-for-mining-and-recycling.html.

[14] An example in this regard is provided by the Gulf Countries that have been increasing their investment on CRM. See for example Fastmarkets, 'Middle East Position in Critical Minerals Markets Continues to Strengthen', https://www.fastmarkets.com/insights/middle-east-position-in-critical-minerals-markets-continues-to-strengthen-fmf-2026/.

[15] Organisation for Economic Co-operation and Development (OECD), 'Export Restrictions on Critical Raw Materials', https://www.oecd.org/en/topics/sub-issues/export-restrictions-on-critical-raw-materials.html.

[16] Beata Javorcik and Helena Schweiger, Geopolitical Shocks and Inflation: Access to Critical Raw Materials, European Central Bank, 2024, https://www.ecb.europa.eu/pub/pdf/sintra/ecb.forumcentbankpub2024_Javorcik_paper.en.pdf

of Chinese critical minerals to request an export approval from Beijing; and comprised restrictions on the transfer of processing know-how.[17]

These requirements can have strong repercussions on the resilience of the supply chain. The need to receive license permits for all products that include even small amounts of CRM from China grants Beijing the capacity to deny licenses when the use case or end user might be perceived as against national interests. In such a situation, the defence sector might become an obvious target.

The suspension of the Chinese legal framework on export control until November 2026 gives European countries some time to find alternatives and implement measures to ensure security of supply.

MAIN EUROPEAN ACTIVITIES TO ENSURE SECURITY OF SUPPLY OF CRITICAL RAW MATERIALS

The security of supply for critical raw materials has been a central topic for the EU and its member states, but it is only in the last couple of years that discussions and policy decisions have been more focused. Among the latest developments to secure supply chains and ensure the provision of CRM for both energy and defence applications, the EU published its ReSource EU Action Plan in December 2025, aiming at de-risking and diversifying CRM supply in support of broader economic security objectives. In 2026, a new European Critical Raw Materials Centre is expected to facilitate strategic stockpiling, incentivize joint purchase of CRM and prioritise acquisition for strategic sectors including defence. The Plan also identifies ways of cooperation with international partners and aims to harmonise all funding instruments available for the strengthening of the CRM value chain.[18]

A component of the ReSourceEU Plan focuses on improving the recycling capacity of the EU and on restricting export from the EU of scraps and waste components containing CRM materials. The Plan further references a stronger leverage of innovation to integrate substitutes to CRM into defence products and technologies through the European Defence

[17] Marcin Szczepański, 'China's rare-earth export restrictions', European Parliamentary Research Service, November 2025, https://www.europarl.europa.eu/RegData/etudes/ATAG/2025/779220/EPRS_ATA(2025)779220_EN.pdf; International Institute for Strategic Studies, 'The EU's Dependency on Critical Minerals from China', Strategic Comments, December 2025, https://www.iiss.org/publications/strategic-comments/2025/12/the-eus-dependency-on-critical-minerals-from-china/.

[18] European Commission, RESourceEU Action Plan Accelerating our critical raw materials strategy to adapt to a new reality, COM(2025) 945 Final, https://single-market-economy.ec.europa.eu/document/download/01c448d6-dc93-40d7-9afe-4c2af448d00c_en

Fund.[19] The European Defence Industry Programme (EDIP) also delineates several activities to ensure the defence industry strengthens its production capacity, including actions on raw materials. Specifically on CRM, the 2024 CRM Act already identified European capacity targets by 2030: 10% of the annual demand for critical minerals must be met from within the EU; 40% for processing and 25% for recycling be satisfied in the region; and the block should not import more than 65% of a mineral's annual need from a single third country.[20] However, the EU is still far from reaching these targets.[21]

Coming to specific activities to increase the circularity of CRM and improve the environmental footprint of the defence sector, the European Defence Agency (EDA) has been conducting projects under the Incubation Forum for Circular Economy in European Defence (IF CEED) framework to help sustain the EU's Green Deal goals and enhance the long-term efficiency of defence capabilities.[22] In addition to recycling and exploiting components through decommissioned items,[23] IF CEED is experimenting the use of additive manufacturing for spare parts based on titanium wires from scraps.[24]

Energy transition in defence is also being investigated through the Consultation Forum for Sustainable Energy in the Defence and Security Sector (CF SEDSS) initiative of the Commission and managed by the EDA. Its fourth phase is supported by a Commission's grant of EUR10million to EDA to assist in its work.[25] The forum produced several reports and analysis on the impact of energy transition in the defence sector and provided guidelines on requirements for energy transition in defence, as well as its impact on operational effectiveness of military activities.[26]

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[19] *Ibid*.

[20] European Commission, European Critical Raw Materials Act 2024, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/european-critical-raw-materials-act_en.

[21] European Court of Auditors, 'EU risks running short of raw materials for renewables', February 2026, https://www.eca.europa.eu/en/news/NEWS-SR-2026-04

[22] European Defence Agency, *Incubation Forum For Circular Economy In European Defence (IF CEED)*, https://eda.europa.eu/docs/default-source/brochures/if-circular-economy-eda.pdf.

[23] European Defence Agency, 'Circular management of Spare Parts from decommissioned assets', project idea, https://eda.europa.eu/docs/default-source/if-ceed/factsheets/if-ceed-factsheet---14---spare-parts-from-decommissioned-assets.pdf

[24] European Defence Agency, 'MICRAM: Recycling of Critical Raw Materials', IF-CEED Factsheet, https://eda.europa.eu/docs/default-source/if-ceed/factsheets/if-ceed-factsheet---02---micram.pdf; and EDA, 'Circularity of Titanium and Additive Manufacturing', IF-CEED Factsheet, https://eda.europa.eu/docs/default-source/if-ceed/factsheets/if-ceed-factsheet---01---circularity-of-ti-and-am.pdf.

[25] *European Defence Agency*, 'EDA and EU Commission Sign Grant for New Phase in Green Defence', 11 December 2024, https://eda.europa.eu/news-and-events/news/2024/12/11/eda-and-eu-commission-sign-grant-for-new-phase-in-green-defence.

[26] *European Defence Agency*, *Shaping the Future – Energy Transition in the Defence Sector*, CF SEDSS III, October 2024, https://eda.europa.eu/docs/default-source/consultation-forum/eda-cf-sedss-publications/shaping-the-future---energy-transition-in-the-defence-sector.pdf.

Different activities under the EDA have focused on the potential to optimise production cycles, life cycle management or recycling of components[27] and the Agency's Energy and Environment Capability Technology Group (EnE CapTech) identifies technological gaps and proposes collaborative projects on ten technology building blocks.[28] The EDA CapTech Materials and Structures complements this effort by performing analysis and tests on alternative materials and their use for military applications.[29] Some of the priorities identified by the EnE CapTech have also received funds from the European Defence Fund.[30]

All these activities, however, have not been sufficient so far to ensure that the EU increases its independence on CRM supply needed for both the defence sector and its energy and environmental transition. Strategic partnerships with international actors are meant to diversify resources and de-risk supply and value chains. Since 2021, the EU has initiated 14 strategic partnerships on CRM including with Australia, Canada, Japan, or the Democratic Republic of Congo. While they help build new cooperative frameworks and alternative supply chains, they do not solve Europe's dependency problem on CRM and are not specifically focused on defence, with the exception of the partnership with Australia, which references defence and aerospace among the goals of the agreement.[31]

[27] European Defence Agency (EDA), 'Critical Raw Materials', https://eda.europa.eu/what-we-do/eu-policies/if-ceed-old/project-circles/critical-raw-materials.

[28] The 10 technology building blocks are: Alternative fuels and drive/propulsion systems; Energy storage: electrical, electrochemical, mechanical, structural, and thermal; Engine and power distribution system efficiency technologies; Energy management technologies: innovative and efficient systems; Solar energy generation (thermal and electrical generation); Militarization of environmental technologies: water and wastewater; Energy harvesting/scavenging; Wind energy; Energy and environmental technology systems integration; Militarization of environmental technologies: energy from waste (or waste to energy) technologies. For more information please see: European Defence Agency (EDA), 'CapTech Energy and Environment', https://eda.europa.eu/what-we-do/all-activities/activities-search/energy-and-environment-programme.

[29] European Defence Agency, 'CapTech Materials', https://eda.europa.eu/what-we-do/all-activities/activities-search/captech-materials-structures

[30] Council of the European Union, 'Joint Staff Working Document. Progress Report on the implementation of the Joint Communication - "A New Outlook on the Climate and Security Nexus"', SWD(2025) 49 final, 18 February 2025, https://data.consilium.europa.eu/doc/document/ST-6321-2025-INIT/en/pdf

[31] European Commission, 'Memorandum Of Understanding Between The European Union And Australia On A Strategic Partnership On Sustainable Critical And Strategic Minerals, 28 May 2024, https://ec.europa.eu/docsroom/documents/59714.

LOOKING AHEAD

European initiatives launched in recent years represent an important shift in awareness and ambition. From a policy point of view, the requirement of decreasing foreign dependency on CRM required for defence and defence energy and environmental transition has been clearly identified. Additionally, studies, activities and tests in the sector both at national and EU level showcase the effort in identifying alternative solutions to ensure appropriate access to CRM. Nevertheless, these efforts remain insufficient to offset decades of external dependence, highly concentrated global supply chains, and the growing weaponisation of raw materials trade. Recycling, substitution, diversification of partners, and strategic stockpiling can mitigate risks, but they are unlikely, on their own, to ensure EU countries access to the required materials in sufficient volume and by the given timelines. Without sustained emphasis and support to access diversified provisions of CRM, including indigenous processing, material dependencies will continue to limit both Europe's strategic autonomy and the credibility of its green transition in the defence sector.

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