



# Sustainability for Resilience

How to Deliver NATO's 1.5% Resilience and Security Investment Target

E-PAPER

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Published by the Heinrich-Böll-Stiftung European Union | Global Dialogue  
March 2026

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# Executive summary

At the 2025 NATO Summit in The Hague, allies agreed to spend a total of 5% of GDP on defence by 2035, with 3.5% allocated to core military expenditures and 1.5% to security-related spending, including civil preparedness and resilience. Increased Russian hybrid aggression towards Europe, climate change and threats to hydrocarbon supply chains have exposed economic, societal and infrastructure vulnerabilities, which are driving an increased focus on resilience.

While NATO has mature governance and processes to manage the 3.5%, the definition of what counts towards the 1.5% is opaque, with greater clarity expected in 2026 to ensure standardisation, accountability and transparency. As European NATO members face severe political and economic pressures, they cannot risk inefficiencies.

Therefore, there is an incentive to spend the 1.5% on policies and projects that deliver benefits across multiple government portfolios by identifying areas of common interest. If well directed, increased funding could be channelled into infrastructure, resilience and nature restoration projects that could both support NATO's three core tasks and mitigate rising emissions and biodiversity loss.

Greater capacity for public transport, particularly rail, is required for military mobility and credible deterrence. Adaptable, decentralised energy systems making use of renewable generation and energy storage can enhance 'energy sovereignty' and make grids more resilient to physical attack. Decentralised electricity is most efficient and resilient when linked by high-capacity transmission interconnections and grid reinforcement, which is also required to facilitate the expansion of NATO defence industries.

Decarbonised technologies have defence applications and share dependencies on vulnerable mineral supply chains. Diversifying these supply chains and boosting R&D will improve both the resilience of defence and clean energy industries, and the competitiveness of the industrial base in NATO countries, while simultaneously supporting multinational industrial partnerships within the Alliance.

Finally, biodiversity loss is a threat to agriculture and ecosystem collapse and can have unpredictable consequences. Wetlands, marshlands and woodlands are important natural defences, which can be exploited to enhance NATO regional plans.

To ensure that this is delivered, NATO and European countries need to quickly define how best to allocate, monitor and coordinate these funds while building on NATO's existing processes and planning.

# Introduction

At the June 2025 NATO Summit in The Hague, in addition to spending 3.5% of GDP on core defence requirements by 2035, allies agreed to 'account for up to 1.5% of GDP annually to inter alia protect our critical infrastructure, defend our networks, ensure our civil preparedness and resilience, unleash innovation, and strengthen our defence industrial base'.<sup>1</sup> Expanding Russian conventional and hybrid aggression against Europe is driving this rapid increase in defence and security spending and a greater focus on resilience.

NATO societies in Europe are being increasingly targeted by hybrid actions, such as: damage to offshore infrastructure in the Baltic Sea; drone incursions into Poland, near Copenhagen airport and in the area of nuclear energy facilities in Belgium, amongst others; explosive parcels sent from Lithuania to Germany, Poland and the UK; and sabotage of rail infrastructure in Poland. These malign activities place more political pressure on governments to keep their people safe from immediate threats. Yet, European publics have other concerns, including myriad challenges emanating from climate change. Europe will not experience these threats equally: eastern states face the greatest threat from a potential Russian invasion. In any case, the over-riding political concern in European capitals is cost of living and squeezed government budgets. Governments are therefore likely seeking to maximise benefits from the new 1.5% spending target beyond traditional security.

Resilience is a national prerogative under Article 3 of the North Atlantic Treaty,<sup>2</sup> which states that 'by means of continuous and effective self-help and mutual aid, [member states] will maintain and develop their individual and collective capacity to resist armed attack'.<sup>3</sup> While member states should lead planning and implementation, if they are not accountable for their resilience spending, there is a risk of inefficiency, duplication and ultimately not realising the maximum value from increased funding, or not realising the increased funding at all. Consequently, in a similar way to how the NATO Defence Planning Process (NDPP) coordinates the spending of 32 allies on hard military equipment to underpin the NATO regional plans, a more prescriptive governance and accountability structure is needed to assess, manage and deliver enhanced resilience.

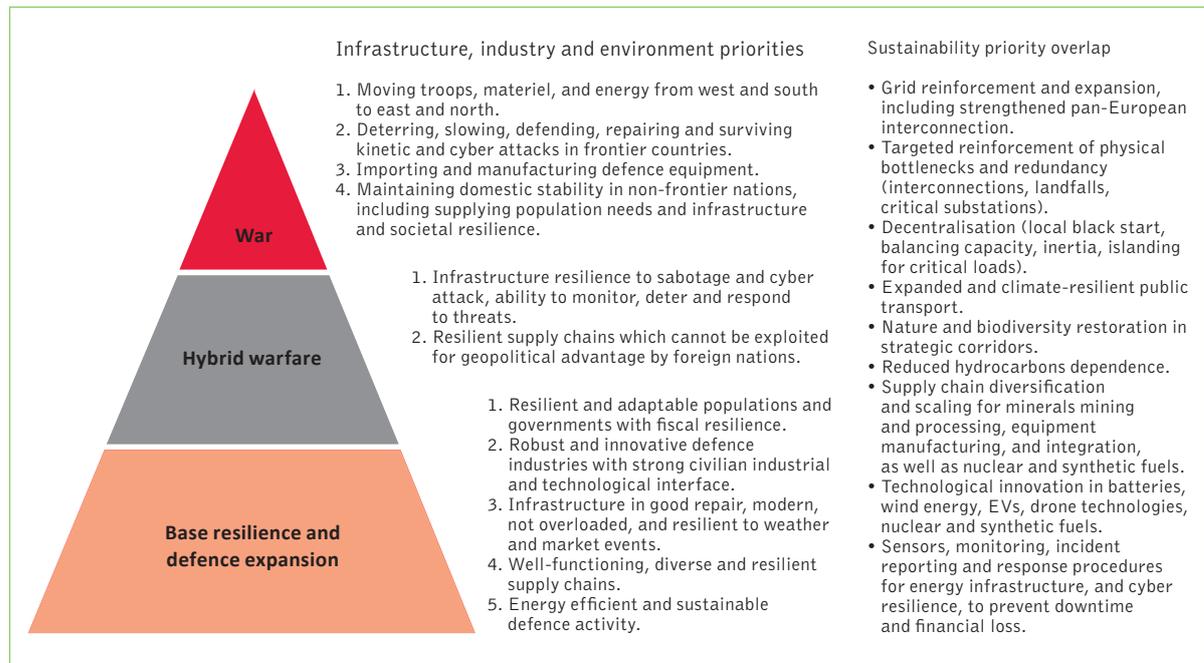
The **purpose** of this brief is to introduce a conceptual framework for NATO and EU governments to assess, plan and manage spending towards the 1.5% target by considering the goals of civil–military necessity, decarbonisation and environmental sustainability. It is intended to be a primer for NATO to develop and adopt its own framework in 2026. We focus

- 1 NATO, 'The Hague Summit Declaration', 25 June 2025, [https://www.nato.int/cps/en/natohq/official\\_texts\\_236705.htm](https://www.nato.int/cps/en/natohq/official_texts_236705.htm) (Accessed 10 November 2025).
- 2 This paper will use the term 'resilience' to collectively refer to each of the areas defined in the Hague Summit declaration: protection of critical infrastructure, network defence, civil preparedness and resilience, innovation, and strengthening the defence industrial base.
- 3 NATO, The North Atlantic Treaty, 4 April 1949, <https://www.nato.int/en/about-us/official-texts-and-resources/official-texts/1949/04/04/the-north-atlantic-treaty> (Accessed 4 December 2025).

on three themes: infrastructure, supply chains and technology, and the physical environment. It is not intended as an exhaustive analysis of the overlap between these themes.

The report argues that investments furthering decarbonisation and nature restoration can measurably support NATO’s core objectives. It will introduce a three-tier framework for assessment:

**Figure 1: A framework for aligning 1.5% defence spending with sustainability goals**



Source: Authors' research.

This paper has the following research questions:

1. How should investments in infrastructure and nature be assessed for the 1.5% target?
2. Can sustainable infrastructure projects support NATO core objectives and baseline requirements?

The research in this paper is based on two sources. First, desk-based research of primary and secondary sources. Second, a series of semi-structured consultations with NATO officials. This paper has been produced in partnership between the Heinrich-Böll-Stiftung European Union | Global Dialogue and the Royal United Services Institute (RUSI).

# 1. Conceptual Framework

Infrastructure, supply chains and the physical environment are critical enablers of NATO's three core tasks: deterrence and defence; crisis prevention and management; and cooperative security.<sup>4</sup> These tasks depend on the alliance's ability to move, sustain and protect forces, maintain societal continuity under stress, and deny adversaries the ability to disrupt operational and logistical systems.

They are underpinned by NATO's seven baseline requirements for national resilience:

1. Continuity of government and critical government services.
2. Resilient energy supply.
3. Managing mass population movement.
4. Resilient food and water resources.
5. Managing mass casualties.
6. Resilient civilian communications systems.
7. Resilient civil transportation systems.<sup>5</sup>

Each of these requirements depends on physical infrastructure, logistics corridors, industrial capacity, digital systems and a supportive physical environment. They underpin NATO's ability to operate across the peace-crisis-conflict continuum.

## 1.1. Differentiated roles in collective defence

Infrastructure, supply chains and the physical environment enable or constrain all core NATO objectives in Europe, not only resilience. But each Alliance member has a unique role in NATO's regional collective defence, depending on variables such as geography, industrial base and logistics networks. In the event of a war with Russia – taken as the base case in this report – existing infrastructure must enable defence industries and facilitate the flow of materiel, people and energy across the Euro-Atlantic area, from west to east and south to north.

The defence of Europe would therefore have differentiated, as well as common, requirements. NATO's strategic shift from deterrence by punishment to deterrence by denial or forward defence<sup>6</sup> suggests a plausible set of non-exclusive possible roles (member states would fulfil several of these roles to varying degrees), which would relate to regional defence plans:

<sup>4</sup> NATO, 'NATO 2022: Strategic Concept', 29 June 2022, <https://www.act.nato.int/wp-content/uploads/2023/05/290622-strategic-concept.pdf> (Accessed 5 December 2025).

<sup>5</sup> CIMIC-COE Handbook, '7.2. Seven baseline requirements', <https://www.cimic-coe.org/handbook-entries/welcome-to-the-cimic-handbook/vii-resilience/7-2-seven-baseline-requirements/> (Accessed 5 December 2025).

<sup>6</sup> Nele Loorents, 'NATO's Regional Defence Plans', International Centre for Defence and Security, Estonia, *Washington Summit Series No. 5*, July 2024, [https://icds.ee/wp-content/uploads/dlm\\_uploads/2024/07/No-5\\_NATOs-Regional-Defence-Plans\\_Nele-Loorents.pdf](https://icds.ee/wp-content/uploads/dlm_uploads/2024/07/No-5_NATOs-Regional-Defence-Plans_Nele-Loorents.pdf)

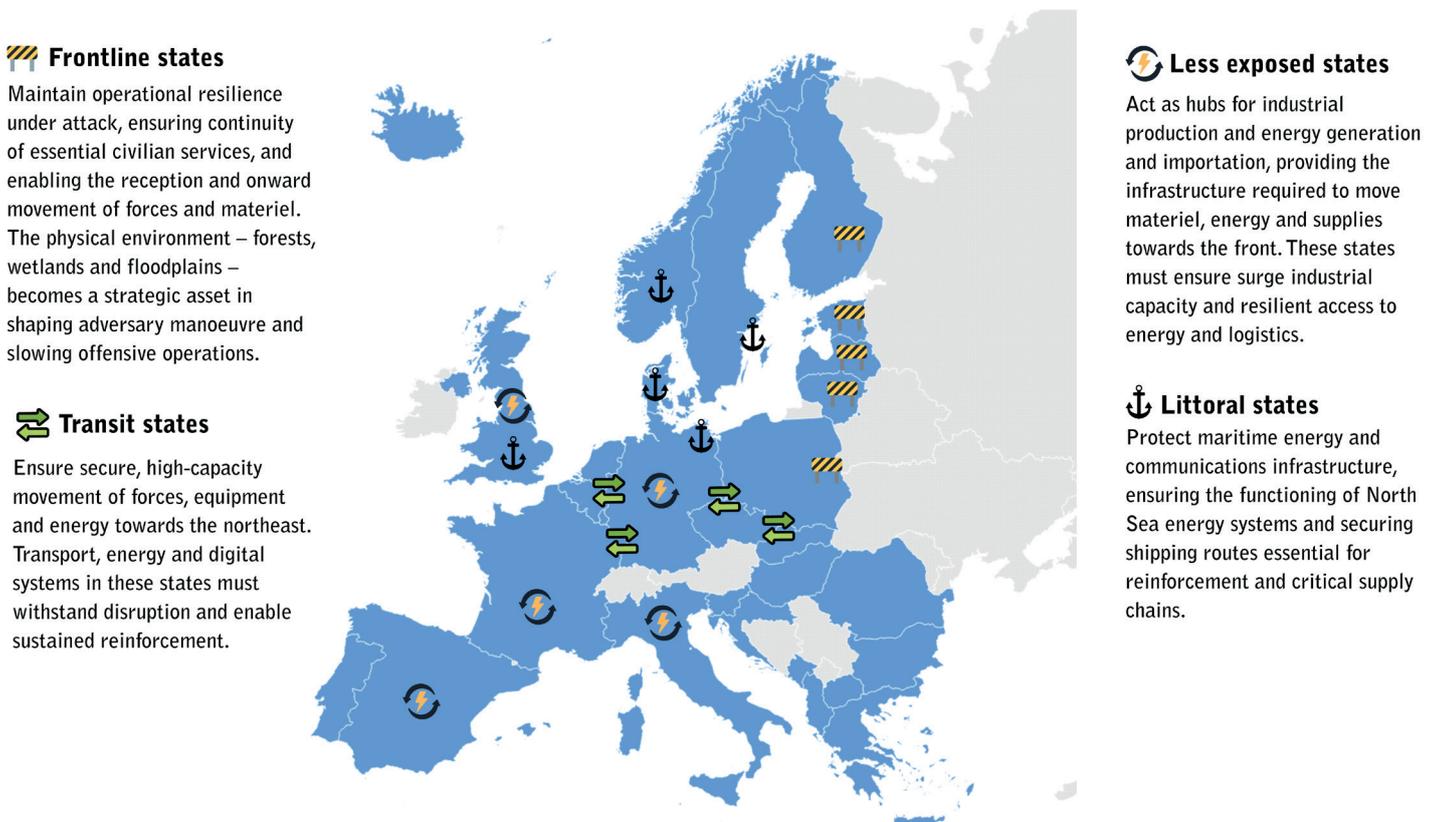
**Less exposed states (e.g. France, Italy, Spain and the UK)** act as hubs for industrial production and energy generation and importation, providing the infrastructure required to move materiel, energy and supplies towards the front. These states must ensure surge industrial capacity and resilient access to energy and logistics.

**Transit states (e.g. France, Germany, Czech Republic and Slovakia)** ensure secure, high-capacity movement of forces, equipment and energy towards the northeast. Transport, energy and digital systems in these states must withstand disruption and enable sustained reinforcement.

**Littoral states (e.g. Denmark, Germany, Norway, Sweden and the UK)** protect maritime energy and communications infrastructure, ensuring the functioning of North Sea energy systems and securing shipping routes essential for reinforcement and critical supply chains.

**Frontline states (e.g. Baltic states, Finland, Norway and Poland)** maintain operational resilience under attack, ensuring continuity of essential civilian services, and enabling the reception and onward movement of forces and materiel. The physical environment – forests, wetlands and floodplains – becomes a strategic asset in shaping adversary manoeuvre and slowing offensive operations.

**Figure 2: NATO Member States' differentiated roles supporting collective defence**



Source: Authors' research. Design: Joan Lanfranco.

## 1.2. Societal resilience and industrial base

Wartime objectives should define the highest priority projects, but these objectives depend on the ability of societies to absorb shocks and resist coercion and hybrid attacks. All alliance members have a role under Article 3 of the Washington Treaty to ensure that critical systems – energy, transportation, food and water systems, and the supply chains that sustain them – cannot be easily disrupted or exploited by adversaries.

Moreover, the ability to surge defence industrial production depends on resilient and adequate civilian infrastructure, including energy supply, logistics nodes, dual-use supply chains and resilience to cyberattack. Defence industrial R&D requirements in emerging and disruptive technologies are continuous and overlapping with civilian initiatives. Natural systems support resilient societies and, in particular, resilient food systems, as well as mitigating the impact of extreme weather and influencing physical manoeuvre in frontline regions.

The growing frequency of extreme weather events is also raising the baseline for resilience and adding to the demands on armed forces. Soldiers are called on to support the emergency services during and in the aftermath of storms, particularly when critical services fail. This increases the risk of compounding events, whereby domestic disaster relief and external demands create unsustainable pressure on the military. Consequently, robust infrastructure and resilient critical services are essential to reduce the risk of defence over-stretch.

## 1.3. National planning

Differentiated roles provide a benchmark for evaluating investments under NATO's 1.5% target for resilience and civil preparedness. Projects should be counted where they directly support a nation's role in collective defence or strengthen resilience against hybrid attack in line with the baseline requirements. As discussed, roles vary by geography, industrial capacity and operational function, so eligible investments will differ across member states.

Given these differences and the cross-sectoral nature of resilience, a national-plan approach is likely to be the most effective method for ensuring coherence and accountability. Member states would submit National Resilience Plans outlining the investments required to fulfil their role in collective defence and meet NATO's resilience objectives. NATO would assess these plans for alignment with military operational requirements, baseline requirements and defence industrial priorities through a new process based on how the NATO Defence Planning Process works.

The plans could be used to generate NATO guidelines and a defence-oriented resilience taxonomy, such that member states would select projects eligible under the taxonomy to achieve the objectives set out in national plans, which relate to collective resilience roles and regional defence plans. A NATO taxonomy could draw on comparable civilian taxonomies, such as the Climate Bonds Initiative's climate resilience framework.<sup>7</sup>

<sup>7</sup> Climate Bonds Initiative, "Designing a climate resilience classification framework", 2023, [https://www.climatebonds.net/files/documents/publications/Climate-Bonds-UNDRR\\_Resilience-Taxonomy-White-Paper\\_Jun-2023.pdf](https://www.climatebonds.net/files/documents/publications/Climate-Bonds-UNDRR_Resilience-Taxonomy-White-Paper_Jun-2023.pdf)

The weak linkage between national critical infrastructure planning and NATO regional defence plans is currently a strategic gap. At present, major investments in electricity grids, gas systems, ports, rail corridors, data infrastructure and clean energy are often planned through civilian, regulatory and climate processes with limited systematic alignment to NATO operational assumptions on reinforcement routes, host nation support, basing, mobilisation timelines and sustainment requirements. This creates a risk that infrastructure is formally compliant with resilience or decarbonisation objectives but not optimised for wartime operability, redundancy, protection and rapid recovery.

The approach outlined here allows NATO to integrate the 1.5% target with wider national objectives and NATO planning. As such, it provides a structured way to assess how sustainable energy systems, low carbon transport, dual-use supply chains and technology, and nature-based resilience projects can, and cannot, contribute to national roles and alliance tasks. Sections 2–4 provide examples for how this would work.

## **1.4. Accounting challenge**

Investment towards the 1.5% target is harder to account than traditional defence spending because infrastructure market structures differ significantly between member states, and because of the central role of private investment. In some member states, infrastructure is owned or financed by the public sector, whereas in other countries it can be privately owned and regulated. To maintain fairness and comparability, NATO may decide that only state-directed or mandated private-sector investments should be included in its accounting, while discounting purely commercial investments. National plans would allow this principle to be applied transparently.

An investment should count towards the 1.5% target if it: 1) is measurably additional for one or more Baseline Requirements, 2) supports national roles in reinforcement or sustainment under regional plans, including support for defence industrial supply chains, and 3) is government spending or state-directed or mandated private investment for resilience.

## **1.5. Limitations**

Limitations remain. GDP-based spending targets safeguard political signalling and burden-sharing optics, but they do not guarantee the delivery of real capabilities when economic growth slows or reverses. In a downturn, declining budgetary revenues typically lead governments to defer or cancel capital-intensive impact. This creates a structural gap between nominal commitment and physical delivery. Large-scale resilience investments are multi-year and lumpy in nature: interruptions erode industrial capacity, delay permitting pipelines and create long recovery tails. Without mechanisms that ensure multi-year continuity, the 1.5% target risks becoming pro-cyclical, weakening resilience precisely when security and system stress are highest.

EU Member States currently benefit from temporary fiscal flexibility for defence spending through national escape clauses under the Stability and Growth Pact, which generally cover the period up to around 2028. However, no permanent exemption or extended framework has yet been agreed for the period beyond this window (though discussions are ongoing). At the same time, NATO discussions increasingly point toward maintaining elevated defence and resilience spending well into the 2030s. This creates a potential discontinuity.

Permitting timelines for clean energy and grid infrastructure are a major structural risk: in several NATO member states, [the permit-granting process for large renewable projects can take almost a decade, and grid infrastructure permits often require 2–3 years \(medium voltage\) or 8–10 years \(high voltage\) to secure](#). These delays far exceed construction timelines and political investment windows, undermining the realisation of resilience outcomes and prolonging system vulnerabilities (e.g. residual gas dependency or lack of redundancy). Without much more rapid progress on permitting, development timelines will not line up with defence requirements.

## 2. Infrastructure

Infrastructure is critical for collective defence and societal resilience. Infrastructure determines: the speed of mobilisation, and therefore the credibility of deterrence; the ability to scale and sustain defence industrial production; the ability to supply the front with materiel and energy; and the achievement of the seven baseline requirements for societal resilience.

As allies have differentiated roles supporting collective defence, their infrastructure requirements are different. The 1.5% target gives allies the opportunity to better understand how their infrastructure supports collective defence, as well as domestic resilience. The process is also an opportunity to understand how different government priorities could be mutually reinforcing. While the issues discussed are relevant to almost all NATO members, the question is one of degree and priority.

Here, we examine how public transportation, decarbonisation, the energy transition and disruptive energy technologies can support member states' NATO responsibilities, within the framework set out in Section 1.

### 2.1. Frontline states

Frontline states are within range for Russia's long range strike capabilities and would face immediate attacks on infrastructure aiming both to disrupt military operations and to reduce the popular will to fight. Infrastructure resilience therefore has three goals. First, to have sufficient scale to serve military operational needs. Second, to be hard to disrupt, thereby enabling effective military operations. Third, to be hard to target or easy to conceal or defend, thereby reducing the incentive for an adversary to attack.

### 2.1.1. Rail networks

Military operations depend on road, rail and port infrastructure. The EU calls for a dual-use transport system that can support military mobility and minimise overall disruption.<sup>8</sup> A 2024 regulation for the development of the trans-European transport network requires EU countries to integrate military mobility into transport policy and identifies four priority multi-modal military mobility corridors. Rail plays a particularly important role in the European context. The EU's 2021–2027 Multiannual Financial Framework (MFF) allocated €1.69 billion (later growing to €1.74 billion) to 95 dual-use transport infrastructure projects in 21 countries, of which 45 are rail projects.<sup>9</sup> The next MFF 2028–2034 proposes to increase funding for dual-use transport tenfold to €17.65 billion.

The importance of civilian rail networks has been clear in Ukraine, with fighting often concentrated around rail hubs like Kupiansk, and a 22 km-long railway connecting western Ukraine with Slovakia opened in September 2025. Preparatory work is under way for additional European standard gauge track connecting to Ukraine and Moldova.<sup>10</sup> But cross-border military transportation in Europe remains constrained and rail networks struggle with large convoys of large and dangerous military equipment, such as explosives.

### 2.1.2. Decentralised electricity networks and system resilience

The Ukrainian experience illustrates how the strategic deployment of clean energy technologies, grid infrastructure and grid management technologies might deter attacks on energy infrastructure and improve resilience. Russia's war on Ukraine, as well as previous Russian military campaigns in Syria, Georgia and Chechnya, have been notable for the targeting of civilian infrastructure, particularly energy. Ukraine, in turn, has attacked Russian oil refineries and energy infrastructure to constrain its military offensive potential, illustrating the vulnerability of the hydrocarbon supply chain.

Some Ukrainian academics are calling for a transition to a more decentralised, localised energy system, including energy storage, and with regions able to self-sustain to deter attack.<sup>11</sup> These technologies may make targeting the energy sector more costly for an adversary because less damage is caused per asset deployed and repair is quicker. Demand

**8** European Commission, 'Joint communication to the European Parliament and the Council on military mobility', 19 November 2025, <https://defence-industry-space.ec.europa.eu/system/files/2022-11/Action%20plan%20on%20military%20mobility%202.0.pdf>

**9** Directorate-General for Mobility and Transport, 'Commission supports military mobility projects with €807 million', European Commission, 24 January 2024, [https://transport.ec.europa.eu/news-events/news/commission-supports-military-mobility-projects-eu807-million-2024-01-24\\_en](https://transport.ec.europa.eu/news-events/news/commission-supports-military-mobility-projects-eu807-million-2024-01-24_en)

**10** European Commission, 'Joint communication to the European Parliament and the Council on military mobility', 19 November 2025, <https://defence-industry-space.ec.europa.eu/system/files/2022-11/Action%20plan%20on%20military%20mobility%202.0.pdf>

**11** Sergii Saukh, 'A Structurally Variable Electric Power System Resistant to Terrorist and Military Threats', The 13th IEEE International Conference on Dependable Systems, Services and Technologies, DESSERT'2023 13-15 October, 2023, Athens, Greece; Sergii Saukh and Andriy Borysenko, 'Modeling of Local Power Systems Development under Conditions of Military Operations', The 13th IEEE International Conference on Dependable Systems, Services and Technologies, DESSERT'2023 13-15 October, 2023, Athens, Greece.

flexibility and energy efficiency are integral tools in this form of deterrence, as well as wider system resilience, because they reduce the impact on households when energy supplies are cut and they allow the grid to function with less generation available and at lower service quality. In future, vehicle-to-grid and, in the shorter term, networked household battery systems have the potential to similarly improve resilience to attacks.

Decentralisation does come with security risks, which must be addressed in planning and would benefit from additional research. These include cyber risks as electricity systems become more dependent on automation. Sufficient redundancy, balancing capacity, storage and ancillary services are required to prevent grids becoming more difficult to manage and potentially less resilient under stress. However, the resulting investments by distribution system operators in localised grid stability as distributed renewable systems connect to their networks has the potential to significantly enhance overall system resilience.

The Baltic states illustrate the distinction between formal system integration and effective resilience. Following synchronisation with the continental European grid in 2025, the Baltic power system is no longer an isolated 'energy island' in technical terms. However, the region remains structurally weak with regard to interconnection with continental Europe in terms of physical transfer capacity and redundancy. Total cross-border interconnection capacity across the Baltic region is limited relative to peak winter demand, and only a single direct land-based interconnector links the region to the continental European system, with remaining capacity dependent on subsea links to the Nordic system. Local balancing resources and system inertia also remain constrained following synchronisation. This configuration leaves the region as a peripheral and capacity-constrained node, where disruption to a small number of assets could rapidly translate into system stress, underscoring the importance of targeted infrastructure.

Consequently, electricity system resilience in the region requires: 1) targeted reinforcement of physical bottlenecks and redundancy (interconnections, landfalls, critical substations and compressor nodes); 2) investment in local system services and operational autonomy (balancing capacity, inertia, black-start and islanding for critical loads); and 3) protection and rapid repair capability for offshore and subsea infrastructure. These investments clearly strengthen NATO-relevant resilience and should be treated as eligible and prioritised under the 1.5% resilience category.

### **2.1.3. Behind-the-meter electricity generation and storage**

Behind-the-meter electricity generation and storage – such as solar and battery or, for large loads, solar, battery and thermal generation – can maintain critical services and industries while allowing electricity grid services to be prioritised. Similarly, the impact of grid outages on vulnerable households and larger residential buildings can be mitigated to some extent with oversized battery systems, particularly combined with solar generation, which can increase the time window in which to restore supply or move vulnerable people.

There are numerous examples of solar and solar-battery systems being deployed to power critical services such as water pumping facilities during outages in Ukraine.<sup>12</sup> In Africa, solar-battery mini-grids have proven resilient during conflict and challenging environmental conditions.<sup>13</sup> Solar plants have also played important roles during extreme weather events.<sup>14</sup> Such systems have the advantage of not depending on a consistent fuel supply and so can withstand siege and transportation disruptions, as well as being less vulnerable to theft by military actors.

## 2.2. Transit states

Transit nations have roles both as industrial and energy hubs, and in facilitating military mobility and energy flows from countries further from the front. Infrastructure in transit nations is likely to be a target for attack or sabotage as adversaries seek to disrupt logistics for military operations and to reduce public support for fighting.

### 2.2.1. Infrastructure backbones and resilient networks

Transport and energy infrastructure must therefore be resilient to attack and facilitate bulk transportation across the country and across borders. Electricity grid backbones and interconnections are key, alongside transport backbone corridors. For public transportation such as rail, this extends beyond just long-distance lines and transporting abnormal freight across borders, encompassing the capacity of the system to manage diverted traffic and support re-routing and idling. The Atlantic Response Force established in July 2024 commits NATO to being able to deploy 100,000 troops in 10 days and 200,000 troops in 30 days,<sup>15</sup> yet according to the European Commissioner for Sustainable Transport and Tourism, Apostolos Tzitzikostas, Europe's road and rail networks are not ready for war.<sup>16</sup>

- 12 Patrick Jowett, 'Solar to power Ukrainian community's water utility', 25 August 2025, <https://www.pv-magazine.com/2025/08/25/solar-to-power-ukrainian-communitys-water-utility/>; UNDP, 'EU and UNDP deliver solar systems to Mykolaiv to secure water access for 440,000 residents', 26 November 2025, <https://www.undp.org/ukraine/press-releases/eu-and-undp-deliver-solar-systems-mykolaiv-secure-water-access-440000-residents>; Nordic Environment Finance Corporation, 'Ukraine completes first solar-powered water treatment project', developmentaid.org, 24 September 2025, <https://www.developmentaid.org/news-stream/post/200407/ukraine-first-solar-water-treatment-project-chortkiv>
- 13 Energy Transition Africa, 'In the Shadow of Conflict, Solar Power is Rebuilding Lives in Goma', 17 July 2025, <https://energytransitionafrica.com/2025/07/18/goma-solar-mini-grid-energy-transition-drc/>; Baba Ahmed, 'Mali embraces solar power for rural areas but the challenges are still vast', AP News, 27 March 2025, <https://apnews.com/article/mali-electricity-energy-crisis-ea3846c19723b3bfbd275155440d1517>
- 14 Hiroko Tabuchi, 'Jamaicans have been turning to solar power. It paid off after the storm'. The Japan Times, 11 November 2025, <https://www.japantimes.co.jp/environment/2025/11/11/energy/jamaicans-solar-power-storm/>
- 15 Geopolitics and Security Studies Center, <https://www.gssc.lt/en/publication/the-history-of-natos-new-defence-plans-2014-present-saceur-and-the-strategy-gap/>
- 16 Barbara Moens and Henry Foy, 'Europe's roads and rail unfit for war with Russia, EU transport chief warns', 29 July 2025, <https://www.ft.com/content/d77d4c1d-da26-4624-8b77-2178d4ac1125>

The regional roles of transit states have practical implications. For example, from the perspective of collective security, France should help facilitate energy interconnections and logistics corridors from the Iberian Peninsula into central Europe. This would be positive for decarbonisation and resilience in Spain and Portugal by improving their ability to manage their grids. It would also increase access to their abundant solar and wind resources, which might be supplied to France to free up French generation for export eastward.

In the longer term, a growing proportion of military logistics is likely to use new technologies to improve efficiency and reduce dependency on hydrocarbon supply chains, such as electric vehicles or zero-carbon fuels. This could create new requirements for charging infrastructure, battery switching facilities and alternative fuel supplies in strategic corridors.

### **2.2.2. Enabling defence industries**

The resilience of the energy system to attack in transit states can be enhanced using the tools discussed in 2.1.2, namely decentralisation, local generation, demand flexibility, energy efficiency, and behind-the-meter generation and storage. But these measures do not need to be applied as intensively and can be focused on particular areas, such as hospitals, military and industrial sites.

Aligning defence and energy sector interests is essential, but this can be challenging. Defence and aviation have emerged as a major challenge for wind power, with the potential for wind turbines to impact radar, causing permitting delays or, in some cases, project cancellations. The issue can, in most cases, be addressed but requires better understanding of the problem and more effective means to coordinate between multiple energy and defence stakeholders.

There may also be a need for grid over-sizing and behind-the-meter generation in defence industrial areas and priority access to the grid. A well-known case in Norway, where defence manufacturer Nammo complained that its ability to expand a munitions factory was being impacted by grid capacity tied to a nearby TikTok data centre, highlights that defence industries are not receiving priority access to the grid.<sup>17</sup> BAE Systems and the Samlesbury Aerospace Enterprise Zone in the UK have similarly required major grid reinforcement to expand and port expansion across the continent is restricted by grid bottlenecks.<sup>18</sup>

Grid expansion, reinforcement, and behind-the-meter renewable generation and energy storage would support both NATO objectives and decarbonisation. Grid strengthening to manage more variable loads from variable renewable power and facilitate more localised generation is a central requirement of the energy transition. If grid upgrades are planned with defence needs, energy security and decarbonisation in mind, they can support multiple priorities simultaneously. Where measures such as behind-the-meter generation and storage are supported by public finance, they also have the potential to increase industrial competitiveness.

**17** Richard Milne, 'European ammunition maker says plant expansion hit by energy-guzzling TikTok site', *Financial Times*, 26 March 2023,

<https://www.ft.com/content/f85aa254-d453-4542-a50e-fa1171971ab0>

**18** SP Electricity North West, 'Council leader visits £7.5m Samlesbury Enterprise Zone site', 23 June 2021,

<https://news.enwl.co.uk/news/council-leader-visits-gbp-7-5m-samlesbury-enterprise-zone-site>

## 2.3. Littoral states

### 2.3.1. Offshore wind and interconnectors

Littoral states would have critical maritime roles during a high intensity war, including protecting offshore infrastructure and shipping. From the perspective of infrastructure and decarbonisation, the main challenges are protecting and making best use of offshore wind generation and electrical interconnectors.

Offshore wind benefits from being relatively distributed and because systems incorporating wind power are designed to continue operating should wind generation drop. For these reasons, wind represents a relatively less attractive target than other parts of the system, unless multiple plants can be impacted simultaneously, such as through a cyberattack.

However, offshore wind could play a heightened role in energy supply into western and central Europe in wartime as gas generation is potentially vulnerable, as discussed below. Protecting wind infrastructure and the interconnections that allow energy to be supplied into Europe is therefore a central wartime role for littoral states with significant offshore wind assets. While more costly to target than oil and gas infrastructure, wind power plants do have single points of failure, such as offshore and onshore substations and cabling, illustrating one of the potential advantages of developing a 'meshed' offshore grid connecting to multiple countries.

Offshore wind generation and electrical interconnections may also have potential to enhance maritime surveillance. Offshore wind already has significant monitoring capabilities, in some cases including undersea noise detection, flying object sensors and camera surveillance, while best in class electrical interconnectors can support distributed sensing. To date, there has been reluctance to share data, with concerns over commercial sensitivity and perceived limited benefits for private companies.

As large above-surface structures covering huge areas – the hub height of the He Dreiht offshore wind turbines in Germany, for example, are 142 metres high,<sup>19</sup> while the UK's Dogger Bank A, B and C have a combined development area of 1,425 square kilometres<sup>20</sup> – offshore wind farms may be useful sites for positioning additional defence sensors.

Data collection and sharing, clear responsibility and accountability for monitoring and reporting, and coordinated emergency response procedures could position wind power plants as important elements of both whole-of-society resilience and collective defence.

**19** EnBW, 'EnBW He Dreiht: First wind turbine on Germany's largest offshore wind farm to date produces electricity', 26 November 2025, <https://www.enbw.com/press/first-wind-turbine-from-enbw-he-dreih-t-produces-electricity.html>

**20** Dogger Bank Wind Farm, 'About the project', <https://doggerbank.com/about/>

## **2.3.2. Natural gas**

Reliable operation of the decarbonising grid and, in many European countries, heating currently depend on a consistent supply of fossil gas. Gas supply is likely to be the most vulnerable part of the energy system to attack because of its criticality to the system and the high concentration of infrastructure at critical nodes, particularly in the North Sea, such as key offshore hubs, processing terminals, pipelines and LNG import terminals.

Successful attacks on only a few of these could plausibly cause severe stresses to the European energy system, primarily through price effects, but also, in particularly adverse circumstances, potential shortages. Offshore platforms can be hard to defend and loss of life at one site could result in evacuation and cessation of operations at others. LNG jetties may be vulnerable to ramming in hybrid attacks and the direct military threat to subsea infrastructure has been apparent since the attacks on the Nordstream I and II pipelines in September 2022. Transatlantic LNG shipping may be vulnerable to submarine attack.

Reducing the criticality of gas infrastructure for electricity and heating will therefore increase resilience. The methods for reducing criticality are well known: strengthening the electricity grid, energy efficiency, demand flexibility, energy storage, renewable energy, network decentralisation, maximal use of biogas, and behind-the-meter generation and storage. But the resilience of Europe's natural gas supply will remain critical for resilience and collective defence for at least the next decade and targeted protection of critical nodes, rapid repair capability and system operability should not be neglected, even as criticality and demand reduce.

## **2.4. Less exposed states**

### **2.4.1. Electricity bottlenecks**

Western and southern states are less vulnerable to direct attack and could develop their core role as energy, industrial and logistics hubs for Europe. In wartime, countries such as Italy, Portugal, Spain and the UK would leverage industrial capacity to supply the war effort and would act as energy and logistics hubs, both producing and importing energy and goods for onward supply.

This requires an infrastructure focus on: 1) energy and transportation interconnection north or east and onwards through transit states, and 2) sufficient infrastructure for defence industrial surge. As with transit states, electrical interconnection and rail capacity are therefore critical and currently a notable bottleneck, particularly for southern countries.

Spain and Portugal both face major electricity transmission bottlenecks into Europe, which reduces the efficiency and security of their networks, increases European emissions and severely restricts the ability to surge electricity into Europe should it be needed. Spain and Portugal frequently have excess wind and solar generation capacity.

Italy is slightly better connected than the Iberian Peninsula, but transmission lines can be congested and interconnection capacity is small relative to the size of the system.<sup>21</sup> This means Italy is not only more highly dependent on hydrocarbons than necessary and has reduced electricity security, but that NATO has restricted access to a potential source of additional supply, and one that could both better exploit significant domestic renewable resources and act as a conduit for energy – whether electricity or gas – produced in North Africa.

#### **2.4.2. Logistics bottlenecks**

As with transit states, supporting defence industries and moving troops and materiel towards the front are potentially core roles, making over-sizing, reinforcing and protecting infrastructure in key areas as important. These states might also act as logistics hubs, making use of ports located in geographically more secure areas for goods imports redirected from Baltic and northern European ports, meaning that sufficient port and onward road and rail infrastructure is required. Similar to electricity, transport bottlenecks affect western and particularly southern states, including the Iberian Peninsula, Italy and Greece.

Spain has poor rail capacity through the Pyrenees, with lines that are often single-track, mixed use and capacity constrained, despite having large, modern and well-located ports. Italy similarly suffers from bottlenecks in its Alpine rail crossings, which are congested and where freight competes with strong passenger demand. Greek south-north rail links have limited capacity and are dependent on less modern Balkan transit, which may have a higher risk of sabotage or delay in a war situation. The UK rail network is at capacity and would similarly struggle to surge throughput without severe impact on other users.

Investment in increased rail capacity would therefore both reduce road use – and associated emissions – and support NATO's collective defence and societal resilience.

### **3. Supply chains and technology**

Defence manufacturing is dependent on civilian industries and demand for capacity utilisation, financing, supply chains and R&D. As the energy transition progresses and technological innovation has accelerated, the overlap between defence and clean energy industries has grown. This overlap encompasses multiple technologies and supply chains, and relates to both present operational requirements and to the evolving demands of future conflict.

**21** Gianluca Geneletti and Elisabeth Cremona, 'Money on the line: scaling electricity interconnection for Europe's energy future', Ember, 1 December 2025, <https://ember-energy.org/app/uploads/2025/12/Money-on-the-line-scaling-electricity-interconnection-for-Europes-energy-future.pdf>

Excluding infrastructure dependencies, shared interests in supply chains and technology might be categorised into three groups:

1. Supply of deployable or embedded technologies (e.g. batteries and battery-dependent technologies, digital integration technologies, power electronics, micro-grid and hybrid generation, and synthetic or bio-fuels) and related manufacturing and production capabilities (e.g. scalable production, quality control and surge production capacity).
2. Shared upstream supply chain dependencies (e.g. minerals, metals and chemicals).
3. R&D for new capabilities (e.g. better batteries, deployable micro-grids and ultra-efficient or compact electricity generation) and operational integration (e.g. how to operate an electrified heavy vehicle fleet, how to shuffle energy around an increasingly electrified battlefield and how to manage an alternative fuels supply chain).

### **3.1. Supply of deployable or embedded technologies**

Military use of dual-use clean energy technologies is increasing rapidly, most clearly relating to drones, power systems, sensors and energy storage. In parallel, the proliferation of electricity-dependent equipment is increasing the demand for electricity supply, which clean energy and grid technologies can help to serve.

#### **3.1.1. The electric tech stack**

Batteries have become an enabling technology in the military operational environment.<sup>22</sup> They have both a determinative impact on the capability of other technologies (such as the range and payload of a drone or vehicle) and in Ukraine have proven an effective means of energy transfer to the frontlines, able to pass through, and be operated more safely in, areas where drones make movement very difficult. Near silent operation and low heat signatures make batteries and battery-dependent systems more difficult to detect than hydrocarbon alternatives. The motors in electric vehicles enable true four-wheel drive and enormous torque for challenging terrain. Deployable micro-grids and grid extension using underground cables is another potential route to supply growing frontline electricity needs.

The performance of modern batteries is determined as much or more by the digital integration of the system than by battery chemistry or production quality. This means that the capability of the technology within which the battery is embedded is tied to a suite of digital technologies to which both defence and clean energy industries require access, not only to the battery cells and packs themselves.

The performance of many military and clean energy technologies is also dependent on the same sensors. These monitor electrical and system characteristics, component performance, autonomous operation, the operational environment (heat, weather, etc.), and anomaly detection, allowing systems to be managed in a way that is secure, efficient and distributed.

**22** Lukas Trakimavicius, 'Wanted: More Batteries for Defence', *RUSI Commentary*, 15 October 2025, <https://www.rusi.org/explore-our-research/publications/commentary/wanted-more-batteries-defence>

This has created interest, particularly in investment and engineering communities, in what some are calling the 'electric tech stack' or 'electro-industrial stack' in defence.<sup>23</sup> The wider concept is that the electric tech stack is the set of core technologies that connect digital and physical systems through autonomous processes. More narrowly, this is sometimes put in the context of the core technologies required to produce smaller electric drones and other robotics: lithium-ion batteries, permanent-magnet electric motors, power electronics, computer chips, and their digital architecture.

Being able to produce these technologies at scale requires sufficient control over the supply chains of critical components, which are used in the manufacturing of an increasingly large proportion of civilian and defence products, as well as demand from civilian industries.

The importance of supply chains and of scale and experience in manufacturing raises doubts about the ability of NATO defence industries to remain close to the cutting edge in the absence of related thriving civilian manufacturing industries. Does Europe, for example, need a sovereign battery cell and precursor manufacturing capacity and to what extent do, and will, defence technologies therefore depend on the success of Europe's struggling civilian automotive and clean energy industries?

### **3.1.2. Clean energy technologies**

By definition, clean energy technologies offer the possibility of reducing dependence on hydrocarbon supply chains. This has major operational benefits for the armed forces, which are well understood. Ukrainian strikes on Russian oil refineries have once again illustrated the vulnerability of hydrocarbon supply chains, a feature of most wars since oil began its ascendancy to be the pre-eminent energy source in the early 20th century.<sup>24</sup> US and British experience in Afghanistan had already revealed the vulnerability of fuel supply, as fuel convoys were frequently targeted. Measures that reduce operational fuel consumption thereby increase the safety of soldiers.

In a high-intensity war, increased availability of zero carbon technologies, particularly for transport, allows potentially scarce oil resources to be targeted where they are most needed. Furthermore, although defence budgets are gradually increasing, funding pressure in defence is significant and many gaps in defence procurement remain to be filled. The cost saving potential of renewable technologies, energy-efficient building and equipment design, demand flexibility, electrified transportation, and better use of these within large defence estates would contribute to the more efficient use of defence funding.

**23** See, for example, Noah Smith, 'Why every country needs to master the Electric Tech Stack', *Noahpinion*, 23 September 2025, <https://www.noahpinion.blog/p/why-every-country-needs-to-master>; Ryan McEntush, 'The Electro-Industrial Stack Will Move the World', *Andreessen Horowitz*, 25 August 2025, <https://a16z.com/the-electro-industrial-stack-will-move-the-world/>

**24** Rosemary Kelanic, *Black Gold and Blackmail: Oil and Great Power Politics*, Cornell University Press (15 May 2020).

## 3.2. Dual-use supply chains

Consequently, both defence and clean energy depend on related supply chains and have shared interests in the success of industrial policy and supply chain strategies to improve supply chain security, particularly around minerals and mineral processing, which are heavily concentrated in China, as well as performance and scale. Defence accounts for only a very small proportion of demand for these minerals and processed metals and chemicals; however, it is also often the least cost sensitive consumer, as only a small proportion of the total cost of most military equipment is accounted for by mineral mining or processing.

As a result, there is potential in some cases for defence demand to crowd in private financing to projects that increase supply chain security and diversity, by anchoring some proportion of offtake and/or providing public investment. The requirement to invest in these supply chains is recognised by NATO through its critical minerals list, as well as the independent lists of many member states.<sup>25</sup> Chinese export controls on rare earths in 2025 – building on restrictions on many other minerals that have accumulated rapidly since 2023 – in response to US tariffs demonstrated the scale of the leverage China now has through these supply chains. This is impacting both Western industrial competitiveness, which suffers from fragmented supply chains and dependence on China, and security.<sup>26</sup>

## 3.3. R&D synergies

As technology and supply chain dependencies converge, defence and civilian synergies increase in R&D. Defence use cases often require high performance and resilience standards and, as importantly, highly effective operational integration, which are also needed for civilian applications. Capabilities such as battery switching, specialist batteries, deployable and highly resilient micro-grids and micro-generation, and high intensity usage are necessary for defence adoption. An R&D focus on enabling technologies such as batteries, sensors, digital integration, power electronics and electric motors promises to improve capability across a huge range of applications, while gradually making new capabilities possible.

This means that increased defence-civil industrial collaboration on R&D in these technologies could potentially yield major defence, economic and environmental benefits. But the industrial ecosystem and associated supply chains required to sustain the R&D effort must be retained and reinforced for this to happen.

**25** NATO, 'NATO releases list of 12 defence-critical raw materials', 11 December 2024, <https://www.nato.int/en/news-and-events/articles/news/2024/12/11/nato-releases-list-of-12-defence-critical-raw-materials> (Accessed 17 December 2025).

**26** Dan Marks, 'Pick Your Poison: China in the UK Energy System', *RUSI Commentary*, 10 February 2025, <https://www.rusi.org/explore-our-research/publications/commentary/pick-your-poison-china-uk-energy-system>; Dan Marks and James Henderson, 'Navigating Clean Energy Industries and Rivalry in Decarbonisation', *RUSI Research Report*, 12 December 2024, <https://www.rusi.org/explore-our-research/publications/occasional-papers/navigating-clean-energy-industries-and-rivalry-decarbonisation>; Michal Meidan, Philip Andrews-Speed and Dan Marks, 'New Energy Supply Chains: Is the UK at Risk from Chinese Dominance?', *RUSI Research Report*, 16 November 2023, <https://www.rusi.org/explore-our-research/publications/occasional-papers/new-energy-supply-chains-uk-risk-chinese-dominance>

# 4. The physical environment

## 4.1. Strategic nature restoration for defence in vulnerable regions

In February 2022, to support the defence of Kyiv, Ukrainian forces deliberately damaged a dam on the Irpin River to flood a boggy floodplain to the north and delay the Russian advance.<sup>27</sup> Then, in June 2023, the Nova Kakhovka dam on the Dnipro River was destroyed, flooding downstream, which enabled the Russian withdrawal to the east of Kherson and prevented Ukrainian forces from pursuing. Each of these incidents highlights the defensive importance of wetlands and peatland, the restoration of which could both support climate targets and delay advancing military forces.

Militaries using natural defences to their advantages – especially in defensive operations – is nothing new. However, the threat from Russia has pushed national governments and defence planners in frontier regions to reconsider the value of nature restoration in strategic areas. Europe faces a significant threat from a more aggressive Russia, yet still has relatively small professional armies, which must be mobilised across many member states. This increases the importance of features which might slow a potential Russian advance.

The benefit is clear in frontline states such as Estonia.<sup>28</sup> The country has two large lakes, Lake Peipus to the north and Lake Pihkva to the south, which create only two viable axes of advance for Russian manoeuvre ground forces. Lake Peipus leaves a gap of just 45 km in the Narva area in the north, with a Russian division frontage of between 15–25 km, creating a narrow concentration of forces.

Slowing this advance – or making these routes impassable – through wetland restoration would allow NATO strike capabilities to degrade Russian forces. Moreover, it could force a Russian advance further south in the Pskov direction, which would allow NATO the advantage in preparing man-made defensive areas and defensive fire support to cover them.

In another example, Poland has announced its €2.4-billion Eastern Shield defensive plan to prevent a Russian invasion.<sup>29</sup> This initiative will likely blend man-made military defences such as anti-tank trenches alongside restoring natural wetlands and reforesting areas to delay any Russian advance.

**27** Politico, 'From Kyiv to the Suwalki Gap, bogs return as Europe's defensive shield', 26 August 2025, <https://www.politico.eu/article/russia-defense-kyiv-ukraine-nato-eu-bogs-poland-war-germany/> (Accessed 27 November 2025).

**28** Politico, 'Estonia considers restoring ailing bogs to protect against Putin', 28 August 2025, <https://www.politico.eu/article/estonia-considers-restoring-ailing-bogs-protect-against-vladimir-putin-peatland/> (Accessed 27 November 2025).

**29** Politico, 'Poland's eastern Maginot Line raises nature worries', 22 June 2024, <https://www.politico.eu/article/poland-eastern-maginot-line-bialowieza-forest-war-defense-east-shield-program-nature-preservation/> (Accessed 17 December 2025).

# 5. Conclusion and policy recommendations

NATO's 1.5% resilience and security-related spending target creates an opportunity to strengthen collective defence while also advancing decarbonisation and environmental sustainability. Yet without a clear governance and accounting approach, the 1.5% risks inefficiency, duplication and politicised re-labelling of domestic spending. This report proposes a role-based framework aligned with NATO's core tasks and Baseline Requirements for national resilience. It argues that Allies have differentiated infrastructure, industrial functions and environmental functions in a high-intensity conflict: rear-area hubs must sustain energy and industrial output; transit states must enable secure movement and reinforcement; littoral states must protect offshore infrastructure and shipping; and frontline states must maintain essential services and operational resilience under attack. Across the peace-crisis-conflict continuum, resilience also depends on robust supply chains, dual-use technologies and the ability to surge defence industrial production. Within this framework, sustainable investments – grid reinforcement, decentralised energy and storage, rail capacity, supply-chain diversification, and strategic nature restoration – can be assessed objectively in terms of measurable contributions to resilience and national wartime roles.

Recommendations:

- **Define and standardise eligibility for the 1.5% target by 2026**, using clear criteria tied to NATO's Baseline Requirements, national wartime roles and measurable additionality, to prevent relabelling of routine spending and ensure accountability.
- **Require all Allies to submit National Resilience Plans**, aligned with NATO regional defence plans, setting out how proposed investments support their differentiated roles in collective defence and resilience against hybrid attack.
- **Prioritise dual-use infrastructure that accelerates military mobility and industrial surge**, particularly rail capacity, port connectivity and electricity grid reinforcement, where benefits to deterrence, emissions reduction and economic resilience coincide.
- **Invest systematically in decentralised and resilient energy systems**, including renewable generation, storage, demand flexibility and behind-the-meter solutions, to reduce vulnerability to attack on concentrated gas and grid assets while supporting defence estates and critical services.
- **Use the 1.5% to crowd in supply-chain security and industrial capacity**, anchoring investment in critical minerals, processing and the 'electric tech stack' through public finance, offtake guarantees and defence-civil R&D collaboration.
- **Integrate defence requirements into energy and infrastructure planning decisions**, ensuring priority grid access, coordinated permitting and anticipatory oversizing for defence industries and strategic transport corridors.
- **Recognise strategic nature restoration as a long-term resilience investment**, funding wetlands, floodplains and forest restoration in frontline regions where ecosystems can delay manoeuvre, protect food systems and help mitigate climate-driven instability.

## Imprint

Published by

**Heinrich-Böll-Stiftung European Union | Global Dialogue, Brussels**

Rue du Luxembourg 47-51, 1050 Brussels, Belgium

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Place of publication: <https://eu.boell.org>



Release date: March 2026

Proofreading: Chris Meikle

Edition: Joan Lanfranco, Head of Communications and Outreach, Heinrich-Böll-Stiftung  
European Union | Global Dialogue, Brussels

Layout: Micheline Gutman, Brussels

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