Strengthening Sovereign Resilience and Security

- Deep tech innovations like AI and quantum computing address ESG challenges while enhancing security and resilience.
- Dual-use technologies support both civilian needs and defense, aiding disaster response and infrastructure protection.
- Defense investments are vital for sovereign resilience and achieving stable, secure societies.
- ESG funds now increasingly include defense stocks, recognizing their role in societal stability.
- AI, quantum modeling, and advanced materials reduce environmental impact and drive net-zero progress.
- Advances in healthcare, education, and cybersecurity boost equity, transparency, and protection.
- Modern threats like cyberattacks require integrated tech, policy, and global collaboration.
- European ESG frameworks increasingly prioritize defense to support stability and sustainability.

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Introduction

Environmental, Social, and Governance (ESG) investing has become a cornerstone for investors aiming to balance financial returns with societal impact. While traditional ESG strategies often focus on renewable energy, green infrastructure, or social equity, the inclusion of deep tech – advanced technologies addressing fundamental challenges – has emerged as a transformative force. These technologies not only drive advancements in renewable energy and healthcare but also intersect with sovereign resilience, encompassing defense, national security, and critical infrastructure protection.

Deep tech's dual-use capabilities exemplify its wide-reaching potential. For example, AI algorithms developed for military logistics can be adapted to optimize disaster response, while advanced cybersecurity systems not only protect government networks but also safeguard essential services such as energy grids and financial institutions. This cross-sectoral applicability underscores the broader societal benefits of deep tech that extend beyond their immediate use cases. By investing in such technologies, stakeholders contribute to a resilient and secure foundation on which environmental and social goals can be realized, emphasizing the vital premise: there is no ESG without security. This also calls for "changing the perception of the defense industry"[1] – an essential cornerstone for strategic stability and sustainable development.

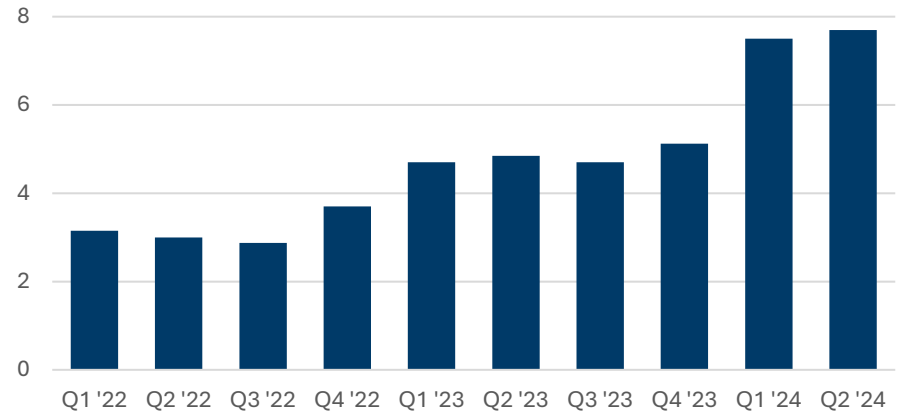
"shifting investor sentiment and evolving regulations are redefining how the sector is assessed through an ESG lens."

Since the onset of the Ukraine war, the value of European ESG funds' exposure to defense stocks has more than doubled, increasing from €3.2bn in Q1 2022 to €7.7bn by mid-2024.[2] This strategic shift aligns with policy adjustments by European pension funds, including those in Finland, which have increased allocations to defense companies to align with national and regional security priorities. Such shifts highlight the growing recognition of defense as integral to societal resilience and sustainability. As Loredana Muharremi, Equity Research Analyst at Morningstar, observes, "shifting investor sentiment and evolving regulations are redefining how the sector is assessed through an ESG lens." This reflects a recalibrated understanding of defense's role in advancing societal resilience and security.[3]

[1] Mitkow, Antczak, Roszkiewicz, 2022, *Challenges for the Defense Industry Against the Background of ESG Concepts*.
[2] Financial Times, *Europe's ESG funds more than double defence holdings amid Ukraine war*, 2 September 2024.
[3] Investment Week, *Defence companies under increased ESG scrutiny as geopolitical tensions rise*, 17 January 2025.

Value of European ESG Funds' Defense Stock Holdings

Market Value of Aerospace and Defense Stocks (€bn)



The Role of Deep Tech in ESG

Deep tech encompasses technologies rooted in scientific and engineering advances, such as artificial intelligence (AI), quantum computing, biotechnology, and advanced materials. These innovations collectively address the pressing challenges of ESG, offering transformative solutions to environmental, social, and governance priorities.

Environmental Impact: Deep tech innovations drive advancements in energy efficiency, carbon capture, and resource optimization. For instance, AI-driven predictive maintenance systems in industrial settings reduce energy consumption and operational waste, directly contributing to net-zero goals. Quantum computing enables more accurate modeling of weather patterns, facilitating improved disaster preparedness and resource allocation. Similarly, AI-powered systems optimize waste management processes, reducing landfill dependency and enabling efficient water resource distribution. Innovations in advanced materials, such as biodegradable plastics and lightweight composites, further contribute to reducing environmental degradation and promoting circular economies. A notable example includes Infleqtion, a BOKA portfolio company. Its partnership with NVIDIA marks a significant milestone in advancing quantum material design. By leveraging NVIDIA's CUDA Quantum platform and logical qubits, Infleqtion has achieved unparalleled computational efficiency. This collaboration enables rapid discovery of high-performance energy storage solutions, contributing to breakthroughs in battery technology with reduced environmental impact. Quantum-driven simulations can now process environmental data millions of times faster, accelerating the shift toward sustainable energy systems.[4]

Beyond environmental concerns, deep tech also addresses critical social challenges, providing solutions to improve societal equity and the well-being of disadvantaged communities.

Social Benefits: AI and advanced biotechnology enable accessible healthcare solutions, smart infrastructure, and improved food security. For example, AI tools have optimized crop yields in regions affected by climate change, contributing to global food security and social equity. Advanced biotechnology is revolutionizing precision medicine, enabling personalized treatments that improve patient outcomes while reducing healthcare costs. Smart infrastructure technologies, such as IoT-enabled urban planning systems, enhance urban living conditions by reducing traffic congestion, curbing energy consumption, and improving air quality. Additionally, AI-driven educational platforms expand access to quality education, particularly in underserved regions, fostering inclusivity and societal advancement.

Addressing governance challenges is equally crucial, as resilient systems depend on transparency, accountability, and robust cybersecurity frameworks.

[4] https://www.infleqtion.com/news/infleqtion-delivers-first-quantum-material-design-application-powered-by-logical-qubits-and-nvidia-cuda-q

Governance Enhancements: Deep tech innovations promote transparency and accountability. Blockchain, for instance, is revolutionizing supply chain traceability, ensuring ethical sourcing and reducing corruption. Cybersecurity solutions safeguard critical data and infrastructure, enhancing trust in digital governance systems. For instance, secure digital identity platforms powered by blockchain help governments and organizations protect citizen data while minimizing fraud. AI-driven analytics enable regulatory bodies to monitor compliance more effectively, identifying anomalies and reducing systemic risks. By integrating these technologies, organizations and governments can build robust governance frameworks that support ethical decision-making and sustainable development. As noted by André Keller of PwC's Strategy&, "public acceptance for drone solutions with clear environmental, social, or security impact is significantly higher compared to purely commercial offerings," reinforcing their integration into sustainable frameworks.[5]

Sovereign Resilience Technologies: The Missing Link in ESG

Sovereign resilience refers to a nation's capacity to withstand and recover from external and internal shocks, whether geopolitical, environmental, or technological. Deep tech investments in defense and national security technologies are foundational to this resilience and align closely with ESG goals. This section explores key dimensions of sovereign resilience, structured into critical themes:

1. **National Security as a Pillar of ESG**: Without secure and stable societies, environmental and social goals become unattainable.[6] Secure and stable societies are a prerequisite for achieving environmental and social goals. Sovereign resilience technologies, including cybersecurity, autonomous systems, and AI-enhanced threat detection, play a vital role in protecting critical infrastructure.
   Example: Cybersecurity advancements safeguard energy grids and water systems from cyberattacks, ensuring the continuity of essential services and supporting societal stability. Such technologies underpin the resilient systems required by modern ESG strategies.

2. **Redefining National Security to Encompass Sovereign Resilience**: The traditional concept of national security has evolved to encompass broader dimensions of societal stability. While defense remains a critical pillar, sovereign resilience encompasses broader societal objectives, such as public health, climate adaptation, and equitable resource distribution, making it integral to ESG strategies. This shift requires governments and societies to address the interconnected risks posed by climate change, resource scarcity, and technological dependencies. The start of the war in Ukraine marked a pivotal moment in how ESG funds approached defense investments.
   Example: Swedish bank SEB reversed its policy within a month of the conflict's start, allowing certain funds to include defense companies, recognizing their critical role in societal resilience.
   Example: Quantum computing's potential to disrupt existing encryption standards highlights the need for proactive measures to secure global financial systems and critical communications and infrastructure.

3. **Challenges in Building Resilience**: Fragmented governance, inadequate technological adoption, and insufficient investment in critical infrastructure hinder efforts to strengthen sovereign resilience. Many nations struggle to modernize their legacy systems, leaving them vulnerable to cascading failures in the face of systemic shocks. Governments must also address societal divides that adversaries exploit, such as misinformation campaigns designed to erode trust in democratic institutions and social cohesion.
   Example: Outdated power grids and water systems are increasingly targeted by cybercriminals, leading to severe disruptions in essential services.

[5] Strategy& (PwC), *Towards Green Horizons: Analyzing UAS and their role in ESG*, 2024.
[6] The UK Government formerly stated their "position that there is no inherent conflict between ESG … financial principles and investment in defence and security companies. The Government is clear that private investment in the UK defence industry is both essential to our national security and can also have economic, environmental and social benefits. Misapplication of ESG principles could compromise that important private investment." Ministry of Defence, *Defence's response to a more contested and volatile world*, July 2023.

4. **Dual-Use Technologies as a Solution**: Many deep tech solutions serve both civilian and defense purposes. AI models developed for military logistics optimization can be repurposed for disaster relief and humanitarian efforts, exemplifying their ESG-aligned versatility. Similarly, advanced satellite systems designed for defense applications can aid environmental monitoring and disaster response, enhancing both security and sustainability. This dual-use nature makes sovereign resilience technologies indispensable for achieving long-term societal goals.
   Example: Finnish pension fund Ilmarinen revised its policies to permit investments in NATO-based defense companies, emphasizing the critical role of defense in ensuring societal resilience.[7]

5. **Weaponization of All Facets of Life**: Although adversaries exploit vulnerabilities, these challenges present unique opportunities for innovation. Adverse elements are increasingly weaponizing information, economics, and even critical infrastructure to destabilize societies. Cyberattacks targeting healthcare systems disrupt essential services, erode public trust, and jeopardize lives, while attacks on energy grids amplify vulnerabilities in national security. Deepfakes and AI-driven misinformation campaigns threaten to undermine trust in media and electoral processes. Economic coercion through supply chain disruptions or resource dependencies further weakens national resilience. Overcoming these multifaceted threats requires comprehensive strategies that integrate technological innovation with policy frameworks and international collaboration.
   Example: Enhanced technologies in healthcare systems and secure communication networks mitigate risks while reinforcing societal resilience.

6. **Responsible Innovation and Accountable AI**: Sovereign resilience technologies often lead the way in ethical AI development and deployment. Collaborative efforts between the public and private sectors are essential to establish governance structures that mitigate risks while maximizing societal benefits.
   Example: Governments and defense organizations are setting frameworks for responsible AI use, ensuring fairness, transparency, and compliance with international norms. However, the rapid pace of technological advancement necessitates vigilance to prevent misuse.

Modern threats are increasingly complex and multidimensional, blurring the lines between traditional warfare and societal destabilization. Adversaries weaponize critical aspects of life, from infrastructure to information, to exploit vulnerabilities. Governments now face unprecedented challenges in safeguarding not just physical assets but also digital networks, information integrity, and the psychological well-being of their citizens. This debate was summarized by Sonja Laud, Chief Investment Officer at Legal and General Investment Management, who noted that the Ukraine conflict has reignited questions about whether nations are prepared to defend themselves, positioning defense as central to ESG considerations.[8]

By redefining national security as sovereign resilience, stakeholders can address the full spectrum of challenges posed by modern threats. This recognition of defense as critical to security and freedom further supports its inclusion within ESG frameworks. As Loredana Muharremi notes, current geopolitical tensions have reframed the sector's strategic importance.[9] This approach ensures that investments in deep tech not only strengthen defense capabilities but also enhance societal stability, economic security, and environmental sustainability. This perspective aligns with the view that national security is foundational to a sustainable society, as highlighted by proponents who argue that defense investments support the stability necessary for environmental and social initiatives to thrive.

Examples of Deep Tech Advancing ESG Goals

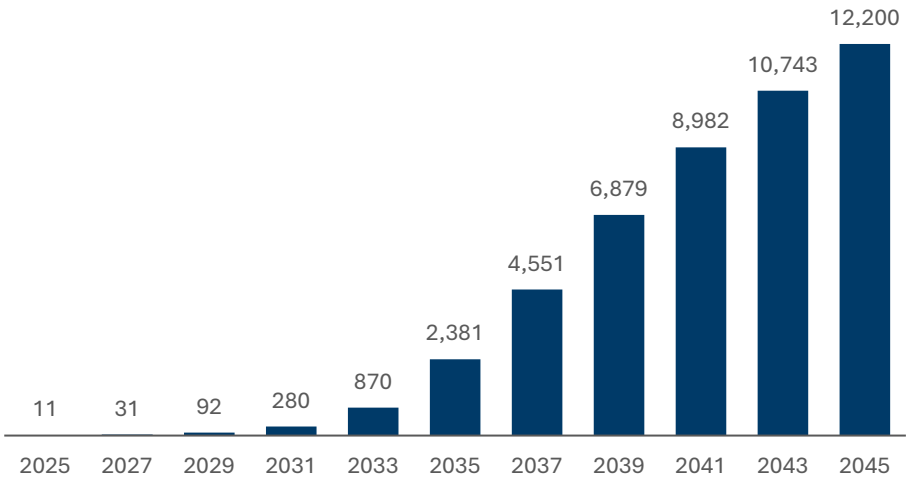
Deep tech innovations are making a tangible impact across diverse sectors, directly advancing ESG objectives. Each example below highlights how these technologies address specific environmental, social, and governance challenges.

[7] Pensions & Investments, *Why Europe's largest investors are building their defense war chests*, 8 May 2024.
[8] The Financial Times, *Europe's ESG funds more than double defence holdings amid Ukraine war*, 2 September 2024.
[9] Investment Week, *Defence companies under increased ESG scrutiny as geopolitical tensions rise*, 17 January 2025.

1. **Safer Renewable Energy Infrastructure**: Quantum computing's ability to model complex systems has accelerated the development of next-generation batteries, reducing reliance on scarce materials and boosting energy efficiency. For instance, IonQ and Rigetti Computing collaborate with energy firms to develop sustainable energy models. Similarly, advanced energy storage technologies from firms like ESS Inc. are facilitating grid-level renewable energy adoption by improving efficiency and reducing emissions. Additionally, integrating drones into logistics systems offers substantial environmental benefits. Studies show that such replacements could save approximately 12.2 million tons of CO_2 annually by 2045, aligning with global net-zero targets.[10]

Forecasted Greenhouse Gas Emission Reductions by B2C Drone Deliveries

'000 t CO_2



Source: Strategy& (PwC), *Towards Green Horizons: Analyzing UAS and their role in ESG*, 2024.

2. **Space Technologies for Environmental Monitoring**: Companies such as SatelliteVu and Planet Labs are leveraging advanced satellite imaging to monitor global carbon emissions, enabling accountability and progress tracking for climate agreements. For example, the European Space Agency's Copernicus program provides vital environmental data used by governments and private sector players alike. Startups such as Spire Global are using nanosatellites to track marine traffic and weather patterns, contributing to sustainable maritime practices.

3. **Advanced Biotechnology for Sustainability**: Synthetic biology firms such as Ginkgo Bioworks are developing eco-friendly materials and sustainable food sources, addressing environmental degradation and food insecurity simultaneously. These technologies are being adopted by multinational corporations such as Unilever and Adidas to reduce their carbon footprint. Additionally, companies such as Beyond Meat and Impossible Foods are using biotechnology to create plant-based meat alternatives, significantly reducing water and land usage compared to traditional livestock farming.

4. **Defense Innovations Protecting Civil Infrastructure**: Multi-link satellite communication systems as those offered by ALL.SPACE[11], a BOKA portfolio company, enhance real-time connectivity for emergency response teams during natural disasters, embodying both security and social equity imperatives. Governments in the United States and NATO allies are

[10] Strategy& (PwC), *Towards Green Horizons: Analyzing UAS and their role in ESG*, 2024.
[11] https://www.all.space/

increasingly adopting these technologies to ensure resilient communications in crises. The UK's Business Secretary, Jonathan Reynolds, has emphasized the defense sector's dual impact, noting its role in supporting national security and economic growth through critical employment: "Our world-leading defence [sic] sector is vital to the economy, supporting thousands of high-skilled, high-paid jobs across the UK."[12] This aligns with broader ESG priorities, as it strengthens economic resilience while driving technological innovation.

The rapid increase in ESG funds holding significant defense positions, tripling from 22 to 66 funds in two years, reflects this sector's growing alignment with sustainable investment strategies.[13] ALL.SPACE exemplifies the sustainability benefits of multi-satellite data transmission by reducing space clutter and the reliance on ground infrastructure such as phone masts. Its technology enhances rural connectivity, enabling access to critical tools, including remote education, healthcare training, and sustainable agricultural practices. Additionally, ALL.SPACE supports environmental monitoring through high-grade satellite data for forestry and fishery management, promoting sustainable resource usage. The integration of AI in disaster prediction systems, such as One Concern's platform, is further advancing resilience by enabling proactive responses to natural disasters.

5. **Cybersecurity Investments for Infrastructure Protection**: Companies such as Palo Alto Networks and CrowdStrike provide cybersecurity solutions that safeguard critical infrastructure. ESG investors have shown growing interest in these companies due to their essential role in maintaining stable and secure societies. Additionally, platforms such as Darktrace are leveraging AI to detect and mitigate cyber threats in real-time, protecting both public and private sector entities.

6. **Innovations in Water Resource Management**: AI-driven systems from companies such as Xylem are optimizing water usage in agriculture and urban settings, reducing waste and enhancing sustainability. Satellite-enabled water monitoring tools, such as those developed by Orbital Insight, are helping governments and organizations track water resources in drought-prone regions, ensuring equitable distribution.

7. **Precision Agriculture for Food Security**: Companies such as Deere & Company (John Deere) are integrating AI and IoT into agricultural machinery to optimize planting, watering, and harvesting. These innovations not only increase crop yields but also reduce water and fertilizer waste, promoting sustainable farming practices. Drones equipped with precision sensors can cut water usage by up to 96% and reduce pesticide applications by 10%, lowering the environmental footprint of farming while optimizing resource use.[14]

8. **AI in Healthcare and Pandemic Response**: AI-driven diagnostic tools from companies such as Tempus and Butterfly Network are revolutionizing healthcare delivery, enabling early disease detection and efficient resource allocation. During the COVID-19 pandemic, AI models were instrumental in tracking virus spread and optimizing vaccine distribution, demonstrating the critical role of technology in safeguarding public health. Drone solutions have further reduced healthcare delivery times by up to 85% in rural areas, preventing stock shortages and ensuring timely access to essential medical supplies.[15]

By showcasing these examples, it becomes evident that deep tech solutions are not only addressing ESG goals but also strengthening the resilience of societies and economies. These advancements highlight the importance of continued investment and innovation in this sector to meet the challenges of a rapidly changing world.

Conclusion

[12] https://www.gov.uk/government/news/business-secretary-to-meet-defence-ceos-and-encourages-investors-to-see-defence-as-a-core-engine-of-growth
[13] Financial Times, *Europe's ESG funds more than double defence holdings amid Ukraine war*, 2 September 2024.
[14] Strategy& (PwC), *Towards Green Horizons: Analyzing UAS and their role in ESG*, 2024.
[15] ibid

Deep tech serves as a pivotal driver in achieving ESG objectives while simultaneously addressing the urgent need for sovereign resilience. By leveraging advancements in artificial intelligence, quantum computing, biotechnology, and cybersecurity, stakeholders can establish a robust framework that ensures societal stability, environmental sustainability, and economic prosperity.

As global challenges become more complex and interconnected, the inclusion of defense and resilience technologies in ESG frameworks is not merely an option but a necessity. For example, integrating AI-driven cybersecurity systems and space technologies for environmental monitoring not only addresses immediate risks but also promotes long-term sustainable development. This dual-use potential underscores the importance of aligning ESG investments with sovereign resilience priorities, creating a virtuous cycle of innovation and societal progress.

Policymakers and investors must strengthen collaborations to expand ESG frameworks to reflect these evolving priorities. European policymakers recognize the strategic importance of defense investments, advocating for a robust defense industrial base as foundational to national security and economic growth.

"Defense is likely to be increasingly seen as a necessity that facilitates ESG as an enterprise, maintaining peace, stability, and other social goods."

The inclusion of defense in the EU's social taxonomy for sustainable finance once seemed improbable. However, Citi analysts now state, "Defense is likely to be increasingly seen as a necessity that facilitates ESG as an enterprise, maintaining peace, stability, and other social goods." This marks a significant shift in how defense is perceived within ESG frameworks.[16] Academic research and international policy shifts, such as the European Union's adaptation of ESG to include defense and the UK MoD's emphasis on security as a sustainability pillar, highlight the growing recognition of this nexus. These efforts require robust ethical oversight, public-private partnerships, and transparent communication to build trust and align stakeholder interests.

In conclusion, embracing the synergy between deep tech and ESG offers a holistic approach to tackling global challenges. By fostering innovation, reinforcing resilience, and prioritizing security, we can shape a future that is not only sustainable and equitable but also resilient and secure in the face of emerging threats.

[16] Financial Times, *Are defence stocks now ESG?* 4 March 2022.

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