Armament Industry European Research Group

GREENING DEFENCE: FRAMING THE STAKES FOR INDUSTRIAL AND MILITARY CAPABILITIES

Defence supply chain monitoring: Leveraging geopolitical challenges for sustainability gains

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Irina Patrahau is the Chair of the Energy Security and Critical Minerals initiatives at HCSS. Her work examines the dynamic interplay between geopolitics, energy, and raw materials: how geopolitical tensions and strategic competition shape the security, resilience, and diversification of energy and critical raw materials supply chains in the EU, and how energy systems, resource dependencies, and control over critical materials in turn influence state behaviour, strategic positioning, and international relations. Her research also focuses on the political economy of the energy transition, including emerging clean technology markets, low-carbon supply chains, industrial resilience, critical energy infrastructure, and the decarbonization of energy-intensive industries.

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ABSTRACT

Geopolitical challenges have intensified the need to strengthen monitoring across defence supply chains. Rising military tensions, trade conflicts, and the shifting global power dynamics have increased exposure to disruptions, ranging from raw material shortages to exports of strategic components being restricted. This essay argues that the growing momentum for monitoring supply chains for security reasons should be strategically used to strengthen sustainability reporting. While enhanced supply chain oversight does not automatically generate more comprehensive data on environmental or other sustainability objectives, establishing structured monitoring systems lowers the administrative and practical barriers to integrating additional indicators. It is essential that monitoring should enhance defence readiness rather than weaken it. A phased integration over time can support supply chain security, but also environmental goals.

Keywords: Monitoring | Supply chain | Security of supply | Sustainability

INTRODUCTION

Responding to the growing security threats on the continent, European leaders pledged to invest in the revitalisation and scale-up of defence industrial capacity during the 2025 NATO Summit[1]. The European Union (EU) aims to achieve full defence readiness by 2030, focusing on strengthening defence capabilities and enabling the European industry to deliver quickly and efficiently[2].

At the same time, many European militaries, including the Netherlands, France and Sweden, pledged to reduce greenhouse gas emissions[3]. While some military operational capabilities are difficult to decarbonize without harming operational effectiveness, "companies active in the defence sector are subject to the general expectation to become more sustainable in environmental, social, and governance dimensions", according to the European Commission[4]. The footprint of the defence industry is measured across the three emission scopes, including directly and indirectly from their own operations (scope 1 and scope 2), as well as from their supply chain (scope 3).

The opacity of defence supply chains is a challenge to achieve both supply chain security and sustainability. Lacking information about the actors and processes involved in defence supply chains makes it difficult to effectively address risks of disruption, but also to minimize the environmental footprint of the defence industry. The European defence industry has recently started to place more attention on systematically monitoring its supply chains to ensure security, in line with NATO's Defence-Critical Supply Chain Security Roadmap from 2024(NATO, 2024)[5]. Still, many of these efforts are early initiatives and require significant time and costs to achieve.

This essay argues that the growing momentum for monitoring supply chains for security reasons should be strategically used to strengthen sustainability reporting. Acknowledging sensitivities around the availability of information and the significant costs and time that would be required to fully monitor a supply chain, addressing the opacity of defence supply

[1] NATO. (2025). *The Hague Summit Declaration*. https://www.nato.int/en/about-us/official-texts-and-resources/official-texts/2025/06/25/the-hague-summit-declaration

[2] European Commission. (2025). *Preserving Peace—Defence Readiness Roadmap 2030*. https://defence-industry-space.ec.europa.eu/eu-defence-industry/readiness-roadmap-2030_en

[3] Dutch Ministry of Defence. (2021). *Defence Energy Transition Plan of Action: New energy in the organisation*. https://english.defensie.nl/binaries/defence/documenten/publications/2021/07/21/defence-energy-transition-plan-of-action/2020+07+16+Plan+van+aanpak+Energietransitie+Defensie_EN.pdf
French Ministry of Defence. (2022). *Climate & Defence Strategy*. https://www.defense.gouv.fr/sites/default/files/ministere-armees/Presentation%20Climate%20ans%20defence%20strategy.pdf
Swedish Ministry of Defence. (2025). *Sustainability*. https://www.forsvarsmakten.se/en/about-the-swedish-armed-forces/official-information/sustainability/

[4] European Commission. (2025). *Commission notice on the application of the sustainable finance framework and the Corporate Sustainability Due Diligence Directive to the defence sector*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CONSIL%3AST_12811_2025_INIT&qid=1757831232294

[5] NATO. (2024). *Defence-Critical Supply Chain Security Roadmap*. https://www.nato.int/content/dam/nato/webready/documents/factsheets/240712-Factsheet-Defence-Supply-Chain-Roadmap-en.pdf

chains is essential. It increases the resilience of the European defence industry by allowing for a more effective identification of bottlenecks and targeted interventions. In doing so, sustainability goals, including carbon footprint assessments, waste management and circularity, and sustainable material sourcing, can be an add-on that yields significant benefits with reduced costs. This would contribute to a more sustainable defence industry and it would support the defence industry's social license to operate.

DEFENCE SUPPLY CHAINS: OPAQUE, FRAGMENTED, COMPLEX AND SENSITIVE

Defence supply chains are highly complex, making it difficult to track the origins of materials and components[6]. The defence industry manufactures and assembles complex systems. These 'systems of systems' consist of thousands of components and subcomponents. Ministries of Defence collaborate closely with original equipment manufacturers (OEM) that assemble the systems. They are considered tier 1 suppliers. In general, European militaries work with OEMs from NATO countries or their partners. OEMs work with their own suppliers, who, in turn, work with other suppliers too. A single supply chain may involve thousands of actors spread across continents, creating opacity and fragmentation. For example, Airbus works with over 18,000 suppliers worldwide[7]. While it is typical for OEMs to know their first tiers of suppliers, it becomes increasingly challenging after the second or third tiers.

Defence supply chains are closely intertwined with civilian markets, adding another layer of complexity. Up to a certain point, the raw materials and components are sourced from dual-use providers[8]. Some of the most widely used raw materials in the defence sector are aluminium, graphite, tungsten, antimony, gallium, germanium and rare earth elements – all of which are part of the European Union's 2023 Critical Raw Materials list and NATO's 2024 list of defence-critical raw materials[9]. These materials are used by either dual-use providers to manufacture semiconductors, lenses or computers; or are made into high performance alloys like special steels or tungsten alloys. In the end, the components are bought by OEMs and assembled into complex systems like jet fighters, tanks or frigates.

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[6] Patrahau, I., & Girardi, B. (2025, March 27). Opaque Supply Chains may prevent ReArming Europe. *The Hague Centre for Strategic Studies*. https://hcss.nl/news/opaque-supply-chains-may-prevent-rearming-europe/

[7] Airbus. (n.d.). *Our Worldwide Presence*. Retrieved 25 February 2026, from https://www.airbus.com/en/about-us/our-worldwide-presence

[8] Patrahau, I., Girardi, B., & PwC. (2025). *Raw material and supply chain vulnerabilities in the Dutch defence sector: An analysis of the Air Defence & Command Frigate*. https://hcss.nl/report/raw-material-supply-chain-vulnerabilities-dutch-defence-sector-frigate/

[9] European Commission. (n.d.). *Critical raw materials*. Retrieved 25 February 2026, from https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en

Girardi, B., Patrahau, I., Cisco, G., & Rademaker,., M. (2023). *Strategic raw materials for defence: Mapping European industry needs*. https://hcss.nl/report/strategic-raw-materials-for-defence/

NATO. (2024). *NATO releases list of 12 defence-critical raw materials*. https://www.nato.int/en/news-and-events/articles/news/2024/12/11/nato-releases-list-of-12-defence-critical-raw-materials

For an OEM that operates at the end of the supply chain, it is very time- and cost-intensive to get in touch with every tier of suppliers involved in a defence system. When such information is required due to performance criteria and certification, like in aerospace, defence systems become much more expensive. What is more, suppliers of OEMs might not be willing to disclose their own supply chains due to business confidentiality. In order to maintain competitive advantage and ensure efficiency gains, suppliers might want to withhold information about who they work with. Additional details that are needed to monitor the operations of these suppliers is even more difficult to retrieve.

In addition, defence supply chains are also characterised by a high degree of information sensitivity. This sensitivity stems from the need to safeguard classified technologies and operational capabilities in the procurement process. To prevent espionage and intellectual property theft, the defence industry follows stringent compliance and security protocols.

The opacity, fragmentation, complexity and sensitivity of information in defence supply chains have led to uneven monitoring practices up to now. Defence companies like Thales, Lockheed Martin and Saab report across all three emission scopes, have set company-specific emissions reduction targets and joined different global voluntary schemes to this effect[10]. As such, the depth of data collected and reported on is uneven. As there are no industry-wide regulations, companies develop specific measurements and indicators, making it difficult to meaningfully assess and compare them[11].

At the same time, while the defence industry is generally included in European sustainability rules under the Corporate Sustainability Reporting Directive (CSRD) and the Corporate Sustainability Due Diligence Directive (CSDDD), the scope of their obligations is more limited than other sectors. For some dual-use products, reporting regulations in the civilian sector will automatically support defence monitoring too. For others, omissions remain. According to Article 3(1)(g)(ii) CSDDD, certain downstream activities relating to export-controlled military or dual-use products fall outside the due diligence "chain of activities" once export has been authorised[12]. Moreover, the European Sustainability Reporting Standards (ESRS) adopted

[10] Lockheed Martin. (2025). *2024 Sustainability Performance Report*. https://sustainability.lockheedmartin.com/content/dam/lockheed-martin/sustainability/2024-Sustainability-Performance-Report.pdf
SAAB. (2025). *Annual and Sustainability Report 2024*. https://www.saab.com/investors/reports-and-presentations/annual-and-sustainability-report-2024
Thales. (2025). *CSR Integrated Report 2024*. https://www.thalesgroup.com/en/sustainability-thales/reports-and-data

[11] Havstrup, E., Jonkers, L., & Van Schaik, L. (2024). Sustainable Security: Reducing Emissions in Military Supply Chains. In *World Climate and Security Report 2024: Military Innovation and the Climate Challenge*. https://hcss.nl/report/imccs-world-climate-and-security-report-2024-military-innovation-and-the-climate-challenge/

[12] European Union. (2024). *Directive (EU) 2024/1760 of the European Parliament and of the Council of 13 June 2024 on corporate sustainability due diligence and amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859 (Text with EEA relevance)*. http://data.europa.eu/eli/dir/2024/1760/oj

pursuant to the CSRD, allow companies to omit classified or sensitive information where disclosure would seriously prejudice their position[13].

The dependency of the defence industry on the civilian market has also brought some indirect benefits in supply chain sustainability, although proactive measures are still needed. Despite formal exemptions for certain military uses, the defence sector has had to align to standards such as the REACH regulation because suppliers operating primarily in civilian markets phased out non-compliant products/processes.

In short, despite some indirect and uneven progress, the defence industry has been excluded from stringent climate ambitions. On the one hand, this is to avoid interfering with the effectiveness of operational capabilities. On the other hand, reporting on emissions may unintentionally disclose other types of sensitive information around the location and activity of important suppliers of certain components and systems.

THE URGENCY TO START MONITORING DEFENCE SUPPLY CHAINS

The defence industry has been able to bypass certain reporting requirements, but geopolitical challenges bring urgency to enhance monitoring. Rising military threats, trade conflicts, and the shifting global power dynamics have made the defence sector more susceptible to disruptions, ranging from raw material shortages and unforeseen price increases to dual-use exports being restricted. As a result of great power competition, more than 10 critical raw materials have been affected by geopolitically-motivated export restrictions as of 2025, including gallium, germanium, antimony, graphite and seven types of rare earth elements[14]. Part of these restrictions, imposed by China, are meant to disrupt NATO's defence supply chains, which depend on these materials[15]. Cyber security requirements are also creating a parallel and reinforcing dynamic, pushing prime contractors to identify, assess and bring into conformity suppliers across multiple tiers.

Even though the defence industry operates with longer procurement timelines than the civilian sector, it might still be hurt by weaponised supply chains. It takes several years for a defence contractor after signing a procurement contract with a Ministry of Defence to deliver the final system. This is caused by design and engineering processes that ensure the highest performance of the system, rather than manufacturing and assembly. As such, under a

[13] European Union. (2023). *Commission Delegated Regulation (EU) 2023/2772 of 31 July 2023 supplementing Directive 2013/34/EU of the European Parliament and of the Council as regards sustainability reporting standards*. http://data.europa.eu/eli/reg_del/2023/2772/oj

[14] Liu, J., & Gan, N. (2025, June). *EU sounds alarm to China over rare earth export controls*. CNN Business. https://edition.cnn.com/2025/06/05/business/eu-china-rare-earth-export-controls-intl-hnk

Lv, A., & Munroe, T. (2024, December 3). China bans export of critical minerals to US as trade tensions escalate. *Reuters*. https://www.reuters.com/markets/commodities/china-bans-exports-gallium-germanium-antimony-us-2024-12-03/

[15] Soler, P. (2025). *Defence industry warns EU to 'urgently' curb dependence on rare earths*. Euronews. https://www.euronews.com/my-europe/2025/10/14/defence-industry-warns-eu-to-urgently-curb-dependence-on-key-raw-materials

business-as-usual scenario, the defence industry could relatively easily overcome temporary trade restrictions by simply waiting it out or paying a premium. The clean tech, transport or digital sectors that have much shorter turnaround times and are more heavily affected by short-term disruptions. Still, with most European Ministries of Defence placing new orders for defence systems, the industry's capacity to rapidly scale up and deliver could be inhibited by supply chain disruptions. Not only are the timelines increasingly more sensitive due to military pressure at Europe's eastern border, but the volumes are also increasing.

In this context, effective monitoring and robust due diligence are essential to achieve Europe's Defence Readiness goals for 2030 and beyond[16]. Dedicating resources, including human capital and financial support, to collect information about the setup of supply chains, assess vulnerabilities and develop risk mitigation strategies and contingency plans is a key enabler of European military readiness. Geopolitical due diligence is an insurance against risks. The upfront premium needed for achieving this goal should be measured against the significantly higher cost of failing to mobilise and protect NATO.

Increased reporting could also contribute to more sustainable practices and strengthen public acceptance. Increasing supply chain monitoring does not in itself generate more robust data on environmental and other sustainability objectives, as this depends on the type of indicators collected. Still, establishing structured monitoring lowers the practical and administrative barriers to incorporating additional environmental and social metrics over time. Once data-collection processes, supplier engagement mechanisms, and traceability tools are in place, integrating indicators such as scope 1-3 emissions, energy efficiency, or governance performance becomes less complex and costly.

This supports climate change mitigation by reducing the environmental impact, as well as adaptation efforts to changing weather patterns. In addition, given that the defence industry is gaining a central position in societal debates and receiving significantly higher governmental spending, it is essential to build a social licence to operate with the European public. Even though the defence industry cannot reduce emissions as fast as other sectors, Ministries of Defence and the private sector should still make efforts to contribute to broader sustainability goals.

WAYS FORWARD

To ensure that the increased European defence spending is done in a geopolitically resilient way that accounts for reduced environmental impact, gaining better insights into supply chains is essential. Monitoring defence supply chains requires a balance between transparency, operational effectiveness, and industrial feasibility. It is essential that

[16] *Commission and High Representative present new Defence Roadmap to strengthen European defence capabilities*. (2025). European Commission. https://defence-industry-space.ec.europa.eu/commission-and-high-representative-present-new-defence-roadmap-strengthen-european-defence-2025-10-16_en

monitoring should enhance defence readiness rather than weaken it. Moreover, monitoring should be an additional effort and not come at the expense of other military requirements or sensitive information. Five recommendations for Ministries of Defence to support effective monitoring in order to achieve readiness in Europe by 2030.

1. *Integrate monitoring in procurement requirements and commit to associated costs to ensure uptake*

Monitoring frameworks should be embedded in capability planning cycles and aligned with national, European and NATO readiness objectives. This implies first defining information needs in collaboration between the industry and Ministries of Defence early in procurement processes to ensure feasibility. Second, it implies incorporating supply chain transparency obligations into contracts and budgeting explicitly for the additional costs. This would ensure that monitoring is treated as a risk-mitigation instrument and is part of strategic defence investment rather than a compliance burden. To achieve this, existing European rules under the CSDDD and CSRD can be optimised and adapted so that they better fit the defence sector.

2. *Develop tailor-made monitoring concepts to create feasible targets*

Supply chains and associated risks differ for munitions, platforms, sensors, or digital subsystems. Among others, the risks depend on the number and complexity of sensitive components and sub-components; the characteristics, ownership and location of suppliers; the availability of substitutes. As such, monitoring requires differentiated approaches, based on risk assessments. High-risk product groups, such as items with limited and unreliable suppliers or a high quantity of critical raw materials usage, should be prioritised. At the same time, multi-tier models may be appropriate, including detailed mapping for critical components and lighter screening for lower-risk items. Such a step-by-step approach supports more manageable and realistic targets and could help increase uptake across the industry.

3. *Strengthen cooperation within the EU and NATO to avoid duplication and ensure a level playing field*

As the defence industry in NATO works with several Ministries of Defence simultaneously, it is essential that all NATO members impose the same requirements on industry. Developing and implementing harmonised frameworks reduce reporting burdens and enhance collective resilience. It also avoids competitiveness issues between NATO defence companies. The European Committee for Standardisation and NATO Standardisation Agreements (STANAG) offer opportunities for aligning methodologies and sharing non-sensitive data.

4. *Draw lessons from other sectors to create benchmarks and synergies*

Aerospace, digital technologies and energy provide well-documented examples of advanced supply chain monitoring practices, including risk assessments and risk mitigation strategies, digital traceability, and supplier-resilience assessments (ASML, 2023; Gauß et al., 2021; US

Department of Transportation, n.d.). The defence sector can learn from some of the practices and adapt them to its own context characterised by high security protocols as well as industrial feasibility. This can accelerate implementation but also create cross-sectoral benchmarking for improving existing practices and methodologies in the civilian sector too.

5. Leverage monitoring to reduce the defence industry's environmental impact and increase social acceptance

Monitoring systems can support more than contingency planning. They can improve procurement forecasting, provide early warnings of industrial stress, inform stockpile management, and help assess compliance with regulatory or ethical standards. Most importantly, they can support the sustainability of the defence sector. Once monitoring systems are in place, adding indicators that measuring performance in achieving sustainability goals becomes less burdensome. This does not just reduce the industry's environmental footprint, but it also encourages institutional and public support.

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