



Connecting capital to capability:

An energy security investment framework to optimize the NATO 1.5 percent investment commitment

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NATO's pledge of up to 1.5 percent of GDP toward resilience presents an opportunity to drive energy security improvements throughout the alliance, an increasingly relevant requirement for bolstering defense capacity and economic strength.

■ Introduction

Russia's 2022 invasion of Ukraine and its subsequent attacks on Ukrainian infrastructure sounded an alarm for both the European Union and NATO. When its so-called special military operation failed to produce a quick and decisive victory, the Russian military, which had initially preserved Ukraine's physical infrastructure, began to attack it directly, giving this conflict distinct characteristics of total war. Russia's strategy did not go unnoticed in Brussels, and nine years after national resilience requirements were first outlined at the 2016 Warsaw Summit, NATO announced at The Hague a commitment to invest 5 percent of gross domestic product into defense-related capabilities, including up to 1.5 percent for resilience. Elsewhere, the closure of the Strait of Hormuz, repeated attacks on Baltic subsea infrastructure, and the vulnerability of other energy choke points further reinforce the need for members to add resilience as a defense spending priority.

The key questions raised are: What can NATO and member states do to better address energy security and what does the desired end state look like? In which capabilities should investments be made to ad-

vance it? And what types of public capital should be aligned against those investment targets?

Ten years of Russian targeting, from the 2015 Sandworm cyberattack through approximately 4,500 strikes on Ukraine's energy system in 2025 alone, offer the strongest evidence available. Our research, reinforced by lessons learned in Ukraine and other conflicts and backed by analyses from multiple research agencies, including NATO's own Science and Technology Organization, has found that the desired end state rests on three pillars, each pairing a lesson with a capability gap and an action (see figure 1). The three pillars are:

- System reinforcement, decentralization, and hardening (physical and digital);
- Logistical foresight and stockpiling; and
- Emergency response and civil-military coordination.

Turning these pillars into meaningful spending requires a "referee" to determine what counts. The NATO Energy Planning Group, already charged with oversight of the resilient energy supply requirement, should

issue clear, consistent qualification guidance, anchored by a formally announced commitment at the Resilience Committee level. One investment rule should apply to all thirty-two members. Although each will tailor its specific projects according to national priorities, qualifying investment counts toward the commitment of the member that funds it, regardless of where it is located or when it is planned, and it is credited when money is spent. Within that single standard, three tiers of public finance run through every pillar: system and infrastructure enabling investment, early deployment and scaling of near-commercial technologies, and R&D and first-of-a-kind spending,

with public money directed at the gaps the private sector does not fill.

Building a comprehensive and effective energy system capable of meeting civilian and military energy demands, hardened physically and digitally and resilient to disruption and attack, will be a generational challenge requiring investment over time. Ukraine has paid for these lessons under fire, but NATO retains the advantage of learning them in peacetime. The 2029 progress review set at The Hague is the natural forcing function, and the alliance should arrive at it with this framework already converted from proposal to measurement.

Figure 1: NATO's energy security rests on three pillars, with a lesson, capability gap, and action

	Pillar 1: System reinforcement, decentralization, and hardening (physical and digital)	Pillar 2: Logistical foresight and stockpiling	Pillar 3: Emergency response and civil-military coordination
Lesson	Decentralized, digitized, and defended systems survive; concentrated single points of failure do not.	Dispersed, hardened storage blunted Russian targeting; long-lead equipment availability is essential.	People, not equipment, kept the lights on.
Capability Gap	The European grid remains under-interconnected, under-instrumented, and exposed to physical and cyberattack.	Fuel deserts, thin equipment reserves, and transformer supply chains are now measured in years.	Repair capacity, assistance agreements, and civil-military coordination are designed for peacetime weather, not attacks on the energy grid.
Action	Optimize current infrastructure while leveraging decentralized resources through cross-border grid enablers; Early deployment and scaling of long-duration energy storage (LDES), small modular reactors, and distributed generation; Cyber hardening of grid control systems to a NATO standard.	Civil fuel-distribution investment and hardened import infrastructure from terminal to end user, connecting to the NATO Pipeline System expansion; Stockpile transformers and critical repair items, dispersed, hardened, secured, and procured through multiyear committed contracts that expand manufacturing capacity.	Standing cross-border mutual-assistance compacts negotiated for wartime conditions; funding for training pipelines and reserve teams for grid repair; Integration of energy operators into NATO exercises, executed where possible by building on mechanisms the EU has already set in motion.



NATO Secretary General Mark Rutte speaks at a press conference at The Hague Summit 2025. Source: NATO

■ A vision for NATO energy security

Energy is fundamental to national survival in peace and in conflict, both as the cornerstone of a modern economy and as a precondition for fighting and winning wars. To NATO's east, the Russian war against Ukraine has made energy a central consideration for European security, with energy infrastructure proving a high-priority strategic target. Energy underpins economic continuity as well as many modern defense systems, and shocks due to armed conflict expose the fragility of that dependence.

Resilient energy supply is one of NATO's seven baseline requirements for national resilience, a focus the alliance has sharpened since the 2016 Warsaw Summit urged enhanced energy security and noted the importance of energy supplies,

routes, and member state responsibilities.¹ In its most recent Strategic Concept, announced in 2022, NATO articulated the importance of energy security in an environment characterized by increasing coercive use of energy by authoritarian states and nonstate actors.²

At the 2025 Hague Summit, NATO entered a transformational phase with the announcement of a new, headline investment target of 5 percent of member-state gross domestic product (GDP), comprising an increased 3.5 percent of GDP for core defense-related spending and a new pledge of up to 1.5 percent of GDP by 2035 to "protect critical infrastructure, defend our networks, ensure our civil preparedness and resilience, unleash innovation, and strengthen our defense industrial base."³ This new commitment presents an opportunity to drive energy security improvements throughout the alliance, long

1. NATO, "Warsaw Summit Communiqué," July 9, 2016, <https://www.nato.int/en/about-us/official-texts-and-resources/official-texts/2016/07/09/warsaw-summit-communication>.
2. NATO, "NATO 2022 Strategic Concept," June 29, 2022, <https://www.nato.int/en/about-us/official-texts-and-resources/strategic-concepts/nato-2022-strategic-concept>.
3. NATO, "The Hague Summit Declaration," June 25, 2025, <https://www.nato.int/en/about-us/official-texts-and-resources/official-texts/2025/06/25/the-hague-summit-declaration>.

overdue and increasingly relevant for defense capacity and economic strength. While the commitment is new, the underlying responsibilities are not. Under Article 3 of the NATO treaty, each member state must develop its capacity to resist armed attack,⁴ and this national and collective resilience is foundational to NATO's purpose of safeguarding its members.⁵

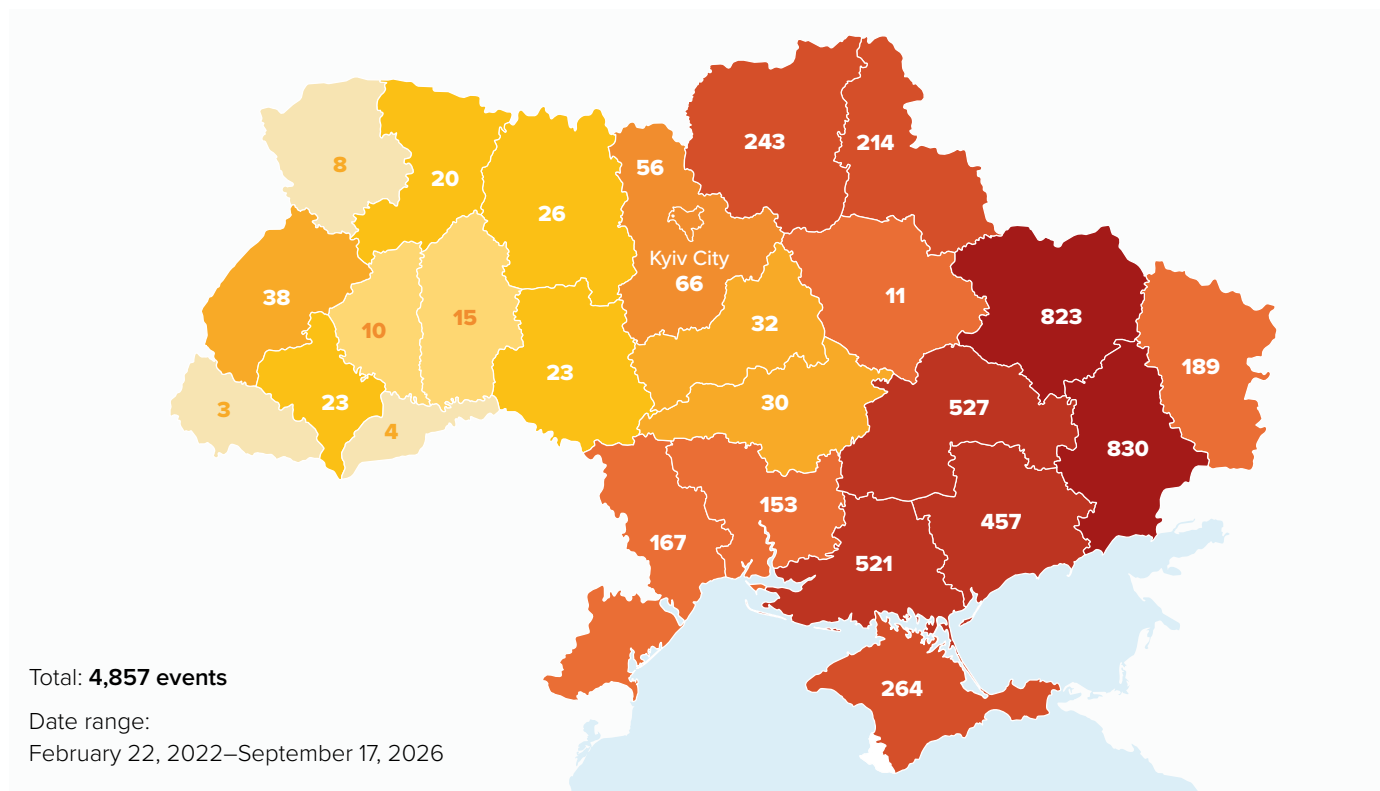
While energy disruptions in Ukraine and beyond have exposed vulnerabilities across NATO energy systems, NATO currently lacks a coherent investment framework linking risks, gaps, and energy resilience priorities across Europe. However, the challenge is not NATO's alone. The European Union (EU) has a role in driving integration across Europe, but the security focus and new mandate put NATO in a unique position to orchestrate investments responsive to the geostrategic environment facing the continent. Beyond the EU's funding instruments and regulatory role in the internal energy market, NATO brings the threat assessment, military-utility perspective, and the convening authority to define, and count, what qualifies as resilience investment. The framework proposed here

assigns NATO the role only it can play, setting the standard for what counts, while leaving the financing and regulation of energy infrastructure where they already reside: with the EU and NATO member states, who will decide for themselves which projects to pursue depending on their specific needs.

The end state this commitment should buy is concrete: a modernized, interconnected NATO energy system, hardened physically and digitally, insulated from coercive supply shocks, and designed around the strongest evidence available, Ukraine's defense of its own grid.⁶ All of those requirements can be addressed by a coordinated investment framework: member states focus on their own capability gaps, connected under alliance-level direction from the NATO Resilience Committee and its Energy Planning Group (EPG), which addresses the broader threats and risks no single member owns. This should not be treated as committee work or an afterthought. It is core leadership activity, ensuring adherence to Article 3 while protecting against Article 5-level threats and the gray-zone attacks that damage civil society and military readiness alike.

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4. The North Atlantic Treaty, art. 3, April 4, 1949, <https://www.nato.int/en/about-us/official-texts-and-resources/official-texts/1949/04/04/the-north-atlantic-treaty>.
 5. NATO, "Resilience, Civil Preparedness and Article 3," November 13, 2024, <https://www.nato.int/en/what-we-do/deterrence-and-defence/resilience-civil-preparedness-and-article-3>.
 6. International Energy Agency, *Energy System Resilience: Lessons Learned from Ukraine*, 2026, <https://www.iea.org/reports/energy-system-resilience/executive-summary>.

Figure 2: Russian attacks against Ukraine's energy infrastructure



Note: Events include battles, air and drone strikes, shelling attacks, and other.
Source: Armed Conflict Location & Event Data (ACLED)

Lessons from Ukraine: Energy security is national security

One of the initial salvos in Russia's energy war against Ukraine was the 2015 cyberattack on Ukrainian energy companies by the Sandworm Group, compromising three energy distribution companies and thirty substations, and leaving 230,000 Ukrainian citizens without power. This was the first known blackout caused by malicious software and the first deliberate strike by Russian-aligned forces on the Ukrainian energy grid.⁷ Despite this warning, little was done to prepare the electrical grid and energy system—and that window to prepare snapped shut in February 2022. Attacks on the grid continued and became kinetic, as Russia's aggression in Ukraine evolved into a

full-scale conventional invasion of its neighbor and the civilian energy grid was identified as a critical center of gravity supporting national resilience.

Russian shellfire, missiles, and eventually drones began striking the power grid of Ukraine on a steady cadence, and repair crews are locked in a constant battle to restore basic utilities to a country that relies on this grid for heat and light during the freezing winter months (see figure 2). These attacks, part of Russia's Strategic Operation for the Destruction of Critically Important Targets, are aimed at striking an enemy state's critical national infrastructure to demoralize the population, according to the UK Ministry of Defence.⁸ And indeed, "it is civilians who have borne the brunt of the Russian tactic of trying to turn the

7. "Inside Sandworm: Decade of Cyber Sabotage and Espionage Activity," Picus Security, January 7, 2026, <https://www.picussecurity.com/resource/blog/inside-sandworm-decade-of-cyber-sabotage-and-espionage-activity>.
8. "Russia's Destruction Tactic of Targeting Infrastructure Has Been 'Blunted,' MOD Intelligence Says," Forces News, December 1, 2022, <https://www.forcesnews.com/russia/mod-says-russia-attempting-implement-target-destruction-tactic>.

cold and the dark into weapons of war.”⁹ This war has redefined the Ukrainian energy worker: The linemen, dispatchers, and miners who fuel and run the grid are no longer seen as utility employees but as part of the national defense, crews repairing under fire what Russia spent the night destroying.

Ukraine’s Ministry of Energy recorded approximately 4,500 strikes on the country’s energy infrastructure in 2025 alone, a campaign involving roughly 1,800 missiles and 50,000 drones.¹⁰ Four years of systematic targeting have left no layer of the energy system untouched: refineries and fuel storage, thermal, hydro, and nuclear generation, and the gas, heat, and power networks that carry energy to Ukrainian homes. And Russia has not been striking blindly, attacking a grid that it designed and for which it holds the blueprints, pairing nonprecision and precision strikes against key nodes. The proliferation of drones in particular has expanded Russia’s ability to exploit supply chain and manpower fragility by cheaply and precisely targeting infrastructure for which replacement requires long lead times or rare technical expertise.

This targeting has developed over the course of the conflict, starting with critical connection points in the Ukrainian electrical system: initially, Russia took out the “highway interchanges,” and Ukrainian engineers had to find a way to route electrons on the “surface roads” of the grid, finding new and flexible distribution pathways. As the Ukrainians adapted to these attacks, Russia moved on to striking power generation directly in its second phase of targeting, with Ukraine losing 9 gigawatts (GW) of power generation capacity in 2024, half of its winter peak consumption.¹¹ As Ukrainians focused on distributed generation and microgrids to address this threat, Russia began focusing on transformers, upstream targets, and gas storage. Multiple strikes on this critical infrastructure in early 2026 have disrupted production. However, attempts to strike Ukraine’s underground gas storage, which is dispersed, hardened, and redundant, have largely failed. This is the clearest example of the path forward for energy resilience.

Russian attacks on Ukraine’s energy grid are a preview of what the rest of Europe must be built to withstand, as NATO begins to shift resources and priorities to the resilience of its civilian infrastructure. Ukraine has paid for these lessons, and

the investment framework for the new 1.5 percent commitment should be built on three pillars:

Pillar 1: System reinforcement, decentralization, and hardening (physical and digital)

Decentralized, digitized, and defended systems survive; concentrated single points of failure do not.

Pillar 2: Logistical foresight and stockpiling

Dispersed, hardened storage blunted Russian targeting; long-lead equipment availability is essential.

Pillar 3: Emergency response and civil-military coordination

People, not equipment, kept the lights on.

The next war will not start in climate-controlled rooms with sanitized decisions moving formations on a map. Rather, it will start in the chaos that will always characterize warfare: repair teams working to provide electricity to hospitals, heat homes, and move fuel to where it is needed, and NATO service members turning their thoughts from loved ones in the dark at home to the mission at hand. NATO owes it to them to build infrastructure ready for that day.

Mapping NATO’s capability gaps against these pillars

With Ukraine’s experience as the evidence base, a clear-eyed assessment of NATO’s modern energy security needs must focus on the capability gaps these lessons illuminate. This analysis provides a menu of options to inform investment decisions and policy proposals to close capability gaps and ensure NATO is ready for the next war and faithful to its Hague Summit commitments. Beyond NATO’s traditional focus on securing oil and gas, the reality of an increasingly electrified world requires a continent-wide electrical system that is sufficient, decentralized, digitized, and protected from physical and cyber threats. Electrons need to be in the right place, at the right time, in the right form, to ensure the success of both critical missions and economic goals.¹² The Russian war against Ukraine has already illuminated risks and associated capability gaps that create logical calls to action for NATO spending commitments across the energy system. The gaps map directly onto the

9. Marc Santora, Matthew Bigg, and Ivan Nechepurenko, “‘Constant’ Russian Airstrikes Stifle Ukraine’s Efforts to Restore Power,” *New York Times*, December 1, 2022, <https://www.nytimes.com/2022/12/01/world/europe/russia-ukraine-war-infrastructure.html>.
10. International Energy Agency, “Key Lessons from Ukraine Can Inform Energy Resilience Planning Worldwide,” IEA news, February 11, 2026, <https://www.iea.org/news/key-lessons-from-ukraine-can-inform-energy-resilience-planning-worldwide>.
11. DiXi Group, “Europe Should Take Advantage of Ukraine’s Experience and Change Approaches to Energy Security” (in Ukrainian), November 14, 2025, <https://dixigroup.org/evropa-mae-skoristatsiya-dosvidom-ukraini-i-zminiti-pidhodi-do-energetichnoi-bezpeki/>.
12. Enrique Kremers, “Highly Decentralized and Intelligent Power Systems – Risks and Opportunities for Energy Security”; NATO Energy Security Centre of Excellence, *Energy Highlights* no. 21 (2026): 17, <https://www.ensecocoe.org/publications/energy-highlights-no-21/>.

three pillars Ukraine's experience established: system reinforcement, decentralization, and hardening; logistical foresight and stockpiling; and emergency response and civil-military coordination. This analysis also confirms the continued need to secure the supply of oil and gas to the EU, which imports almost 60 percent of its energy.¹³

Pillar 1 gaps – System reinforcement, decentralization, and hardening (physical and digital)

Ukraine lesson: systems that are decentralized, digitized, and defended survive; concentrated single points of failure do not.

Alliance gap: a European grid that remains under-interconnected, under-instrumented, and exposed to physical and cyberattack.

The first gap is the existing grid. Delivering more electricity more efficiently by improving the existing grid offers NATO members the option for quick, low-risk improvements in the near-term. The European Union Agency for the Cooperation of Energy Regulators (ACER) acknowledges that long-term solutions like large-scale grid additions and reconfigurations have not materialized, with delays in roughly 30 percent of all projects of common interest that represent major infrastructure works.¹⁴ Upgrading current infrastructure is less permit intensive, because existing sites have already addressed many environmental, social, and political hurdles, and it can improve and standardize market access while creating a more integrated energy system. NATO's Energy Security Centre of Excellence (ENSEC COE) identified several benefits of this increasingly integrated energy system, including economic stability and national security, as well as enhanced resilience to market disturbances and the mitigation of electricity price volatility.¹⁵

Momentum already exists upon which the alliance can build. The REPowerEU initiative's stated goal is to phase out Russian oil and gas imports, through measures including renewable power generation.¹⁶ In June 2025, the EU identified that significant investment in the electric grid is a critical issue, emphasizing that approximately €1.2 trillion¹⁷ of "anticipatory" investments are needed by 2040 in support of the European electric grid as it accommodates a combined approximately 200 GW of installed renewable generation from 2022 to 2024.¹⁸

Improvements to the existing grid, or "system reinforcements," such as dynamic line rating (DLR) and series and shunt compensation, which are two techniques to manage voltage and reduce losses along transmission lines, can all deliver electricity more efficiently through existing infrastructure, improving the capacity of the system as a whole.¹⁹ The Baltic Sea Region (BSR), in particular Sweden and Finland, demonstrates the potential for these improvements to unlock the full transmission capacity of the grid. The transmission system operators (TSOs) in both nations have identified in their grid development plans that static line ratings (SLR) leave capacity considerably underused.²⁰ Access to weather data and advanced analytic tools allows actual transmission capacity to be forecast, which in some cases is double the SLR calculated capacity. Sweden's TSO, Svenska kraftnät, estimates DLR will add 20 to 30 percent more capacity to the electricity market while waiting for new power lines to be built.²¹ Finland's TSO, Fingrid, also plans to utilize series and shunt compensation to effectively shorten transmission distances by reducing the warming of grid components and improving voltage support.²² Applied across NATO's footprint, these near-term improvements can have material impacts on the resilience of Europe's interconnected grid to disruption and attack.

13. Eurostat, "Energy in Europe — 2026 Edition," accessed August 7, 2026, <https://ec.europa.eu/eurostat/web/products-eurostat-news/w/wdn-20260310-1>.

14. European Union Agency for the Cooperation of Energy Regulators, "Transmission Capacities for Cross-Zonal Trade of Electricity and Congestion Management in the EU," 2025, 6, <https://www.acer.europa.eu/monitoring/cross-zonal-electricity-trade-2025>.

15. Jānis Kramens, *Enhancing Societal Resilience in the Baltic States to Energy Outages*, NATO Energy Security Centre of Excellence, 2025, 30, <https://www.enseccoe.org/publications/societal-resilience-in-the-baltic-states/>.

16. European Commission, "REPowerEU," accessed August 7, 2026, https://commission.europa.eu/topics/energy/repower_eu_en.

17. European Commission, "EU Guidance: Ensuring Electricity Grids Are Fit for the Future," June 2, 2025, https://energy.ec.europa.eu/news/eu-guidance-ensuring-electricity-grids-are-fit-future-2025-06-02_en.

18. European Commission, "Commission Notice on a Guidance on Anticipatory Investments for Developing Forward-Looking Electricity Networks," C/2025/3179, 2025, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52025XC03179>.

19. Svenska kraftnät, *Grid Development Plan 2024–2033*, 2024, 9, https://www.svk.se/siteassets/om-oss/rapporter/2024/grid_development_plan_2024-2033.pdf.

20. Fingrid, *Main Grid Development Plan*, 2023, 124, https://www.fingrid.fi/globalassets/dokumentit/fi/kantaverkko/kantaverkon-kehittaminen/fingrid_kehittamissuunnitelma_syksy23_en.pdf.

21. Svenska kraftnät, *Grid Development Plan*, 24.

22. Fingrid, *Main Grid Development Plan*, 19.

Beyond improving the existing transmission and distribution lines themselves, smart-grid technologies are crucial for ensuring the stability and efficiency of electrical networks. These technologies, now often integrated with AI, combine data communication and collection, and system operations and asset management without requiring an expensive overhaul of the existing physical system. Proper design also ensures that critical infrastructure, such as hospitals, emergency services, and military installations, remains operational through these disruptions. Advanced smart-grid systems detect faults, isolate damaged segments, and reroute power in seconds rather than hours. Under attack, that speed is the difference between localized damage and cascading failure. DTEK, the largest private investor in Ukraine's energy sector and a leader in the development of energy security and resilience in the country, has made a recommendation to the alliance that is explicit: build every new project resilient-by-design.²³

Beyond the grid, additional generation will be necessary to meet the future demands of NATO energy resilience. This does not mean only hardened, large-scale baseload power plants, but also decentralized power generation systems that force an adversary to strike multiple sites to achieve the same effect as a single, high-capacity target. These resilient-by-design networks benefit from component generation being too small to present high payoff targets, while at the same time carrying the advantage of rapid repair and reconnection.²⁴ These networks should be modular, scalable, and focused on ensuring continuity of power to the most critical infrastructure. Overreliance on any single generation type, including renewables, creates its own vulnerability; therefore, resilience requires diverse and dispatchable capacity. In addition to commercially proven generation that can meet near-term needs, three areas for investment in future generation are microgrids, battery energy storage systems (BESS), and small modular reactors (SMRs).

Microgrids offer resilience to critical infrastructure nodes, from the building to campus level, by combining a control system

that enables islanding and black-start capabilities with generation across a variety of technologies.²⁵ These technology-agnostic distributed energy resources (DER) that provide power are the foundation of total microgrid system scalability and flexibility. By existing within, and interacting with, the integrated grid providing baseline generation, microgrids offer localized energy resilience and have been identified as crucial in the near and long terms for Ukraine's defense of its energy infrastructure.²⁶ These projects provide another resilience capability within NATO amid the continued focus on interconnection of the grid across the continent.

BESS, especially long-duration energy storage (LDES), will play an outsized role in NATO energy resilience, especially as microgrid DERs. The primary role of a BESS is to dispatch stored energy on demand. While a BESS is not the complete answer to energy resilience, it supports the greater system by providing backup power and improving effectiveness in islanding and black-start scenarios. BESS can provide immediate, short-term power to critical military, emergency services, and industrial installations, ensuring that these locations can continue to operate despite disruption to the grid. The first major energy infrastructure project of the US-Ukraine Economic Partnership Agreement put this into practice: DTEK's installation of 200 MW of BESS in 2025 across six strategic locations, completing construction in only six months and providing grid stability not achievable by conventional power plants.²⁷

Nuclear power represents the largest opportunity for adding scaled generation to the European grid over the long term. This includes both hardened large reactors and dispersed SMRs. Key challenges remain beyond the SMR technology itself, including lengthy permitting and construction timelines coupled with pockets of public resistance. However, support is strongest in Eastern Europe, where Poland, Hungary, the Czech Republic, Romania, Slovakia, and Slovenia, along with nuclear-powered France in the west, successfully lobbied the European Commission to include certain nuclear activities in its approved list of sustainable investments.²⁸ Poland has re-

23. DTEK Advisory Council, *Ukraine's Energy Future*, White Paper, June 2026, 9, https://dtek.com/content/announces/pdf/dtek-advisory-council-white-paper-june-2026_s1429_t8610_i16773_s182_t7821_i17153.pdf.

24. DTEK Advisory Council, *Ukraine's Energy*, 8.

25. The U.S. Department of Energy defines the following terms with respect to microgrids: Islanding is when a microgrid system can disconnect from the main utility grid to operate in island mode. A black start is the process of restoring a power station to operation after a complete or partial shutdown without relying on the external electric power transmission network.

26. International Energy Agency, *Empowering Ukraine through a Decentralised Energy System*, 2024, 9, <https://www.iea.org/reports/empowering-ukraine-through-a-decentralised-electricity-system>.

27. "DTEK—Fluence Battery Energy Storage Project," DTEK website, accessed August 7, 2026, <https://dtek.com/en/dtek-fluence-project>.

28. "Nuclear Has a Place in EU Taxonomy, Court Rules," *World Nuclear News*, September 11, 2025, <https://www.world-nuclear-news.org/articles/nuclear-has-a-place-in-eu-taxonomy-court-rules>.

newed its nuclear energy program and plans to commission its first nuclear power plant in 2036,²⁹ while Finland is actively working to double nuclear power generation to account for 60 percent of total supply and replace coal.³⁰ Estonia, where nuclear power is second only to wind in public favorability, is also moving: A start-up is aggressively looking to construct Europe's first SMRs to achieve dual goals of energy security and 2050 climate targets.³¹ This pathway must be supported by efforts to diversify nuclear fuel sources and supply chains, and its payoff compounds over time: new nuclear capacity in Poland, Finland, Estonia, and across Eastern Europe would steadily reduce the gas dependence that has been Russia's principal lever over the region.

Concerns about physical and cyber defense are perhaps at their highest around nuclear facilities, but cyber and physical security will be critical to defend the advancements being made across the entire energy resilience landscape. As European grid systems and generation sites decentralize and diversify to enhance resilience, there must be a parallel effort to digitize to enable data communication and collection for grid management. This digitally connected grid, while more physically resilient, has increased surface area for cyberattack. Cyberattacks on supervisory control and data acquisition (SCADA) systems in the energy sector can trigger widespread disruptions and blackouts. Russian cyberattacks have been a constant threat in Ukraine, interspersed with waves of physical attacks, and they have increased by 30 to 40 percent since the invasion began.³² Robust cyber protection is already a critical need for the European grid.³³ Physical security matters equally: beyond decentralization and distribution to challenge an adversary's targeting decisions, hardening the facilities that cannot be dispersed is a gap that must be closed.

Pillar 2 gaps – Logistical foresight and stockpiling

Ukraine lesson: dispersed, hardened storage blunted Russian targeting; long-lead equipment availability is essential.

Alliance gap: fuel deserts, thin equipment reserves, and trans-former supply chains now measured in years.

Beyond the electron, the war in Ukraine has demonstrated the critical importance of resilient fuel infrastructure. It has also exposed this as a gap throughout NATO's territory. Russia's most recent targeting phase has concentrated on refineries, upstream production, and gas storage, encompassing the molecules of Ukraine's energy system. NATO-sponsored research has already identified a crucial "fuel desert" between the Central Europe Pipeline System's eastern edge and NATO's forward-deployed forces, and recommended expansion of the NATO Pipeline System and hardened storage capacity.³⁴ The absence of hardened, dispersed fuel storage, distribution, and import infrastructure, connected to the electrical system it ultimately powers, is a critical capability gap that must be closed within Europe. When addressed, it will enable greater defense in depth of the NATO alliance across the European continent and through Atlantic resupply.

Russian targeting of civilian energy infrastructure with both massed indirect fires and precision strikes in Ukraine has exposed a need for industrial depth as part of energy supply chain resilience and provided a role for NATO members behind the front line. Repair and replacement both require two key resources: trained manpower and ready equipment. Stockpiling of the most critical equipment, such as transformers, is the most effective approach. Stockpile locations must be kept secret, decentralized, and protected from attack, yet close enough to transportation nodes for rapid delivery.³⁵ Beyond equipment, industrial depth is itself a form of stockpile. On a global scale, the United States and Canada offer two key attributes to delivering industrial depth: protected geography

29. "Application Lodged for Poland's First Nuclear Power Plant," *World Nuclear News*, March 31, 2026, <https://www.world-nuclear-news.org/articles/application-lodged-for-polands-first-nuclear-power-plant>.

30. Trine Villumsen Berling and Izabela Surwillo, "New Energy Technology Will Make the Baltic Sea Region More Crisis-Resilient," Danish Institute for International Studies, December 15, 2021, https://pure.dii.dk/ws/files/4915559/green_energy_technology_single_pgs.pdf.

31. Leon Hartwell and Agnė Rakšytė, "Energy Security in the Baltics: Perceptions in the Midst of the Russia-Ukraine War," *LSE IDEAS*, London School of Economics and Political Science, 2025, <https://www.lse.ac.uk/ideas/publications/Research-Reports/Energy-Security-in-the-Baltics-Perceptions-in-the-Midst-of-the-Russia-Ukraine-War>.

32. Nic Steinwand and Silvia Cossa, *Battle Tested Power Systems*, Eurelectric, February 2026, 4, <https://www.eurelectric.org/publications/battle-tested-power-systems/>.

33. Eurelectric, *Redefining Energy Security in the Age of Electricity*, 2025, 28, <https://energy-security.eurelectric.org/wp-content/uploads/Eurelectric-report-energy-security-in-the-age-of-electricity-1.pdf>.

34. NATO Science and Technology Organization, *Energy Security in the Era of Hybrid Warfare*, STO-TR-SAS-163, May 2024.

35. Steinwand and Cossa, *Battle Tested*, 7.

and manpower depth. Within Europe itself, NATO member states not directly under attack will also be able to provide this support. These nations can provide secure, accessible storage facilities for critical infrastructure while also providing robust transportation assets at the time and place of need. They can also provide manpower trained in repair and replacement of key infrastructure. Importantly, in a time of European land conflict, a North American labor force is available to work without the societal disruptions of conflict at home.

Pillar 3 gaps – Emergency response and civil-military coordination

Ukraine lesson: people, not equipment, kept the lights on. **Alliance gap:** repair capacity, assistance agreements, and civil-military coordination designed for peacetime weather, not attacks on the energy grid.

Ukraine's grid has survived because trained repair crews, mutual-assistance arrangements, and civil-military coordination existed, or were built under fire, before each winter demanded them. Across most of the alliance, the mechanisms Ukraine improvised do not yet exist in organized form. Utility mutual-assistance arrangements, the reciprocal agreements through which neighboring operators surge crews and equipment to a stricken system, function within many member states for storm recovery, but they are not designed for wartime conditions, for the cross-border movement of crews and heavy equipment, or for coordination with military logistics and air defense. Nor do most member states maintain a trained reserve of grid-repair personnel sized for sustained attack rather than seasonal weather. Ukraine's workforce learned its trade under fire. NATO members currently have no collective peacetime mechanism to build that proficiency in advance, but components of this mechanism already exist, fragmented across multiple roles: the European Civil Protection Pool (ECPP) certifies pre-committed national response teams as deployable modules, but is focused on search and rescue and not grid repair;³⁶ the Electricity Risk-Preparedness Regulation lays out cross-border assistance agreements, governance and responsibility for electricity crises in the grid, but has no provision for the

necessary repair crews;³⁷ and the EU Cybersecurity Reserve is a standing pool of rapidly mobilizable, precontracted and certified, incident-response providers for attacks on critical infrastructure.³⁸ The model exists for the digital layer of the grid, but has never been built for the physical one.

Civil-military coordination presents a parallel gap. Energy operators and armed forces largely plan on separate tracks: Utilities rarely feature in NATO exercises, and militaries seldom rehearse the protection, prioritization, and restoration of the civilian energy nodes on which their own mobility and sustenance depend. Closing this gap requires no new technology, only organization, training, and funding made routine before they are needed, which is precisely what an investment framework can incentivize.

Beyond Ukraine: Gaps the land war does not capture

The war in Ukraine does not illustrate every threat the alliance faces. Two, in particular, fall outside it: maritime choke points and import dependence. Beyond NATO's reaches, the US conflict with Iran and the closing of the Strait of Hormuz, a strait that carried roughly a quarter of the world's seaborne crude and petroleum products, demonstrated how quickly critical sea lane disruptions translate into alliance-wide consequences for fuel availability and costs.³⁹ As Europe completes its divorce from Russian pipeline gas, its dependence shifts to seaborne liquefied natural gas (LNG) and to the terminals, ports, and sea lanes that deliver it—infrastructure now exposed to the choke-point disruptions the Hormuz closure demonstrated. These maritime and import-dependence risks do not map onto a single pillar; they are met through hardened import infrastructure under the logistical foresight and stockpiling pillar and the protection of undersea and coastal assets under system reinforcement, decentralization, and hardening.

Geography still matters and a few, limited connections in the BSR are indispensable to the region's electrical transmission and distribution. Its maritime choke points and the constrained land routes along Russia's periphery make the undersea in-

36. EU European Civil Protection and Humanitarian Aid Operations, "European Civil Protection Pool," accessed August 7, 2026, https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/european-civil-protection-pool_en.

37. EU Regulation (EU) 2019/941 on Risk-preparedness in the Electricity Sector and Repealing Directive 2005/89/EC, <https://eur-lex.europa.eu/eli/reg/2019/941/oj/eng>.

38. European Union Agency for Cybersecurity, "ENISA to Operate the EU Cybersecurity Reserve," August 26, 2025, <https://www.enisa.europa.eu/news/enisa-to-operate-the-eu-cybersecurity-reserve-with-eur-36-million>.

39. Michael Ratner, Liana W. Rosen, and Clayton Thomas, "The Strait of Hormuz: Security Developments and Impacts on Oil, Gas, and Other Commodities," Congressional Research Service, R45281, August 7, 2026, www.congress.gov/crs-product/R45281.

Figure 3: Undersea electricity interconnections in Northern Europe



Source: ENTSO-E

terconnectors irreplaceable transmission links (see figure 3).⁴⁰ The entire Baltic energy market is connected to the European energy market through four interconnections: two submarine cables linking the Estonian and Finnish systems, Estlink I (350 megawatt) and Estlink II (650 MW); the overland Lithuania-Poland interconnection, LitPol Link 1 (500 MW); and the submarine Lithuania-Sweden interconnection, NordBalt (700 MW).⁴¹

While the Nord Stream 1 and 2 sabotage in September 2022 may be the most famous attack on European undersea infra-

structure, the cutting of the Estlink II power cable by the Eagle S, a Cook Islands-registered oil tanker, on Christmas Day 2024 was the true turning point. This attack, by a ship assessed to be part of Russia's "shadow fleet" by several European intelligence agencies, led NATO Secretary General Mark Rutte to announce the establishment of Operation Baltic Sentry at the Summit of Baltic Sea Allies in January 2025.⁴² Presence matters in national security execution, particularly in the global commons. Through heightened air and maritime presence in

40. ENTSO-E, "Interconnected Network of Northern Europe 2024," grid map, 2024, https://eepublicdownloads.entsoe.eu/clean-documents/Publications/maps/2024/ENTSOE_Grid_Map_Northern_Europe.pdf.

41. Kramens, *Enhancing Societal Resilience*, 19.

42. Seth G. Jones, "Russia's Shadow War Against the West," Center for Strategic and International Studies, March 18, 2025, <https://www.csis.org/analysis/russias-shadow-war-against-west>.

the Baltic Sea under the command of NATO's supreme allied commander, Baltic Sentry aims to deter illegal maritime activities, specifically by Russia's shadow fleet.⁴³

Beyond the Baltic Sea, the Black Sea region has become a flashpoint due to rising Russian hybrid activities. Neptun Deep, an offshore gas field developed by OMV Petrom and Romgaz, is expected to make Romania the EU's largest gas producer, easing Europe's import dependence. But the pattern Ukraine knows well has already arrived. In August 2026, Romanian forces destroyed drifting and explosives-laden drones in the exclusive economic zone near the platform, while GPS interference across Black Sea shipping routes and floating mines have already been reported.⁴⁴ Romania's own chief of defense has stated that Neptun Deep falls outside the territorial scope of Article 5, even as the country's newest defense strategy identifies Russian militarization of the Black Sea as a direct threat to the exploitation of energy resources.⁴⁵ NATO's response is still forming. Eastern Sentry, established in September 2025 after drone incursions into Poland and Romania, has bolstered allied presence along the eastern flank, and Romania has pressed for it to be adapted and strengthened for the Black Sea.⁴⁶ As in the Baltic, presence deters, but the persistent surveillance, monitoring, and repair capacity that offshore production and its pipelines require is a critical gap.

■ Implementation and investment framework

NATO already has an established framework for defense investing, built from decades of monitoring member states' contributions. Nations self-report defense figures to NATO, which restates national budgets against NATO's agreed definition of

defense expenditure, and the defense planning process separately ties that spending to assigned capability targets.⁴⁷ A similar framework, building from NATO resilience requirements and grounded in capability gaps and lessons learned from recent conflicts, should be applied to this new investment commitment. The NATO EPG⁴⁸ is already charged with the oversight of this resilience requirement, and together with NATO ENSEC COE is actively engaging EU and member state counterparts in strategic energy security dialogues and exercises.⁴⁹ The EPG should build from this engagement and clearly and consistently identify the type of spending that would qualify for inclusion in this framework. As an example, the EU's military mobility program under the Connecting Europe Facility has co-funded €1.7 billion of infrastructure projects across twenty-one member states, with a proposed expansion to almost €17.7 billion starting in 2028.⁵⁰ This is the working European precedent for what the EPG must build now for energy: civilian energy infrastructure spending defined, qualified, and counted against NATO requirements. The most impactful result would be a formal agreement on initial collective energy resilience targets, announced at the NATO Resilience Committee level. When it comes to civil infrastructure, there are many overlaps with the goals of the European Union. The US-EU Energy Council, a ministerial/cabinet-level coordinating body, could become an excellent resource for the EPG, if expanded to include Norway and Canada, as it develops energy resilience-focused guidance for NATO investment.⁵¹

This 1.5 percent commitment should not only be looked at as encouraging new investment, but also as properly recognizing the investments into energy resilience that have already

43. Vienne Abrahamian, "The Baltic Sentry: NATO Effort to Deter Russia's Shadow Fleet in the Baltic Sea," Joint Baltic American National Committee, March 2026, <https://www.jbanc.org/baltic-insights/the-baltic-sentry-nato-effort-to-deter-russias-shadow-fleet-in-the-baltic-sea>.
44. Luiza Ilie, "Romania Destroys Marine Drone Near Neptun Deep Gas Project, Minister Says," Reuters, August 20, 2026, <https://www.reuters.com/world/europe/romania-destroys-marine-drone-near-neptun-deep-gas-project-minister-says-2026-08-20/>.
45. "Romania's Neptun Deep Project May Not Be Covered by NATO Security Guarantee, Army Chief Says," Romania Insider, January 16, 2026, <https://www.romania-insider.com/business/romania-neptun-deep-nato-security-guarantee-2026>; "Romanian National Defence Strategy Highlights Risks to Black Sea Infrastructure," Reuters, November 12, 2025.
46. "NATO's Eastern Sentry Meets the Black Sea: Romania's Push for a Dedicated Mission and the Rising Hybrid Risks to Energy Infrastructure and Investments," Atlas Institute for International Affairs, March 24, 2026, <https://atlasinstitute.org/natos-eastern-sentry-meets-the-black-sea-romania-push-for-a-dedicated-mission-and-the-rising-hybrid-risks-to-energy-infrastructure-and-investments/>.
47. NATO, "Defence Investment and NATO's 5% Commitment," last updated June 29, 2026, <https://www.nato.int/en/what-we-do/introduction-to-nato/defence-expenditures-and-natos-5-commitment>.
48. NATO, "Resilience Committee," updated October 7, 2022, https://www.nato.int/cps/en/natolive/topics_50093.htm.
49. Authors' interviews with NATO officials, July–August 2026.
50. EU Defense Industry and Space, "Military Mobility," accessed August 7, 2026, https://defence-industry-space.ec.europa.eu/eu-defence-industry/military-mobility_en.
51. US Department of Energy, "U.S.-EU Energy Council," accessed August 7, 2026, <https://www.energy.gov/ia/us-eu-energy-council>.

Figure 4: Investing in resilience: A three-tier financing framework for NATO's 1.5 percent commitment

Tier	Category of investment	Project examples
Private capital delivers; public money derisks and accelerates	Early deployment and scaling of near-commercial technologies	LDES, SMRs, and distributed generation, through tax credits, concessional loans, guarantees, and regulated revenue mechanisms similar to the UK cap-and-floor model.
Mix of private and public funding	System and infrastructure enabling investment	Shared grids, pipelines, and ports that markets under provide; cross-border enablers on the GRIP/SPARK model and Baltic synchronization; permitting and cost-allocation spending qualifies.
Public funding is the only funding	Research and development and first-of-a-kind spending	Where private markets cannot capture the return: R&D on the ARPA-E and EIC model; members' contributions to alliance-owned vehicles such as DIANA and the NATO Innovation Fund.
	Pure security goods	Stockpiles, reserve capacity, trained repair teams.

Source: NATO, "The Hague Summit Declaration," June 25, 2025 (fn. 1); authors' analysis.

been established by member nations. The sequencing should be deliberate: a crawl-walk-run approach in which members first map their vulnerabilities against the pillars, the alliance then curates shared priorities from the lessons of Ukraine and beyond, and the full framework operates as routine practice, with utilities, investors, and technology developers engaged throughout. The 2029 progress review set at The Hague is the natural forcing function for this governance work.⁵² In many ways, this operationalizes the vision of Rutte, who has emphasized the collaboration between governments and industries as part of the NATO 3.0 transition.⁵³

Investment options by pillar

The framework applies one rule to all members: qualifying investment counts toward the commitment of the member that funds it, regardless of where the investment is located. And it counts when money is spent, not when projects are planned or announced. Within that single standard, members can craft their national resilience plans and strategy intelligently: where

private markets already deliver a capability, as US commercial demand is now delivering LNG infrastructure at scale, for example, public money is best directed at the gaps no market fills. These investments range from privately financeable assets, where public money and policy derisks and accelerates, to pure security goods with no revenue model, such as stockpiles and reserve capacity, where public funding is the only funding (see figure 4).

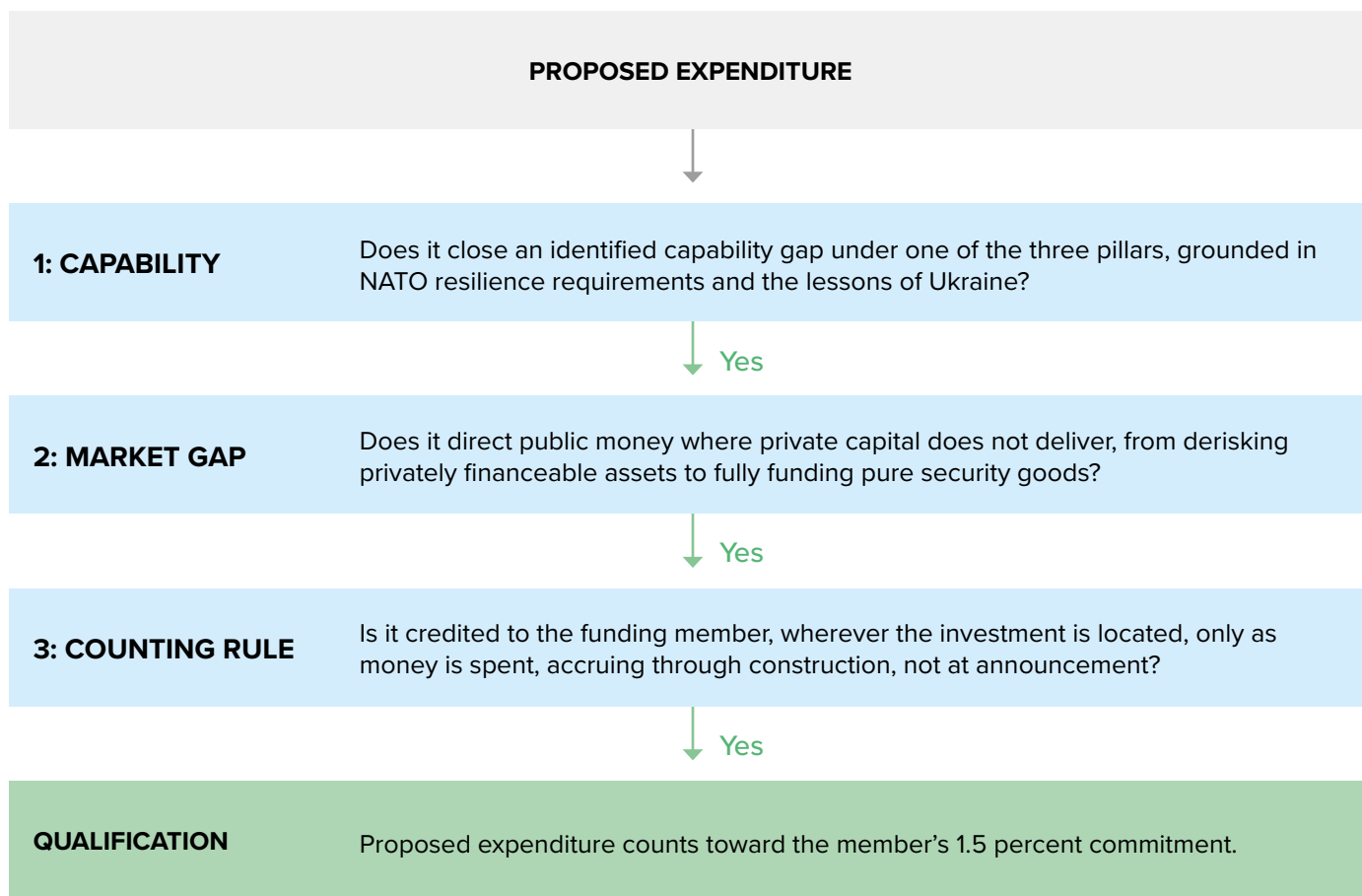
This rule reflects how energy risk behaves. On an interconnected grid, resilience is a network property. Hardened substations in one member state protect supply lines that many members depend on, and crediting the funder regardless of geography removes incentives to keep investment at home. Crediting only money spent, rather than plans announced, keeps the commitment focused on real projects and effects on the ground. Qualification reduces to a three-part test that EPG guidance should codify. First, the expenditure must close an identified capability gap under one of the three pillars. Second, it must direct public money where private capital does

52. NATO, "The Hague Summit Declaration."

53. Mark Rutte, "Remarks by the NATO Secretary General and the US Secretary of War," Transcript, NATO, June 18, 2026, <https://www.nato.int/en/news-and-events/events/transcripts/2026/06/18/remarks-by-the-nato-secretary-general-and-the-us-secretary-of-war>.

Figure 5: Does it count? The three-part qualification test for proposed expenditures

Energy Planning Group qualification guidance: Guidance must be clear and consistent, anchored by a formally announced agreement at the Resilience Committee level.



Source: Authors' analysis.

not deliver, or where public money accelerates what private capital alone would deliver too slowly. Third, it is credited to the funding member only as money is spent, accruing through construction rather than at announcement, wherever the investment sits. An expenditure that fails any part of the test does not count. That includes spending merely reclassified into the category. Genuine resilience programs already under

way pass on the same terms, credited as their spending continues (see figure 5).

There is a role for NATO-organized spending across system and infrastructure-enabling investment, early deployment and scaling of near-commercial technologies, and research and development (R&D) and first-of-a-kind (FOAK) spending. These three tiers of public finance run through the pillars below.

PILLAR 1 INVESTMENTS – System reinforcement, decentralization, and hardening (physical and digital)

Alliance gap: a European grid that remains under-interconnected, under-instrumented, and exposed to physical and cyberattack.

Investment framework: cross-border system and infrastructure enabling investments into the grid, early deployment and scaling of critical new generation technologies, R&D and FOAK spending on new fuels, generation, and cyber defenses.

Perhaps most critical to a NATO-wide, cross-border investment plan is major investment in system and infrastructure enablers. These electric grids, pipelines, LNG ports, and other shared infrastructure projects are essential to a strong, independent, and resilient NATO. Not all this spending will be from NATO's governments, as private capital continues to identify infrastructure projects with attractive returns on both sides of the Atlantic, but the NATO member states must be ready, with approved programs and financial support, to ensure projects succeed that are valuable to the alliance. There are several programs in the United States and EU that are focused directly on scaled investments into the energy grid, notably the US Department of Energy's Grid Resilience and Innovation Partnerships/Speed to Power through Accelerated Reconductoring and other Key Advanced Transmission Technology Upgrades (GRIP/SPARK) program,⁵⁴ which represents approximately \$10.5 billion of investment into grid flexibility and resilience in the United States. GRIP/SPARK includes the technology-enabled grid-software and outage-management systems critical to a cybersecure, agile, and decentralized grid. This can be an example for other NATO member states to follow, and the European Commission has identified €730 billion for distribution and €477 billion for transmission grid developments needed by 2040.⁵⁵ Europe has already proven this model at its most contested frontier: the synchronization of the Estonian, Latvian, and Lithuanian grids with continental Europe, completed in February 2025 after decades inside the Russian-controlled energy system and financed with the Connecting Europe Facility's €1.2 billion.⁵⁶ Aligning both these calls for investment

with the lessons learned from Ukraine will be critical for ensuring investment contributes directly to civilian infrastructure resilience. Capital alone will not deliver these projects. Permitting and cross-border cost allocation set the pace of development, and spending that addresses these bottlenecks should itself qualify as enabling investment under this framework.

NATO member states' support for the early deployment and scaling of near-commercial technologies should be capability-focused and technology-agnostic, aimed at the physical requirements of the energy system that the market alone will not meet. For functional technologies with high costs and immature supply chains, including LDES and small-scale distributed generation, member states should use tax credits, concessional loans, or loan guarantees to reduce the cost of capital and accelerate adoption or support for redundancy and hardening that may be difficult to fund out of the private sector. The United Kingdom has recently awarded 7.6 GW of LDES capacity via another instrument that belongs in this tool kit: a regulated revenue "cap and floor" for long-duration electricity storage that guarantees minimum revenue to guard against high capital costs and long build times, paired with a cap that protects consumers.⁵⁷ The EPG should recognize public funds spent to maintain cap-and-floor commitments as qualifying investment alongside expenditures related to grants and guarantees.

One example of this stage of investment would be emerging nuclear technology. The Janus Program, sponsored by the US Department of the Army, is focused on building commercial nuclear microreactors through a milestone-based contracting model supporting the private sector as companies seek to demonstrate the business case for their technological innovation.⁵⁸ Though this program is focused on building these types of commercial reactors on domestic military bases in the United States, similar programs for SMRs and microreactors could be developed in European member states, and spending on them should count toward the commitment as a means of installing reliable, distributed baseload capacity

54. US Department of Energy, Office of Electricity, "Speed to Power through Accelerated Reconductoring and Other Key Advanced Transmission Technology Upgrades," updated March 12, 2026, <https://www.energy.gov/oe/speed-power-through-accelerated-reconductoring-and-other-key-advanced-transmission-technology>.

55. European Commission, "EU Guidance: Ensuring Electricity Grids Are Fit for the Future," June 2, 2025, https://energy.ec.europa.eu/news/eu-guidance-ensuring-electricity-grids-are-fit-future-2025-06-02_en.

56. European Climate, Infrastructure and Environment Executive Agency, "CEF Energy: Baltic Synchronisation," n.d., https://cinea.ec.europa.eu/cef-energy-instrumental-funding-achieve-baltic-synchronisation-continental-european-network_en.

57. Office of Gas and Electricity Markets, "Assessment of Impacts of the Proposed LDES Portfolio," June 2026, <https://www.ofgem.gov.uk/consultation/long-duration-electricity-storage-window-1-minded-decisions>.

58. "US Army Launches Advanced Reactor Programme," *World Nuclear News*, October 16, 2025, <https://www.world-nuclear-news.org/articles/us-army-launches-advanced-reactor-programme>.

that can anchor military and civilian microgrids throughout the continent. Recent policy efforts in the United States may also serve as a useful guideline for the EPG in its planning, such as the recent executive order to deploy nuclear power production on at least one domestic military installation by 2028.⁵⁹ This power would not only serve the military facility itself but also support nearby critical infrastructure outside the fenceline. The EU's own SMR strategy aims to coordinate European countries in installing between 17 and 53 GW of SMR capacity by 2050.⁶⁰ The EPG should recognize in its guidance the immense value of baseload capacity both independent of Russian gas and freed from the vulnerability of global choke points, and the potential broader energy security connection to EU initiatives such as REPowerEU. Investment in enrichment diversification and high-assay low-enriched uranium (HALEU) production would further secure this generation and deepen energy security.

Full microgrid projects and physical hardening efforts also benefit from the financing mechanisms used for early deployment and scaling of near-commercial technologies. Both are often long-term efforts that require large up-front capital expenditures. If a microgrid project or physical hardening of existing generation is not financially feasible, NATO and member states must pursue incentive policies and microgrid-ready construction standards, or provide public financing for projects that require these capabilities. This requirement would ensure that new systems for critical infrastructure can support DERs, microgrid operations, and hardened generation sites, enhancing energy resilience. This future-proofing measure would include the installation of energy management and control systems to enable islanded operations, the integration of future DERs regardless of generation technology, and the automated load management and demand response needed for effective microgrid operations. In addition to the physical hardening requirements, this infrastructure must be interoperable with existing and future SCADA systems and comply with NATO cybersecurity standards. Cyber hardening of grid control systems, bringing civilian energy infrastructure up to NATO cybersecurity standards, should qualify directly toward the 1.5 percent commitment. The first attacks on energy in-

frastructure in Ukraine were from cyberspace,⁶¹ and though overshadowed by physical attacks as the war has escalated, cyberattacks remain a critical threat throughout NATO's territory. The monitoring and repair of undersea cables, pipelines, and coastal infrastructure are equally qualifying cross-border investments. Operation Baltic Sentry demonstrates the alliance's will to protect this infrastructure; qualifying investment would build the persistent monitoring and repair capacity that a naval deployment cannot sustain alone. NATO's emerging Black Sea posture will test the same proposition around Romania's offshore gas fields.

For the greatest impact, R&D and FOAK spending from the government should be focused on unproven technology where private markets cannot capture sufficient return and failure rates are too high, but where relatively modest amounts of capital can have outsized effects via R&D grants, demonstration funding, or "moonshot" competitions. Two standout examples of this type of investment would be the Advanced Research Projects Agency-Energy (ARPA-E)⁶² in the United States, and the European Innovation Council (EIC). ARPA-E and EIC have specific programs, funds, and awards that can be focused on the EPG's identified energy resilience gaps, which should directly count toward a member state's commitment. The alliance already has precedent with NATO's Defence Innovation Accelerator for the North Atlantic (DIANA), whose challenge areas include energy resilience, and the NATO Innovation Fund, a multisoovereign venture fund of over €1 billion.⁶³ Aligning DIANA challenge topics with the EPG's identified gaps requires no member state legislation, and members' contributions to alliance-owned innovation vehicles would count toward this commitment. Notably, ARPA-E's most recent funding opportunity is focused on developing domestic US supplies of nuclear fuels,⁶⁴ expanding the allied supply of enrichment and HALEU on which the early deployment and scaling of SMRs in both the United States and Europe will likely depend. Innovations in cyber defense via AI developments and continued improvements of the science underpinning the grid will also be crucial.

59. Exec. Order No. 14299, 90 Fed. Reg. 22581 (May 29, 2025), <https://www.federalregister.gov/documents/2025/05/29/2025-09796/deploying-advanced-nuclear-reactor-technologies-for-national-security>.

60. European Commission, "Strategy for the Development and Deployment of Small Modular Reactors (SMRs) in Europe," European Union Law Index COM/2026/117, March 10, 2026, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52026DC0117>.

61. NATO Science and Technology Organization, *Energy Security in the Era of Hybrid Warfare*, TR-SAS-163, May 2024.

62. Advanced Research Projects Agency-Energy, homepage, accessed August 7, 2026, <https://arpa-e.energy.gov/>.

63. NATO Defence Innovation Accelerator for the North Atlantic, homepage, accessed August 7, 2026, <https://www.diana.nato.int/>.

64. ARPA-E, "RFI-0000094: Announcement of Teaming List: Advanced Reactor Fuels," updated January 16, 2026, <https://arpa-e-foa.energy.gov/#Foald8e2883e2-e11d-4388-85d0-2341d4c5fae2>.

PILLAR 2 INVESTMENTS – Logistical foresight and stockpiling

Alliance gap: fuel deserts, thin equipment reserves, and transformer supply chains now measured in years.

Investment framework: the expansion of the strategic petroleum reserve precedent into a strategic energy stockpile and the enhancement of oil and gas storage across the continent.

One key public mechanism that can be developed, which will not be funded by private capital, is a European Strategic Energy Stockpile. The United States maintains the Strategic Petroleum Reserve, and the EU requires each member state to maintain emergency oil stocks,⁶⁵ but it does not maintain a consolidated centralized reserve. The heart of this program already exists. The rescEU energy reserve under the EU Civil Protection Mechanism has maintained thousands of generators, from household scale to units capable of powering hospitals and central heating points, hosted across twenty-four member and participating states, and has deployed thousands of them to Ukraine to keep critical infrastructure alive under Russian attack.⁶⁶ The task before the alliance is therefore not to invent a European energy stockpile but to extend a proven one: from generators to the transformers, switchgear, and critical repair equipment that keep a grid functional under sustained attack. Lead times for critical grid equipment are long even in peacetime, and transformer supply chains are now further constrained by surging demand from data center expansion, with step-up transformer lead times surpassing 160 weeks—over three years—in the first quarter of 2026.⁶⁷ As a next step, NATO and its member states should begin the stockpiling of transformers and critical repair items comparable to existing fuel reserves, which are dispersed, hardened, and secured, in line with the lessons of Ukraine’s defense of its own storage infrastructure. The EPG should coordinate the approved list of stockpiled items, prioritizing standardized spare designs that can substitute across sites, and member state spending on these items should count toward the 1.5 percent investment commitment. Executed properly, the stockpile is also industrial policy. Purchases made through multiyear committed contracts, rather than sharply increasing demand in an already constrained market, give critical

component manufacturers long-term demand certainty to finance new manufacturing capacity, on the model of defense multiyear procurement and the Defense Production Act authorities in the United States. In this case, the structure of the purchasing model will matter as much as its scale.

These reserves form a gradient across the alliance’s geography: LNG storage at Atlantic terminals, hardened and distributed gas storage nearer NATO’s eastern flank, and prepositioned transformers and critical repair equipment for the grid itself. Fuel infrastructure is the second stockpiling investment, and the alliance has already moved forward. At the 2026 NATO summit in Ankara, the alliance announced a €27 billion investment to overhaul and extend the NATO Pipeline System,⁶⁸ a fuel storage and distribution network created during the Cold War. Similar investments must be made into the civil infrastructure on the continent to support a continued ramp-up of US-supplied LNG to replace Russian gas. As the EU completes its commitment to cut off Russian gas, the US commercial market is filling the gap, and NATO member states’ policy should ensure import capacity and infrastructure keep pace. The US Department of Transportation’s Natural Gas Distribution Infrastructure Safety and Modernization (NGDISM) program,⁶⁹ which provides \$200 million per year to enhance natural gas distribution pipelines in the United States, would be an excellent model for the EPG’s investment criteria.

Enhancing the ability of NATO to deliver natural gas to import terminals in Europe and then quickly and efficiently across the continent is crucial to a flexible natural gas supply. This type of defense in depth is where the strength of the alliance is clearest. Electrons cannot cross the Atlantic, there is no transatlantic interconnection, and none is feasible, but molecules can. These cargoes can be shipped, stored, and redirected as necessary within weeks. Shipping molecules across the Atlantic to power a society under attack is the resilience function at the heart of this interconnected, alliance-driven energy system, and building the hardened infrastructure to receive, move, and convert that energy into power is equally essential.

65. European Commission, “Obligation on Member States to Maintain Minimum Stocks of Crude Oil and/or Petroleum Products,” Council Directive 2009/119/EC, September 14, 2009, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009L0119>.

66. EU European Civil Protection and Humanitarian Aid Operations, “RescEU.”

67. Kavya Balaraman, “US Power Companies Scramble to Secure Equipment,” Reuters, July 9, 2026, <https://www.reuters.com/business/energy/us-power-companies-scramble-secure-equipment-surgingly-data-center-demand-strains-2026-07-09/>.

68. NATO, “Overview — 2026 NATO Summit in Ankara,” July 2026, <https://www.nato.int/en/news-and-events/events/2026/07/overview---2026-nato-summit-in-ankara->.

69. Pipeline and Hazardous Materials Safety Administration, “Natural Gas Distribution Infrastructure Safety and Modernization Grants,” updated March 26, 2026, <https://www.phmsa.dot.gov/about-phmsa/working-phmsa/grants/pipeline/natural-gas-distribution-infrastructure-safety-and-modernization-grants>.

PILLAR 3 INVESTMENTS – Emergency response and civil-military coordination

Alliance gap: repair capacity, assistance agreements, and civil-military coordination designed for peacetime weather, not attacks on the energy grid.

Investment framework: assemble coordinated programs and invest in training and organization before a war begins.

Equally important to storage and stockpiles is their human counterpart, including prepositioned and trained repair crews, mutual assistance mechanisms between member state utilities, and improved civil-military coordination in the energy sector. Stockpiled equipment is only useful if trained crews can install it under wartime conditions; Ukraine's resilience has been driven by the people behind the grid. The NATO EPG's guidance should recognize spending in each of these categories, and member states should build dedicated funding programs against them.

Four types of investment would qualify: First, standing cross-border mutual-assistance compacts between member state utilities, negotiated for wartime conditions rather than adapted from storm-recovery agreements. Second, funding

for training pipelines and reserve teams for grid repair, sized for sustained attack. Third, the integration of energy operators more deeply into NATO exercises, building on the efforts of the NATO ENSEC COE. Fourth, preagreed civil-military coordination mechanisms for the protection, prioritization, and restoration of the energy nodes that military mobility and sustainment depend on. Each of these can be executed as assembly rather than invention. A certified "grid restoration" module class within the European Civil Protection Pool would place repair crews inside existing certification, funding, and dispatch machinery; the binding assistance-agreement architecture of the Risk-Preparedness Regulation should be extended to prenegotiate the wartime movement and tasks of utility crews; and the precontracted provider model of the EU Cybersecurity Reserve should be applied to the grid's physical repair as it already is to its digital defense. None of this requires new institutions, only the integration of existing mechanisms. A training pipeline or a coordination agreement costs a small fraction of a single substation, which is what makes this pillar the fastest set of gaps the alliance can begin to close.



Rescuers remove debris at a thermal power plant damaged by multiple Russian missile strikes, amid Russia's attack on Ukraine, in an undisclosed location in Ukraine February 9, 2026. REUTERS/Valentyn Ogirenko

Conclusion and collected recommendations

NATO's 1.5 percent commitment can be the catalyst that connects capital to capability across the alliance. This broad mandate, encompassing thirty-two members with differing political considerations and priorities, requires a capability-based framework grounded in lessons from Ukraine's defense of its energy system. Building a comprehensive and effective energy system capable of meeting civilian and military energy demands, hardened physically and digitally and resilient to disruption and attack, will be a generational challenge requiring investment over time. Moreover, by explicitly linking spending in this area to a national or alliance-level resilience plan that connects to NATO's institutional security objectives, member states can make logical and informed decisions on how best to spend.

Energy security is a unique opportunity where allied interests compound. The clearest proof is already crossing the Atlantic: As Europe nears its complete divorce from Russian gas, American LNG races to fill this need as fast as the capital markets can support, already replacing half of Europe's pre-war Russian gas imports.⁷⁰ This logic runs in both directions: Large power transformers, conductors, and grid components critical to the expansion of the US energy system are sourced in part from a European manufacturing base already at capacity,⁷¹ and trade friction in these categories raises the cost of closing every capability gap for every member of the alliance, including the United States. Preserving open, predictable trade in critical energy equipment is therefore itself an essential part of resilience.

The job is clear: Every lesson from Ukraine's defense of its grid has been examined against NATO member states' capabilities, and every gap identified carries a program to enhance, a coordination mechanism to formalize, or a funding proposal the alliance can act on. These eight recommendations provide actions for NATO's member states to build upon as they evolve the framework into operational capability in the coming years.

Pillar 1: System reinforcement, decentralization, and hardening (physical and digital)

1. Strengthened grid

Gap: A European grid that remains under-interconnected and under-instrumented, with roughly 30 percent of major grid projects delayed.

Action: Grid modernization programs on the GRIP/SPARK model, including outage-management and grid-software systems, with spending that accelerates permitting and resolves cross-border cost allocation qualifying as enabling investment.

2. Distributed generation

Gap: Concentrated generation that presents single points of failure, and long-term dependence on gas-fired baseload.

Action: Deployment programs on the Janus model for commercial reactors and other nascent technology, including long-duration storage and distributed generation, supported by R&D funding on the ARPA-E and EIC model and by microgrid-ready construction standards in EPG guidance.

3. Cybersecurity throughout

Gap: A digitizing grid whose control systems present a growing surface for cyberattack.

Action: Cyber hardening of civilian grid controls to a NATO standard, qualifying directly toward the commitment.

4. Protected undersea infrastructure

Gap: Undersea cables and pipelines concentrated at maritime choke points, as the Estlink II cutting and drone incidents at Neptun Deep demonstrated.

Action: Protection and monitoring of undersea and coastal infrastructure as cross-border investments that draw on NATO's convening strengths: persistent monitoring, sensing, and repair capacity that complements rather than duplicates the naval presence of Baltic Sentry and NATO's emerging Black Sea posture.

70. S&P Global Commodity Insights, "US LNG Impact Study: Phase 4 Summary Presentation," July 16, 2026, https://spglobal.scene7.com/is/content/spglobalcom/US_LNG_Impact_Study_Phase_4_Summary_Presentationpdf.

71. Neil Ford, "US Power Transformer Buyers Scramble for Imports, Factory Slots," Reuters, May 11, 2026, <https://www.reuters.com/business/energy/us-power-transformer-buyers-scramble-imports-factory-slots--reeii-2026-05-11/>.

Pillar 2: Logistical foresight and stockpiling

5. Alliance-wide fuel distribution

Gap: A fuel desert east of the Central Europe Pipeline System and import infrastructure unbuilt for the LNG volumes replacing Russian gas.

Action: Civil fuel-distribution investment on the NGDISM model and hardened import infrastructure from terminal to end user, connecting to the €27 billion NATO Pipeline System expansion announced at Ankara and funded through core defense spending.

6. Evolved stockpiles

Gap: Equipment reserves too thin for wartime attrition, with transformer lead times now measured in years.

Action: A European Strategic Energy Stockpile of transformers and critical repair equipment, procured through multi-year committed contracts that expand manufacturing capacity, with the NATO EPG coordinating the approved list.

Pillar 3: Emergency response and civil-military coordination

7. Deeper collaboration

Gap: Mutual-assistance and repair capacity designed for storms, not war, and utilities absent from alliance exercises.

Action: Standing cross-border mutual-assistance compacts, funding for training pipelines and reserve teams for grid repair, integration of energy operators into NATO exercises, and preagreed civil-military coordination mechanisms executed where possible by building on mechanisms the EU has already set in motion.

All pillars: Strategic direction underpinning the above

8. Clear guidance

The NATO EPG should issue clear qualification guidance for what counts toward the 1.5 percent commitment, grounded in the existing resilient energy supply baseline requirement, anchored by a formally announced agreement at the Resilience Committee level, ahead of the 2029 review.

Member states will focus first on their own needs, codified in national resilience strategies and reviewed by NATO's EPG. Through this investment framework, over time these institutional mechanisms will create an agile investing landscape focused on orchestrating alliance capability where it will be most impactful. This guidance will meaningfully shape Integrated Resource Plans and National Energy Plans throughout the alliance, maximizing value and strategic impact in every member state. The strategic effects over time will be telling: a more durable alliance that can withstand a dedicated attack on the civil infrastructure that enables a robust military defense. The upcoming review should look beyond the mechanics of 1.5 percent spending, to the capabilities that have been developed and implemented to close these gaps in NATO's energy security. Ambassador Geoffrey Pyatt, after serving on the front lines of energy security in Europe, put the principle clearly: "The safest source of energy is what we generate ourselves, and what we can build or share with our allies and partners globally."⁷²

Ukraine has shown what it costs to learn these lessons under fire, and what it takes to survive them. NATO has the rare advantage of learning them in peacetime, with capital, institutions, and time still on its side. The 2029 review will show whether the alliance has used that advantage.

72. Geoffrey Pyatt, "Energy Security Is Global Security," in *The Global Energy Agenda*, Atlantic Council, February 7, 2024, <https://www.atlanticcouncil.org/content-series/global-energy-agenda/energy-security-is-global-security/>.

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