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Sustainability on the Edge

Use less. Do more. Go further.

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Foreword: Victoria Doherty

Sustainability on the Edge

Report

Climate change is now a recognised driving force for transformation across defence and security. With collaboration, we can deliver resilient advantage in a climate changed world.

Diverse representatives across international defence organisations, industry and academia, including non-traditional roles such as virtual reality and simulation, gathered to share their perspectives. This report builds on those discussions and the actions that were highlighted as essential to future military resilience and operational effectiveness.

There is an increasingly sobering view of climate change impacts on crucial strategic and operational locations, resource availability, and global geopolitical stability. Multidisciplinary collaboration is essential to spot and work on 'the gaps between the gaps', and understand how training, research and development translates into action through processes, policy and standard practises.

Energy was highlighted as crucial to operational effectiveness. Given the significant international transition towards novel energy solutions, we established broad agreement on the need for common lexicon and standards, and for a wide-reaching energy insights model to support our forces to *'use less, do more, and go further'.*

By actively participating and influencing cross-sector research and development, defence can be a 'proactive fast follower' and learn from adjacent industries and consumer markets. In parallel defence can use these insights to identify defence-specific needs early, and to create specifications that enable and encourage adoption of new technology as it emerges.

Across all roles and organisations, we need to consider the changing landscape, its impacts, threats and opportunities for ways of working, supply chains, security and people. This includes systematically identifying and building resilience to criticalities and bottlenecks of vulnerability. Most pressingly, we must now build in key questions such as: *'How will this work with new weather patterns? 'How will this work if the world decarbonises?'* and '*What are the alternatives to fossil fuels?'* This is just one tangible input to business-as-usual decision-making that can be a significant lever for change.

This report reflects a collaborative effort, highlighting key observations and advice on how we can build operational advantage in the face of climate change and energy transition. We hope you find this an informative and stimulating read. If you have any feedback or would like to explore the topics discussed, please contact us at: innovation@QinetiQ.com

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Introduction

The defence industry is facing a crucial turning point in the pursuit of sustainability, one which has military resilience and operational freedom at its heart.

While familiar activities such as reporting and reducing carbon emissions, lowering energy consumption and transitioning to renewable energy all remain key steps in the fight against climate change, demand is increasing for the adoption of a more comprehensive approach when addressing the sustainability challenge, one which has military resilience and operational freedom at its heart. These are not, however, two separate challenges. Building a more sustainability focused defence industry provides opportunities to integrate sustainability into every level of operations - from early research and development, throughout the procurement process, into deployment and at the end of the product life-cycle - ultimately helping to build climate change resilience, which will be vital for maintaining future operational advantage[1].

Defence and security planning and preparedness should rely not only on a thorough understanding of the wide-reaching practical impacts of climate change, but also on the accelerated integration of innovative renewable technologies and greater investment in next-generation skills and training. We must position ourselves at the forefront of sustainable investment, from climate secure supply chains to the advancement of the electric battlespace; our forces must be equipped to operate in ever more challenging environments; energy security must be ensured; and industry emissions must be reduced in compliance with, if not ahead of, government targets.

This report explores the impacts that a warming planet has for the defence and security industry and considers how we can build climate resilience. It also calls for the defence and security industry to collaborate on efforts to develop a baseline understanding of sector sustainability and commit to holistic climate related risk assessment, while setting out a framework for policy-based change and calling for investment to close the sustainability skills gap.

[1]IPCC (2023) Climate Change 2023 Synthesis Report

The impact of climate change on security

Climate change is a threat multiplier. The myriad effects of a warming climate, including rising sea levels, increasingly frequent and extreme weather events, greater competition for scarcer resources, and mass displacement of climate refugees, all have implications for defence.

The rise in extreme weather events will weigh heavily on global economic growth. Global costs associated with climate-change-related extreme weather events reached an estimated USD280bn in 2022, and this figure is likely to rise as climate change continues[2]. There is growing evidence that the economic disruption from hurricanes, floods and droughts will affect global poverty levels and contribute to social insecurity, potentially leading to a rise in armed conflicts as order is degraded[3]. In this unstable global environment, there is a risk that governments will tend to stick towards the status quo reliance on fossil fuels rather than pursue the potential benefits and risks of sustainable technology development.

Overstretched water supplies could lead to greater competition over the control of water sources, particularly as developing nations invest in large-scale hydropower projects to address energy shortages – impacting on downriver water supplies for agriculture and consumption. These tensions are already playing out in Africa where Ethiopia's dam developments have led to cross-border tensions[5]. Arable land availability will also be impacted by rising temperatures, soil erosion, desertification and increases in flooding.

In countries already hindered by a weak governance structure, this could contribute to a more unstable geopolitical environment, leading to an increased risk of internal and external conflict.

There is a significant disparity between the countries most affected by climate change, and those responsible for the majority of emissions: many of the states considered most vulnerable to the rise in extreme weather events linked to climate change also have the lowest national greenhouse gas emissions[6]. At COP27, an agreement was reached to provide "loss and damage" funding for those countries hardest hit by climate disasters and this is an important step towards limiting a potential rise in tensions between wealthy and developing nations.

[2] The global costs of extreme weather that are attributable to climate change | Nature Communications
[3] Conflict and Climate | UNFCCC [4] Five ways the climate crisis impacts human security | United Nations
[5] Ethiopia and Egypt say no agreement in latest talks over a contentious dam on the Nile | AP News
[6] Many of the world's poorest countries are the least polluting but the most climate-vulnerable. Here's what they want at COP27 | PBS NewsHour

What this means for defence

The impacts of climate change are already being felt in the defence sector. If climate change continues along current projections, the operational impact on the military will be extensive across all domains.

The Intergovernmental Panel on Climate Change's analysis shows that the 1.5°C increase in global temperatures threshold, after which we can expect to see a rise in extreme weather events, rising sea levels and threats to ecosystems, could be reached within the next decade[7].

In the maritime domain, rougher, warmer seas could accelerate damage to engines, turbines and hulls, resulting in greater pressure on the maintenance cycle and reduced mean time between equipment failures for our Navies[8], while rising sea levels will put numerous military installations at risk of flooding[9]. Research also indicates that a warming ocean may impact the effectiveness of sonar detection which has enormous implications for submarine warfare[10] and require extensive re-optimisation and testing. A warmer planet has also contributed to an increase in aviation turbulence, raising costs and risks in the air domain, while increased temperatures mean thinner air and therefore less lift, requiring more power, and therefore fuel consumption, to achieve the same outcomes[11].

While preparing our troops to operate in potentially more hostile environments, we must also consider the development of an asymmetrical operating space whereby adversaries benefit from aspects of environmental change such as easier acclimation to more extreme heat[12]. With climate change likely to speed up mass migration[13] leading to more densely population urban areas, there is a greater risk that we will face adversaries in urban environments, an environment potentially more suited to insurgent groups than technologically superior military forces[14].

> The sustainability challenge is not taking place in a vacuum; there are many security crises and conflicts playing out on the world stage.

As with all industries, the defence sector has a responsibility to respond to the climate change crisis. This challenge is not taking place in a vacuum; there are many security crises and conflicts playing out on the world stage. While responding to these threats quickly is undoubtedly a priority, it is our belief that survivability and sustainability go hand-in-hand and that the defence industry has an ongoing responsibility to achieve both, in order to protect lives short- and long-term.

A holistic, defence-wide strategy which builds sustainability into the planning and operating model has the potential to give a vital operational advantage in a context where climate change can significantly alter how, where and why forces are deployed, and in what conditions.

[7] Global Warming of 1.5 ºC — (ipcc.ch), Analysis: When might the world exceed 1.5C and 2C of global warming? - Carbon Brief
[8] Climate Change and Military Power: Hunting for Submarines in the Warming Ocean - Texas National Security Review (tnsr.org)
[9] The Navy's Vanguard Against Rising Sea Levels | Proceedings - June 2020 Vol. 146/6/1,408 (usni.org)
[10] New Research Suggests Submarine Stealthiness Could Fall Victim to Warming Oceans - Defense Opinion
[11] Aviation turbulence strengthened as the world warmed - University of Reading
[12] 34. Own The Heat: DoD Climate Change Action with Mr. Richard Kidd (castos.com)
[13] Climate change-induced migration: UK collaboration with international partners - House of Lords Library (parliament.uk)
[14] Urban insurgency in the twenty-first century: smaller militaries and increased conflict in cities | International Affairs | Oxford Academic (oup.com)

Building climate change resilience

Building climate change resilience demands an integrated and ambitious stance from government, industry and allied nations. Clear, consistent leadership is vital and the shifting of climate-related targets (such as the UK postponement of the ban on new petrol and diesel vehicles from 2030 to 2035[15]) creates uncertainty in the investment environment and could limit sustainable technology development.

The defence industry will need to collaborate with internal and external partners to deepen understanding of the operational impacts, both of climate change and of the drive towards sustainability. A changing climate has broad implications for systems durability and performance, and will change the constraints and opportunities to secure operational readiness or advantage.

The defence industry needs to do more as a sector to review existing capability against a backdrop of environmental and geopolitical change, as well as the energy transition, in order to ensure that we can keep pace with the challenges our customers face. Defence typically plans ten years in advance. We need to consider what the future world could look like over a longer timeframe (20, 30, 40, 50 years), accounting for the likelihood that we will be required to conduct operations in new environments and using different strategies. In order to keep up with possible adversarial advantage, is imperative that the next UK Defence Strategic Review incorporates the longer-term challenges of sustainability, while maintaining short-term readiness.

[15] Government sets out path to zero emission vehicles by 2035 - GOV.UK (www.gov.uk)

Building climate change resilience will require addressing several key challenges in the defence industry

Defence needs to measure and forecast its energy needs accurately. This will be paramount to future defence energy security.

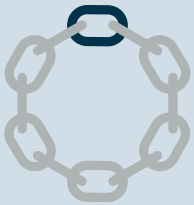
A. Developing better understanding

It is vital to address the significant knowledge gaps which are hindering defence's response to climate change, particularly with regards to its potential impact on relevant operating environments. Further work needs to be done to evaluate existing platforms and capabilities against projected mid-life upgrade and out-of-service dates, while taking into account the demands of sustainability and the new pressures that are arising.

We believe that the development of climate data tailored to defence and security questions will empower more sustainable procurement across the sector. This includes the expansion of horizon-scanning that synthesises industry, science and technology developments in order to capture opportunities to enhance defence-related sustainability.

More research is needed to understand defence supply chains, particularly identifying critical pathways where we are reliant on a single supplier for a crucial component without an alternative. This is of particularly vital importance where our adversaries may control critical material resources. Sustainability requires an understanding of potential production threats faced by suppliers due to climate change, not just the physical and economic changes but the human and social impacts too. This understanding should extend throughout the product life cycle.

The quantification and forecasting of defence energy usage is paramount for achieving future energy security in the defence sector, as it can identify opportunities for smart energy-allocation, consumption reduction and the introduction of new, potentially more diverse, technologies, as well as enabling progress against targets to be tracked. Practical frameworks are required to guide energy planners to the power sources, energy storage and distribution options best suited to each mission and context.



B. Preparing supply chains

A key consideration in preparing the defence industry to meet the challenges of sustainability is the need to build a sustainable and climate resilient supply chain. Defence supply chains are complex and often global, which can create certain vulnerabilities. For example, increases in temperature associated with climate change could lead to raw material shortages, disrupting production. Some sustainability technologies are more reliant on rare earth metals which can create a supply issue or over-reliance on individual nations[16].

Supply chain vulnerability was demonstrated by the shortage of semiconductors during the Covid-19 pandemic. Rising demand coupled with lower supply affected a broad range of industries including electronics and automotive as well as defence. This experience has provided the defence industry with a learning opportunity.

In order to secure a sustainable and climate change resilient supply chain, the defence industry should embrace a sustainability based supply chain audit combined with a horizon-scanning element to anticipate changes to the operating environment and technological developments. It is likely that this process will face some difficulties due to issues surrounding commercial sensitivities. These must be balanced against the value of a shared knowledge and understanding. There is also a role for trade associations to contribute in this area. Advisory firms can be particularly helpful for Small to Medium Enterprises (SMEs) in understanding how to attain sustainability across the length and breadth of their supply chain.

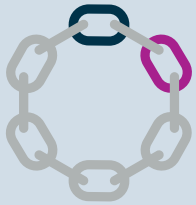
Understanding the implications of climate change for current supply chains will enable us to protect them into the future. Addressing climate-related risks includes not only considering an individual organisation's supply chain, but systematically identifying criticalities and bottlenecks of vulnerability and focussing on building resilience at these points.

It is also incumbent on analysts to identify opportunities to do things differently. This is a time of major change and there are advantages to be gained from remote or distributed scavenging of power over a traditional logistics chain.

Similarly, 3D printing close to the locations where components are required and modular manufacturing concepts bring innovation to a logistics supply chain that may allow deployed elements to be more self-sustaining for a longer period of time.

The same is true in the digital sphere. Innovations in computing and cyber security allow for greater 'edge' computing and processing without returning all data to the home nation for analysis. This reverses a decade long trend to pull all data back to a central point with expert analysts and will require a system of systems holistic analysis to exploit the opportunities that the technological innovation offers. This is where a human centred perspective is essential, one that combines people, process and technology with the operational imperatives of both generic policy and each individual activity.

This means anticipating requirements for systems and materials (and building awareness of where those materials are situated). Currently, the defence industry is not doing as much as it should be to understand the supply chain needs of the future when it comes to sustainability technologies. Being proactive and forward-looking is a vital part of achieving supply chain security. Improving supply chain resilience may also rely on a greater drive towards increasing sovereign supply, which could come at a premium.



[16] Can Europe go green without China's critical minerals? (ft.com)

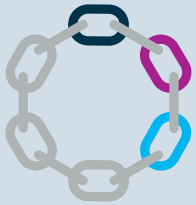
C. Achieving energy security

Energy security is a strategic imperative – both at home and overseas. There is much speculation about what type of power sources and energy storage solutions might replace fossil fuels, with options varying by application and domain. We need to ensure that we look at energy through a coherent defence lens in order to bring common language and standards to the several strands of activity already in motion from various national and international organisations.

Close collaboration across multiple sectors is essential to ensure that the equipment we deploy remains compatible and operational. We are advocating for a consistent and wide reaching approach to modelling energy insights to support our forces to 'use less, do more, and go further'. An operational energy analysis approach, which processes location and operation specifics alongside energy consumption requirements to identify appropriate energy production technology solutions, could be an important contributor to the development of energy security. Bespoke toolkits for energy planners could support implementation as skills and insights in new systems develop. This suggests a need for energy to be regarded as a capability more than a commodity.

There is pressure in the defence sector to balance the need for short-term energy management with investment in renewable technological advances, collaborating with other industries where more investment is needed to establish a clear technological frontrunner. Understanding that we do not yet have all the answers means that we need to build flexibility into platforms and systems in order to integrate new solutions as they are developed and prepare ourselves for the future. This creates an opportunity to consider energy resilience in the design process, linking investment appraisals with energy security challenges such as the ability to accept multiple energy sources / fuel types, and suitability for midlife upgrades. The funding cycle must adapt and not only facilitate but positively encourage mid-life upgrades, building modularity in from the start and supporting improvements and adoption of new technology as it emerges.

Energy security is a strategic imperative – both at home and overseas.



D. Addressing key skills gaps

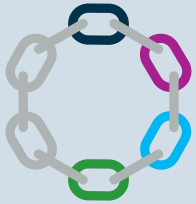
In order to support the transformation that the defence industry requires to achieve its sustainability goals, we must address the substantial gaps in science and technology skills that our industry currently faces. In the UK, there is a long running skills gap across Science, Technology, Engineering and Mathematics (STEM) which is hindering productivity[17]. If the aim is to facilitate operationally-advantageous and emission-reducing solutions that are future-proofed and deliver change, this demands highly effective multidisciplinary teams to identify opportunities and use innovative thinking to design capability. It is therefore imperative for the defence industry to create an attractive career pathway for STEM professionals, from apprentices through to PhDs.

International cooperation and collaboration with our allies should form a key part of strategies to address key skill gaps. This has been exemplified by the trilateral security partnership between Australia, the UK and the United States (AUKUS) which includes developing advanced capabilities, such as quantum, under Pillar Two commitments[18].

In order to reframe the idea of sustainability into one that constitutes operational advantage on the battlefield, cultural and behavioural changes are needed, integrating sustainability into every stage of the development process, particularly long-term (beyond 2050) capability development. Addressing the sustainability literacy gaps (which includes climate and energy literacy, in addition to broader health and well-being literacy) is therefore paramount for creating real industry change, and educating the workforce so that they are empowered to deal with the challenges ahead is vital.

There are many examples of sustainability related skills gaps, which have the potential (or indeed already are) impacting on the defence industry. For example:

- sustainability leadership and management, which is vital given the scale and complexity of the challenge ahead;
- modular manufacturing technology to reduce reliance on long logistics chains and improve operational efficiencies;
- novel materials to replace those that are rare or damaging and create a more secure supply chain;
- power and energy technology options and the systems that manage them in order to drive operational advantage in an energy contest environment; and
- domain and defence-specific impacts of climate change in order to ensure that the armed forces are prepared and resilient.



[17] Action needed across Government to secure a high-skilled STEM workforce for the UK - Committees - UK Parliament
[18] AUKUS security partnership - House of Lords Library (parliament.uk)

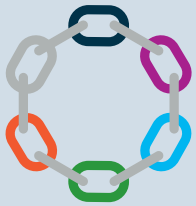
E. Partnering with commercial industry

While the powerful investment capabilities of the commercial sector mean it will lead development in many areas of decarbonisation, it should be acknowledged that priorities are often different. The commercial sector is not going to be looking for answers to the defence sector's specific questions. For example, national strategies for energy storage typically focus on the automotive industry (in the UK the battery strategy is centred on electric vehicles[19]) and long-term energy storage for renewables, leaving gaps for critical defence and security applications. As such, militarising commercial solutions may not always be sufficient or appropriate.

Rapid investment in a range of competing renewable technologies without coordination means that energy provision is likely to diversify before a new coherent system of energy generation and storage solutions is settled upon. A proliferation in power sources could create significant challenges for deployed forces and the logistics needed to support them, including within NATO which has long adopted the Single Fuel Policy[20].

At the same time, a proliferation of energy-related innovation brings with it opportunities for new ways of working, whether through power scavenging, distributed recharge, robotics and autonomous systems or reduced noise and vibration signature. These opportunities frequently emerge from cross sector collaboration.

Defence therefore needs to maintain active participation and influence in system design, alongside keen learning from adjacent industries and consumer markets. This enables the defence industry to pull in skills and methodologies from other sectors.



The proliferation of energy related innovation brings with it opportunities for new ways of working.

[19] About - UKPN Innovation (ukpowernetworks.co.uk), See 'Our Electric Vehicle Strategy'
[20] Can NATO Supercharge Military Greening? | RAND

F. Supporting systemic change

It is important to note that while providing knowledge to people is helpful, systems also need to be put in place that enable this knowledge to be put into practice through the procedures that individuals follow in day-to-day roles, creating a clear link between training and output. The process of supporting the application of taught knowledge already exists in military capability planning practise (for example, many military personnel are taught how to apply data knowledge through use of generic architectures). However, energy solutions are still typically devolved to platform level without a coherent response to creating resilience to a contested energy environment or reduced energy supplies. To support the sustainable energy transition, a similar consideration must be made for energy at the 'system of systems' level of concept development and planning. This requirement extends across the full range of Defence Lines of Development and demands a holistic, energy-related strategy to sustainability.

Working with our allies

International cooperation is key throughout the twin challenges of creating a more sustainable defence and security industry and in preparing for the ramifications of global climate change. It is imperative that nations collaborate, both directly and through international defence organisations, particularly NATO, as it marks its 75th anniversary in 2024.

NATO recognises that climate change is a 'crisis and threat multiplier'[21] and aims to become the leading organisation when it comes to understanding and adapting to the impact of climate change on security. NATO will also contribute to combating climate change by reducing greenhouse gas emissions (GHG), improving energy efficiency, investing in the transition to clean energy sources and leveraging green technologies, while ensuring military effectiveness and a credible deterrence and defence posture. In this way, NATO has been at the forefront of research, innovation and disaster relief support. In 2023, the NATO Climate Change and Security Centre of Excellence (CCASCOE) opened in Canada, creating an additional resource for doctrine development, training and broader climate security innovation. The CCASCOE received successful accreditation in July 2024, during the 'NATO in a Climate-Changed World' event.

NATO has a convening power that can help to bring agreement and compatibility in solutions between allies and is developing tools, frameworks and methodologies to support allies in this space of climate analysis and resilience. NATO also seeks to achieve a 45% reduction in GHG emissions by 2030, and Net-Zero by 2050.

In such a fast-paced innovation environment it is both essential and challenging to maintain momentum in discussion and agreement that is sufficiently forward-leaning to influence technology design while taking into account the challenges of the energy transition moving at different speeds in different locations. This emphasises the need for a coherent approach to analysing the impact of climate change on defence and security, which NATO is endeavouring to lead[22]. Strong leadership will be required, particularly in areas such as fuel interoperability, as alternative energy sources are developed and the shift away from fossil fuels accelerates.

[21] NATO - PDF: NATO 2022 Strategic Concept (in English, French and other languages)
[22] NATO Review - Climate change threatens NATO's readiness and resilience at sea

A systematic approach to practical decision making

A sector framework for sustainability and climate change would enable practical decision making in defence. This would be triggered at key decision points in strategy and procurement, taking into account factors such as the long-term timescales for equipment replacement. Cost savings achieved through energy reduction could be reinvested into sustainable technology.

The goal is to act with holistic, defence-wide coherence to overcome the challenges of sustainability. It requires the industry to:

01

Enhance operational effectiveness through climate resilience by:

a. acting as a call-to-action;

b. achieving top down buy-in; and

c. setting clear expectations.

02

Drive simplicity for decision makers by:

a. providing practical and tangible actions for crucial roles, such as energy planners choosing what equipment is required for a particular deployment; and

b. agreeing climate change, sustainability and energy transition assumptions that can be incorporated into existing planning scenarios, strategic development methods and test and evaluation planning.

03

Tailor investment recommendations according to operating maturity:

a. in-service: enact change where efficiencies provide near-term operational advantage such as through fuel efficiencies, manoeuvrability or greater choice in component supply to mitigate any disruption to logistics;

b. in-pipeline: require modularity and fuel agnosticism (or multi-fuel options) in design. Include energy, environment and supply chain scenarios in test and evaluation throughout lifecycle with a focus on circularity; and

c. concept development: design systematic integrated concepts with ways of working that embrace the features of new technological solutions designed with environmental, energy and supply chain disturbance integrated into the system resilience.

Sustainable technology and operational advantage

Addressing the challenges surrounding sustainability cannot come at the expense of operational effectiveness. We argue that defence can go further and utilise research into sustainability to contribute to the development of operational advantage and national security:

- **Electric and hybrid vehicles** which could reduce noise and thermal signatures and reduce detectability. Also lower operational cost.

- **Modular energy storage,** advanced **biofuels, hydrogen** for energy storage, and **synthetic aviation fuel** for flexibility and resilience in power sources, energy storage and distribution.

- More **portable solar energy installations** and **microgrid technology** for operational agility, range, endurance and independence.

- Optimisation of **wind power generation** and compatibility with critical radar.

- Tech for **water purification, recycling** and **conservation** which can improve water supply security in the field.

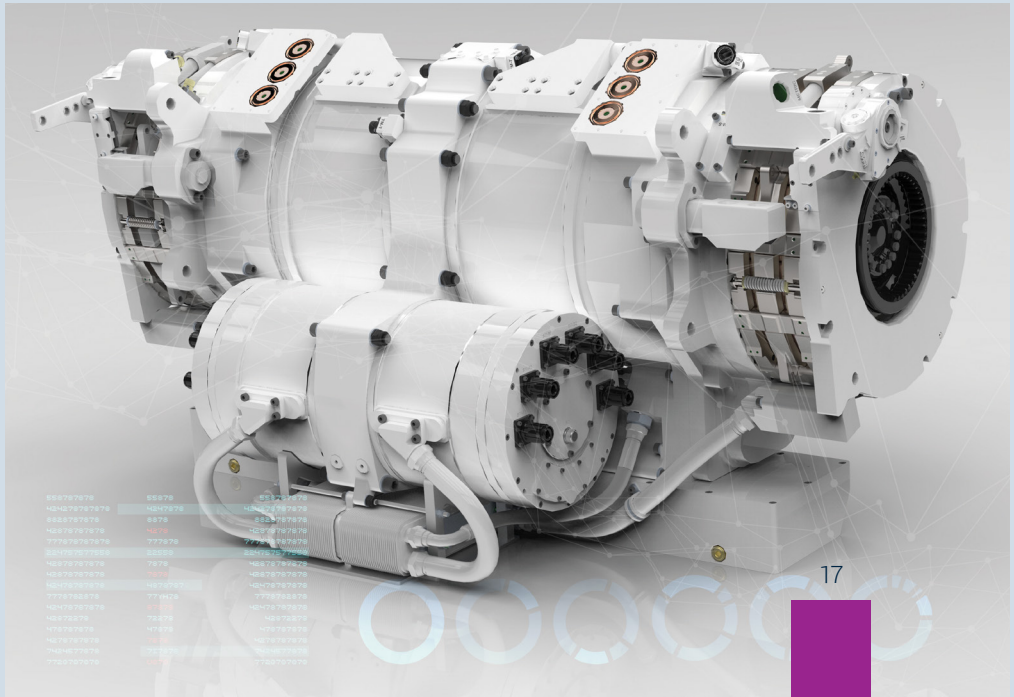
- **Advanced materials** or **lightweight composite materials** which could lead to more efficient equipment and structures, greater adaptability, and alternatives to scarce materials, particularly if developed to increase circularity.

- **3D printing in the field/additive manufacturing** – ability to produce components directly in the field as needed, this frees up logistics capacity.

- **Computing solutions** that allow greater processing at reach, meaning less transfer of data back to a central point.

- **Digital solutions** to simulate multiple future scenarios during scenario planning, war-gaming, test and evaluation and training, though it will also be important to consider the associated carbon footprint.

There are exciting innovations by start-ups, academia and industry which need defence expertise to inform development and establish if such new technology can meet the required sustainability and operational efficiency standards required, within the cost parameters.



Test and evaluation for climate resilience

The potential effectiveness of new sustainable technology will need to be assessed, often at the very early stages of research and development, and well before the technology is ready to be implemented. This creates a challenge due to the long-term procurement timescales common in defence, as well as lengthy in-service lifetimes of some defence equipment.

Adapting procurement so that defence takes a proactive role in sustainability technology development means that enhanced test and evaluation (T&E), including modelling and simulation, will be required which must incorporate climate change variables to ensure relevance for the shifting operational landscapes. Modelling and simulation has a key role to play in achieving fast adaption of emerging technologies in order to prepare for the long-term effects of climate change. This requires T&E facilities which can simulate different environmental conditions and will need the involvement of climate scientists.

Analytic wargaming is a valuable tool for assessing both the impact of technology and doctrine on various conflict preparedness scenarios. To ensure that outcomes remain relevant, professional wargaming should take into account the ways in which climate change can impact on decision-making and operating conditions.

This can be done through scenario development, which allows the user to test for all kinds of preparedness, such as:

- **Environmental variables** – Temperature changes, wind patterns and other environmental variables which may affect mobility, visibility and logistics (this could be based on real-time weather forecasts or longer-term changes)
- **Resource availability** – Shortage of critical resources, such as water and energy, or access in a contested environment
- **Infrastructure disruption** – Military bases and lines of communication could be affected by storms, floods and wild fires
- **Geopolitical changes** – For example, competing claims to shipping routes and resources as the Arctic sea ice melts.

What next?

Building a sustainable defence industry needs greater cooperation both within the sector and with partners from further afield, bringing fresh opinions into the debate, expanding insights and accelerating investment collaboratively.

The benefit comes when we each take the gathered insights to inform our actions. We need to consider the changing climate landscape and the threats and opportunities this creates across defence organisations, industry, supply chains, physical conditions, security and people. Most pressingly, building in key questions such as 'how will this work when the world warms?' is just one tangible input to business-as-usual decision making that can be a significant lever for change.

Nations around the world have pledged to reduce carbon emissions. In the UK, for example, this is under the Net-Zero by 2050 pledge. Typically defence accounts for an estimated 50% of central government emissions and therefore faces an obligation to take action.

Collectively and individually, we can take action to integrate sustainability into everything we do, by:

Energy, science and technology

1. Strengthen the baseline of current energy use and emissions to support accurate forecasting tools
2. Develop an energy model, a digital twin, to aid planning of energy needs and solutions
3. Lean in to dual use science and technology that will underpin future solutions across the whole defence and security system

Evidence-based action

4. Integrate climate-change insights into standard training and ways of working for selected decision makers
5. Deepen understanding of specific impacts of climate change on future operating environments and activities
6. Map supply chain vulnerabilities
7. Increase logistics constraints in wargaming to improve decision making

Solutions that work together

8. Work with government and industry partners to develop standardised solutions that talk to one another (both software and hardware)
9. Synthesise allies' industry, science and technology horizon scanning
10. Update standards, commercial and policy documents to drive change, coordinating across organisations for a simplified approach

[23] Defence and Climate Change - Defence Committee (parliament.uk)

Conclusion

Use Less. Do More. Go Further

Without a dramatic reduction in global emissions, the effects of climate change are only expected to become more challenging over time. The operational landscape is likely moving into a messy energy transition space, against a backdrop of sobering social, economic and environmental challenges. It is imperative that we consider how we are going to respond to climate change as allies, in addition to how other actors will respond - from the public, to adversaries and insurgents.

This report calls for greater investment into climate change mitigation and adaptation, as well as defence industry sustainability - so that we may not only reduce the industry's impact on global warming, but also achieve operational advantage in a climate-changed world. Sustainability should be incorporated into all levels of decision-making, from supply chains to battlespaces, and individuals working in the sector should be empowered to consider the energy, sustainability and climate resilience perspective as part of what they are able to achieve in their day-to-day roles.

It is critical that we embed a sustainable mind-set in defence and this must be permeated throughout every layer of the industry. Defence needs to operate on both a long-term and short-term basis simultaneously; sustainability by design will give us that long-term edge, but we must not forget that immediate and incremental changes, such as the introduction of alternative energy options, are also paramount for creating real and lasting change.

Contributor biographies

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Head of Futures and the Operational Energy Authority, Defence Support
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Ange joined the RAF as a logistics officer in 1996, after completing a degree at Leeds University. Her early years were operationally focused, undertaking tours in Kosovo, Bosnia, Iraq and Afghanistan. She gained a range of staff experience in MOD, Permanent Joint Headquarters and Air, in both logistics and generalist roles. As a group captain, she was the logistics lead in Air Command and then became the Air Commodities Team Leader within Defence Equipment & Support, prior to attending the Royal College of Defence Studies. She was promoted in 2021 into her current role as Head of Futures and the Operational Energy Authority in Defence Support.

Victoria Doherty (Co-chair)

Group Head Sustainability & Electrification Client Engagement
QinetiQ

Victoria leads on client engagement for electrification and sustainability from the Chief Technology Office at QinetiQ. Her passion for collaboration between technical disciplines and practical challenges has led her to work in human factors, cyber security, energy and power and sustainability. Victoria has held senior roles in client engagement, business development, as chief of staff and in technical consulting. She is a chartered Ergonomist and Accredited Coach.

Dr Deborah Allen

Group Director Climate, Environment & Infrastructure
BAE Systems Plc

Deborah is a chemical engineer by background and has more than 30 years' sustainability experience across both consultancy and industry. She led the development of the sustainability agenda within BAE Systems and currently leads their global programme on climate resilience, environment and infrastructure. Deborah chairs the Climate & Defence Task Force for the European Aerospace, Defence & Security group of companies, sits on the Board of International Aerospace Environmental Group and is also a Non-Executive Director of the UK National Composite Centre.

Thomas Bohné

Head Cyber-Human Lab
University of Cambridge

Thomas is the founder and Head of the Cyber-Human Lab at the University of Cambridge. His team engineer learning and training systems to empower human performance in industry. He is also leading research on human-oriented digital systems and the impact of digital technologies on human behaviour as part of a new £5m Engineering and Physical Sciences Research Council Made Smarter Innovation Research Centre. He co-founded and is co-leading a consortium at the World Economic Forum on Manufacturing Talent of the Future, where his team led reports on topics such augmented workforce, industrial metaverse, and frontline workers' perspective on technology introductions.

Contributor biographies

Richard Brewin
Energy and Environmental Security
NATO

Richard is a chartered scientist, member of the UK Royal Society of Biology, and Institute of Environmental Management and Assessment. He worked for several years in the UK government, first in the Department for Environment, Food, and Rural Affairs, but spent most of his UK career in the MOD working on policy development, research management, and equipment acquisition. In the EU, he managed the European Defence Agency's Energy and Environment Programme including a suite of capability development projects. He is currently focused on the establishment of NATO's Climate Change and Security programme; he also manages a portfolio of international science and technology collaboration projects with NATO partner nations in NATO's Science for Peace and Security programme.

Mick Brown
Environmental and Sustainable Acquisition (EPSA) Lead
Defence Equipment & Support, MoD

Mick leads the Environmental Protection and Sustainable Acquisition team in DE&S. He joined the MOD in 1987 as an apprentice electronics engineer. His career anchor is defence acquisition, and he has experience in a variety of roles in DE&S and predecessor organisations covering project and programme delivery, policy development, and function management. Mick holds a BEng(Hons) in electronic engineering and an MSc in defence systems engineering. He is a Chartered Engineer, a member of the Institution of Engineering and Technology, and a member of the Association for Project Management.

Dr Colin Cockroft
Capability Manager Power & Energy
QinetiQ

Colin holds a PhD in hydrogen-based transport systems, a Masters in Engineering Science and an Honours degree in Electronics and Communications Engineering. Colin has 20 years' experience in defence as both a soldier and an officer in Special Forces and conventional units. He has held senior engineering positions in several defence companies and founded an energy consultancy that provided energy analysis and project development services to commercial, mining and government clients. In his current role as the Capability Manager for Power and Energy at QinetiQ Australia, Colin is responsible for the development of a number of generation, storage and electrical distribution products for military applications.

Dr Duncan Depledge
Senior Lecturer
Loughborough University

Duncan is a Senior Lecturer in Geopolitics & Security at Loughborough University. He is the Principal Investigator for 'Net Zero Militaries' (2023-2025), an Engineering and Physical Sciences Research Council funded research project examining the implications of the UK Governments climate change and net zero ambitions on military operations.

Contributor biographies

Dr Sam Healy FICRS
Group Director ESG
QinetiQ

Sam trained as a geophysicist and has worked in environment and sustainability for over 25 years. She is recognised as a QinetiQ Fellow for her leadership and contribution. As Director of ESG (Environmental Social Governance), Sam is responsible for ESG strategy and the delivery of a broad range of programmes across QinetiQ including climate change, ethics, community investment, and ESG stakeholder engagement. In addition, Sam is Chair of the ADS Sustainability Working Group and is a Board Director of the Institute of Corporate Responsibility and Sustainability, focusing on the continued professional development of Corporate Responsibility & Sustainability practitioners. She also co-chairs a working group as part of the Defence Suppliers Forum Climate Change and Sustainability Steering Group.

Group Captain Jamie Miller
Head of Capability and Climate Security, Climate and Environment Directorate, MOD
Royal Air Force

Group Captain Jamie Miller commissioned into the Royal Air Force in 1993 and has been grounded in the logistics world. His early staff roles included logistics policy, Human Resource Management for logistics officers and the Chief of the Air Staff international briefing team. Miller attended Advanced Command and Staff College, at the UK Defence Academy, in 2015. Command appointments have included the Logistic Squadron at RAF Benson and Commanding Officer of Tactical Supply Wing, the in-field helicopter refuelling wing for defence. On promotion to Group Captain, Miller became Head of the Defence Strategic Fuels Authority and on completion of that tour moved, in 2022, to the newly established post of Head of Capability and Climate Security, within the Climate and Environment Directorate MOD.

Tom Odell
Chief Analyst - Climate Change and Sustainability
Dstl

Tom started his career with Dstl as a force structure analyst, with multiple roles within MOD Main Building, supporting major reviews such as the Strategic Defence and Security Review 15 and Spending Review 19, where Tom led large analytic studies to provide balanced and affordable defence programmes. As Chief Analyst for Climate Change and Sustainability. Tom is responsible for ensuring MOD research is designed to deliver innovative solutions in response to climate change and that the impact of Dstl's research and advice is realised, helping military users to understand the value of the solutions presented.

Mari Troskie
Strategic Consultant
QinetiQ

Mari joined QinetiQ in 2023 as a Strategic Consultant in the UK Intelligence Sector. Her work focuses on enhancing operational effectiveness in a range of research areas, including electronic warfare, air defence, C5I (Command, Control, Communication, Computers, Cyber and Intelligence) and deployed power. She has a particular interest in the implications of climate change on conflict development and military operations. Prior to joining QinetiQ, Mari worked as research analyst specialising in forecasting infrastructure, energy, and defence investment trends in emerging markets. She has a BA in War Studies, MA in Conflict, Security and Development and MSc in Environmental Decision Making.

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