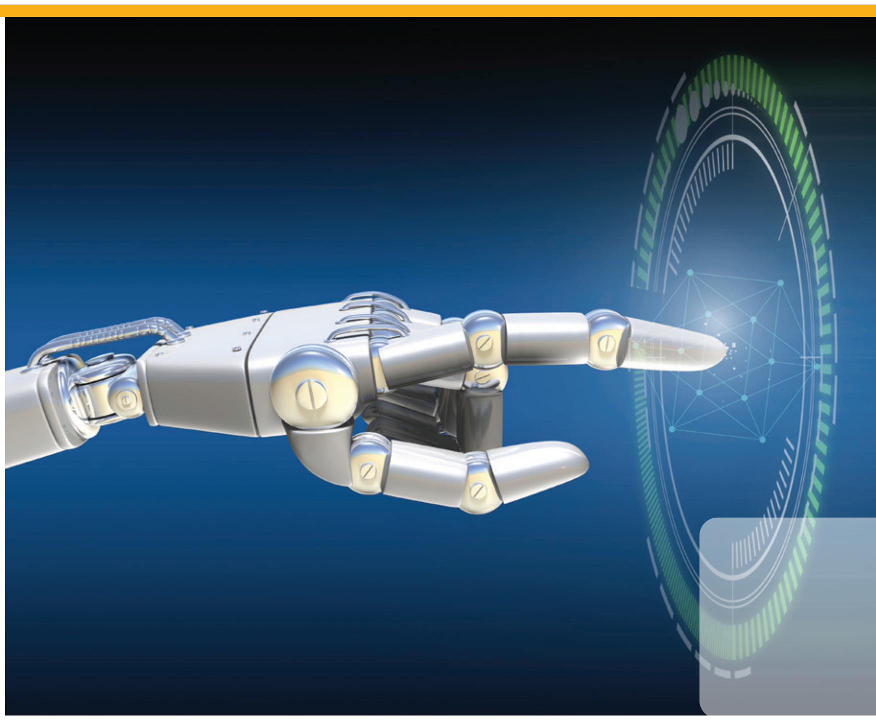
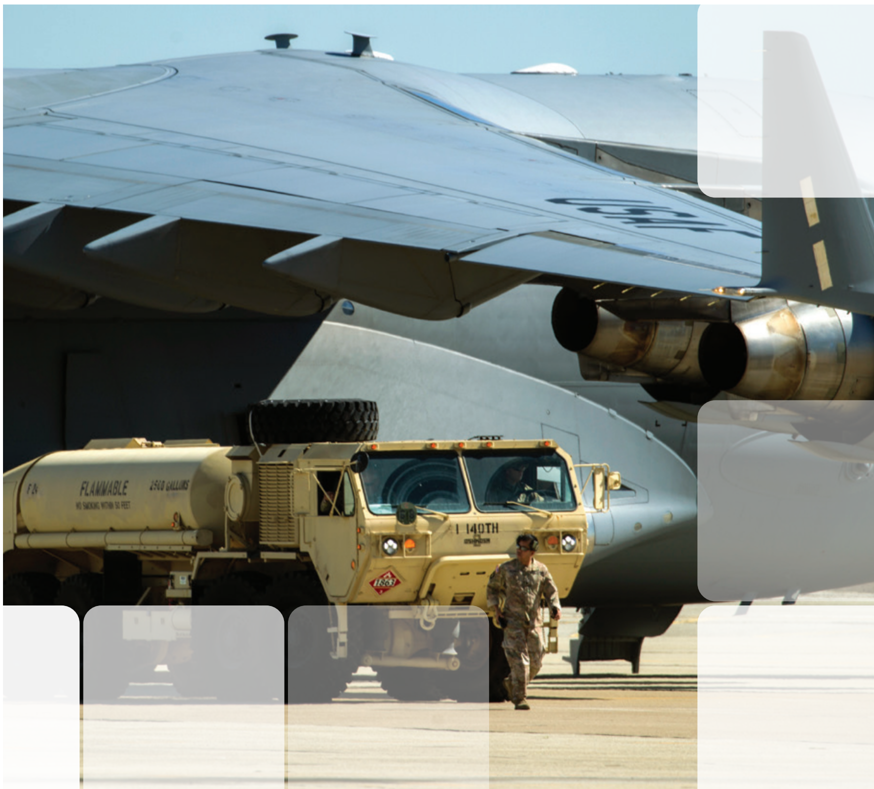
NATO ENERGY SECURITY
CENTRE OF EXCELLENCE

ENERGY HIGHLIGHTS





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Content

Commander's Corner

Director's Foreword

By **Col. Gytis Kazokas, Director of NATO ENSEC COE**

As the Director of the NATO Energy Security Centre of Excellence, it is my privilege to introduce the latest edition of *Energy Highlights*. The journal reflects the COE's keen involvement in identifying the key strategic considerations for maintaining the Alliance's long-term energy security and resilience.

At the Washington Summit, NATO reinstated its commitment to enhance energy security efforts amongst Allies. In today's complex and rapidly evolving geopolitical landscape, it is becoming clearer that energy is a critical capability enabler to NATO's core tasks and military operations. In addition, reliable and affordable supply to citizens can be seen as integral for national and international security. Our collective ability to access energy when and where it is needed is indispensable to the defence of our nations and the functioning of our societies.

Yet, in Washington, Allies also noted the global and interconnected threat landscape. Terrorism, pervasive instability, cyber and hybrid threats all pose risks to the Alliance – each with applications to the energy supply chain. Moreover, Allies again recognised that climate change is a defining challenge with a profound impact on our security. This necessitates careful consideration to the way in which we consume energy throughout the transition. For NATO, energy supply security therefore hinges on the effective protection of critical infrastructure, developing and maintaining our resilience to shocks, and the efficient consumption of energy to minimise total risk and contribute to lower carbon emissions. All three of these elements feature in the mission of our Centre.

Energy Highlights provides a platform for the free exchange of ideas, research, and best practices among the energy security community of interest. In this edition, as with others, you will find a diverse array of articles and studies on some of most pressing issues in the field. Here, we discuss the potential capacity crunch facing European electricity transmission through the transition; the benefits and risks of implementing Artificial Intelligence within the sector; investment interests of the People's Republic of China in European infrastructure; and the historic and projected consumption of oil products in the US Department of Defence and the strategic considerations for its long-term security. With these, the journal aims to provide the community with insights that are both timely and far-sighted.

Our work at the NATO Energy Security Centre of Excellence is more than just an academic exercise; it is about ensuring that NATO and its partners remain prepared to face the challenges of the 21st century. The articles presented in this journal are the result of rigorous analysis and collaboration among experts across disciplines and borders. They reflect our commitment to advancing knowledge, fostering innovation, and building resilience within the Alliance.

I encourage you to engage with the content of this journal, to consider the implications of the research presented, and to join us in our efforts to enhance energy security for the benefit of all NATO member states.

Thank you for your interest in *Energy Highlights* and to our authors for their contribution to this critical field of research. Together, we will continue to strengthen the foundations of energy security and ensure that NATO remains ready to meet the challenges of tomorrow.

Editorial

By **Ben Cook, Subject Matter Expert and Managing Editor, NATO ENSEC COE**

Welcome to the latest edition of Energy Highlights, the NATO ENSEC COE's platform for research and analysis on critical energy topics.

The global energy transition is underway within a dynamic security environment. Russia's war of aggression in Ukraine and escalating tensions in the Middle East continue to pose acute threats to international market stability and supply security. Clearly, as the global energy landscape evolves, so too do the challenges and opportunities we face in getting supply to where it is needed. This issue explores some of most pressing issues in the sector today: commodity availability and accessibility; technological innovation, and foreign direct investment.

Our first article, provided by former Norwegian Vice-Minister for Energy Amund Vik and Henning Gloystein of Eurasaia Group, pinpoints how Europe collectively avoided widespread energy shortages since Russia's full-scale invasion of Ukraine. Looking forward, the authors outline the need for significant investment in transmission capacity to handle the intermittency of renewables and avoid losses. Drawing parallels with NATO's principle of interoperability, they demonstrate that energy security throughout the transition requires enhanced cooperation and interconnection – building on the collaborative success seen during the recent crisis.

Alan De'Ath from the UK's Department for Energy Security and Net Zero provides the second article, examining the exciting opportunities and critical risks associated with Artificial Intelligence in the energy sector. AI's capability to significantly reduce operational costs and improve efficiency is poised to be a game-changer in meeting the urgent demands of global energy transition. However, we need to ensure AI-enabled systems are resilient to cybersecurity threats, that unintended consequences of integration are avoided, and that workers' skills and policymakers understanding keep up with innovation. The author calls for continued collaboration amongst government, industry, and academia as these risks are identified and mitigated.

The third article in this edition is provided by Dr Jutta Lauf and Dr Reiner Zimmerman. Here, the authors examine the motivations behind the People's Republic of China ambitious investment programme, the Belt and Road Initiative (BRI). This article balances the advantages that come with engaging with BRI investment against the strategic and economic complexities that follow. Ultimately, the authors demonstrate the need for Allies to carefully consider the long-term implications of foreign investment in critical national infrastructure. The lessons learned from BRI projects will form a crucial base from which to develop future engagement strategies with global actors.

Finally, we present an in-depth look at the United States Department of Defence's (DoD) consumption of oil products since 1975. By analysing the consumption trends of the largest Allied military alongside the policies & investments shaping it into the future, this article presents a view out to 2030. Situating this in the context of global production and refinery projections, it pinpoints strategic considerations for security and resilience like increasing import dependence and lengthening supply chains. Recognising the existential threat posed by climate change, this article provides considered recommendations for maintaining security throughout the transition.

As always, *Energy Highlights* aims to provide the community of interest with insightful analysis and diverse perspectives on key issues shaping the energy sector. We hope that this issue will not only inform but also inspire critical discussions and strategic actions within the energy security community of interest.

Thank you for your continued engagement and support.

Lessons from the energy crisis for Europe's green transition and security of supply

By **Amund Vik** and **Henning Gloystein, Eurasia Group**

Europe is entering a crucial phase for securing its future energy needs, following two years' worth of crisis management caused first by the COVID pandemic and then Russia's gas pipeline supply cuts.

Russia's weaponisation of energy flows was unprecedented at this scale, even if there had already been some previous disruptions, especially during the global financial crisis and cold winter of 2008/09. Through the Cold War and into the early 2000s most Russian supply problems for western Europe were due to transit problems between Moscow and countries through which Russian energy flowed to get to European consumers. While relying on Russian gas as part of European energy mix was logical, the high degree of dependency on supply from Russia amid its uncompleted green transition in the period leading up to 2022 left many European countries highly vulnerable to supply shocks.

For major economies to start the phase out of coal-fired power plants, nuclear power, and of domestic natural gas production at the same time while increasing the dependency of cheap but intermittent renewable electricity production left the system in imbalance. Russia's curtailment of supply to Europe during this period deeply threatened European supply security and worsened price volatility.

Battling an ongoing energy crisis for two years improved Europe's understanding of the security shortcomings of full speed energy transition without a sufficient focus on short to medium term energy security.

In this article, we argue that the lessons learned over the last two years should help form a new energy security underpinning of Europe's climate policy efforts in the years to come.

CRISIS MANAGEMENT

It is easy to forget that just two years ago, in summer of 2022, few thought the EU and its closest allies would be able to get through a winter without gas supply from Russia, which had just been cut. The expectation was for industrial rationing and a deep economic crisis.

This hasn't happened. While there was a mild recession, caused in large part by prohibitively costly energy, employment has been stable, and houses remained warm

By **Amund Vik** and **Henning Gloystein**

Amund Vik is a Senior Advisor to Eurasia Group, supporting various teams and the firm's executive clients on matters including energy transition, energy security, and geopolitics. Prior to joining Eurasia Group in 2023, Amund served as Deputy Energy Minister in the Norwegian Ministry of Petroleum and Energy from 2021 to June 2023. Before that, Amund worked for the Norwegian Labour Party, beginning in 2010, as a political advisor in the parliamentary group before transitioning to head of strategy and policy for the party. He has also worked as a consultant for Nordic Energy Research. Amund has a Bachelor's Degree in Political Science and Economics from NTNU (the Norwegian University of Science and Technology) and a Master's Degree in Political Science from the University of Oslo. He is based in Oslo and, when not immersed in all things energy, enjoys burning off some of his own energy on runs around the city.

Henning Gloystein is Eurasia Group's Practice Head for Energy, Climate, and Natural Resources, based in London. He covers geopolitical risk in energy and raw material supplies, the transition from fossil fuels to renewable energy, as well as green industrial trends. Prior to returning to London in 2021, Henning was based in Singapore for seven years, covering the rise of the Indo-Pacific region to become the world's biggest consuming region of natural resources. Before joining Eurasia Group in 2019 as a Director, Henning was Editor in Charge for Energy in Asia at Reuters news agency. Henning started his career in energy analysis at commodity pricing agency Platts (now S&P Global) in 2007, where he was responsible for pricing European wholesale power, natural gas, coal, and carbon markets. Henning has a dual Master's Degree in History, Politics, and Science & Technology from Humboldt and Technical University in Berlin. Half British/German, he lives near Oxford with his family.

thanks largely to successful political, industrial, and consumer efforts across Europe. This allowed for several crucial things to happen:

- Quickly installing new facilities to import and store more liquefied natural gas (LNG), and allowing for a swift transfer of this from regions with ample supply (e.g. Belgium, Netherlands, Spain) to regions that previously relied mostly on pipeline imports from Russia (e.g. Austria, Czech Republic, Germany, Slovakia).
- Cooperating with NATO ally Norway to establish more gas imports via pipeline which, in the long-term, can be transformed into low or zero carbon supply.
- Efforts by industry and households to cut back energy use in the short-term (including some industrial shutdowns to shield households from shortages) and become more energy efficient in the long-term (enabling ongoing industrial output while using less energy).
- Government action to enable an accelerated green energy and industry transition, including reduced imports and consumption of fossil fuels.

While points one to three were instrumental for emergency supply management, the last point will be crucial to enable Europe to permanently cope with lower fossil fuel imports. That's because prohibitively high energy costs caused by fossil fuel supply disruptions amid geopolitical crises in key producer regions (e.g. Russia, Middle East) send a key economic and political signal: invest into domestic and clean energy supply. Points one-three will be in place over time to ensure a supply backstop as Europe moves further in its energy transition.

Europe's chosen path (one that China is also pursuing) is to de-carbonize and electrify as much of the energy supply chain as possible, roughly in the following order of priority:

- De-carbonization of power supply through a huge expansion of renewable electricity generation capacity (solar and wind), plus back-up systems to cope with the intermittency of these assets.
- Electrification of land passenger and goods transport.
- Electrification of household heating.
- De-carbonization of heavy industry (including, where possible, through electrification) to avoid the loss of strategically important sectors, especially steel and metals, chemicals, and cement making.

Strategically important and "hard to abate" sectors (e.g. some back-up power, fertilizer, virgin steel) in which a full phase-out of fossil fuels (esp. natural gas) is still seen as technically difficult and too costly will still receive government support.

The ultimate goal is to interconnect Europe's vast but widely disbursed green power resources (e.g. Iberian solar, North/Baltic Sea wind, Alpine/Nordic hydro) so that local power surpluses can be either put into storage for later use, when there is higher demand or lower supply, or be sent through the pan-European grid to regions with a deficit.

The fundamentals of such a grid already exist. Europe's integrated electricity market allows for seamless power flows across virtually the entire continent. Building this network has taken a quarter of a century, and on several occasions, it has ensured the continued flow of energy even during unprecedented disruptions, including the 2022 Russian gas pipeline supply. In 2024, this grid is ensuring that the lights stay on in Ukraine, even as Russia pummels its power infrastructure.

EXPANSION REQUIRES COOPERATION

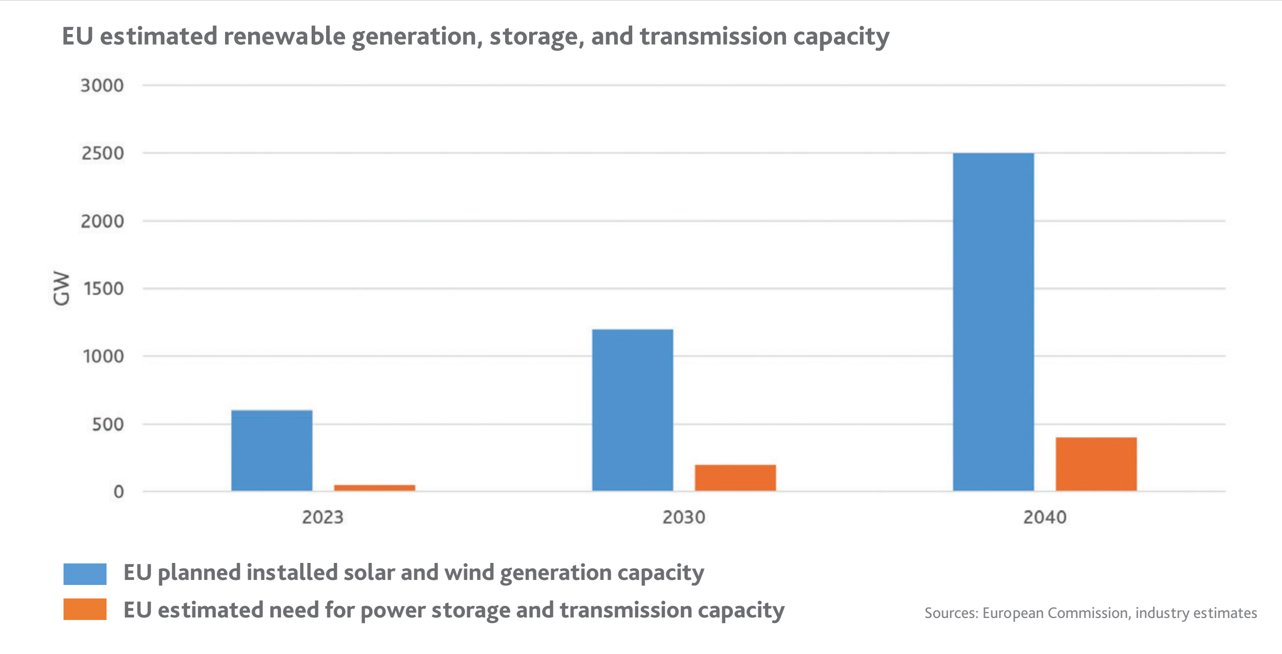
In the coming years, this European grid must be hugely expanded to cope with the surge in intermittent renewable capacity and allow for reduced fossil fuel import reliance. As Europe moves from a centralized thermal energy system to a decentralized, weather-based energy system, the grids will have to change as well.

To put some numbers to the task, the EU alone plans to raise its renewable power capacity by some 1,200 gigawatts (GW) by 2030, mostly using solar and wind, up from about 600 GW installed as of 2024. By 2040, the plan is to have about 2,500 GW of solar and wind power capacity installed.

This expansion will require consensus building, especially within the EU among Europe's non-EU NATO partners. Inaction could open a power supply gap as early as 2027, especially in landlocked parts of central Europe, where power will need to be imported, perhaps over the long-term, or until enough domestic low-carbon capacity can be built. Success, by contrast, will allow for the distribution of clean, low-cost energy across Europe by the end of this decade, ensuring reliable and affordable energy for European industry and households.

It is difficult to estimate how much additional storage and transmission capacity is needed to cope with this surge in renewables. Increasingly frequent times of extreme but local oversupply will require the surplus to be stored for later use or sent away to regions with a deficit.

Overall, it is estimated that about one unit of storage (e.g. batteries, hydrogen electrolysis) and transmission capacity (e.g. cross-border interconnectors) needs to be built for every six units of installed renewable generation capacity. Given the EU's renewable targets and that its current storage and transmission capacity is still relatively small, that implies a need to install 200 GW of storage and transmission capacity by the end of this decade, with another doubling needed in the following decade.



SECURING ELECTRICITY SUPPLY

While a successful European clean energy and industry transition is possible, and even likely, such a large-scale electrification comes with serious security challenges.

In the oil and gas industries, stockpiling plans are well established. In the oil sector, most countries have so-called Strategic Petroleum Reserves (SPR), in which governments ensure there is enough crude oil stored in the country to meet 90 days' worth of import demand. In the gas sector, many European countries in 2022 introduced targets to use the low-demand spring and summer seasons to fill up national gas inventories by November, the start of the high demand winter heating season. In Europe's biggest gas consumer nations, Germany and Italy, these inventories can meet almost three months' worth of winter consumption.

As Europe increasingly electrifies its systems, new challenges will emerge. The biggest one is that power cannot be stored long-term in the way that oil and gas can.

The grid expansion to enable electricity to be sent from areas in Europe with surplus to regions with a deficit is only one part of ensuring security of supply.

Clean power assets, from wind turbines to solar panels and batteries, require critical minerals like copper, lithium, cobalt, or rare earth metals. Most of these are not mined or processed in Europe. Ensuring affordable and secure access to these will require European nations to establish new trade relations with countries that have such resources in abundance.

These include non-European NATO members like Canada and the US, but many more such nations are in the southern hemisphere (especially South America, Southern Africa, and Australia and Southeast Asia).

Much like what's already the norm for oil and gas, Europe will need to build critical mineral stockpiles so it can cope with potential import disruptions, while investing at least in some capabilities to process these materials locally.

HYDROCARBONS ARE A SCARCE RESOURCE

Europe's energy crisis has been one of access to hydrocarbons, especially natural gas, which has become a scarce (and therefore expensive) commodity. This means securing access to new pipeline gas and shipped LNG will be crucial for as long as there is demand for hydrocarbons.

Even amid an accelerating green transition, this will create some demand for oil and gas for decades to come, as witnessed in Germany's recent announcement to build at least another 10 GW worth of gas-fired power generation capacity to replace coal. This, by extension, means European governments need to keep an eye on security of hydrocarbon supplies even amid the green transition.

To ensure secure, affordable, and sustainable energy supply will Europe to move to an energy system where domestic and clean supply covers as many hours as possible of electricity production, while having reliable import agreements in place to secure affordable hydrocarbon imports for hard-to-abate sectors and system balancing.

In the aftermath of the crisis, Europe has continued to act in this direction. Governments across Europe have put financial incentives in place for households to replace their gas heating systems with electric ones, while also subsidizing household solar and battery installations.

Doing so reduces grid demand for electricity and gas, meaning the remaining consumption, including by strategic industries, is secure and affordable.

GREENER, BUT LESS DIVERSE SYSTEM

As Europe moves from one energy system to another, it will get cleaner (which is good) but it will also become less diverse (which comes with challenges). Most national energy systems in Europe are made up of diverse energy carriers, where activities like transportation, lighting, heating, cooking, or industrial activity use different and to some extent interchangeable fuels, including gasoline/petrol, diesel, natural gas, coal, or electricity.

Electricity is itself sourced from various sources including coal, gas, oil, nuclear, and renewables.

The new system will have much fewer energy carriers. Electricity will do most of the heavy lifting as power generation, transport, and heating are greened.

Clean hydrogen (either from electrolysis generated from renewables, or from de-carbonized natural gas) will also help to some extent, especially in heavy industry and possibly in heavy transportation, although some of the more optimistic clean hydrogen expectations look set to be disappointed.

SECURE POWER

For Europe's security and civil emergency services this loss of diversity poses a serious question: what does single carrier energy security look like?

- How, for example, do you evacuate a city where there is no grid electricity when transportation is electric.
- How do households secure winter heating during a blackout?
- Could, perhaps, a volcanic eruption and related ash clouds threaten energy supply in regions that rely heavily on solar power?
- How prone are power grids to digital or physical sabotage by malicious domestic or foreign actors?

Again, this points to a need to establish back-up and transmission systems. Although technically feasible, the costs of such systems are currently insufficiently debated politically.

LESSONS FROM UKRAINE

Over the last two years, Europe's grid companies have gained experience through helping Ukraine maintain power supply under constant Russian attack.

Amid the list of things Ukraine has needed to maintain supply we also find where the rest of Europe needs to invest and stockpile; transformer components, cables, mobile generators.

On a system level, we move from supplies dependent on global fuel markets (esp. oil, gas, and coal), to one in which operations depend largely on local weather conditions.

Whenever weather conditions create an energy deficit (e.g. through high demand from heating or cold, and/or because of shortages of renewable supplies like wind, solar, or hydro), natural gas imports will have the responsibility of balancing the system (i.e. meeting the shortfall in local supply).

The lowest possible price for this is currently US shipped LNG, which is priced off cheap American shale gas plus transportation costs to Europe. Over the past two years, the global gas market has proved sufficiently capable and adaptable to cope with the extreme disruption caused by Russia.

This, however, came at extremely high costs. Even if a repeat of the record prices seen in 2022 seems unlikely, future gas import prices can easily spike again in case of unplanned production outages or through import price competition with other regions (especially Northeast Asia for US LNG).

LESSONS FROM NATO

To limit exposure to volatile and potentially unreliable hydrocarbon imports, Europe must therefore reduce consumption of these.

As Europe de-carbonizes it must, however, avoid doubling-up its renewable plus storage capacities from country to country. Doing so would be prohibitively costly and therefore threaten future clean, affordable, and secure supply.

Ongoing lessons from NATO can be drawn, where interoperability of national defense systems can, in some ways, be compared with interconnectivity of European energy systems.

As we saw during the 2022 energy crisis, Norway could help Germany replace lost Russian gas, Germany was able to supply France with electricity amid its big reactor outages, while Scandinavian power supply was able to meet demand in a tight UK grid.

More of this will be needed in future. Like in defense, Europe's security is limited if every country tries to defend itself in isolation. Instead, its strength lies in cooperation. Given the sheer amount of infrastructure (8,000 km of pipeline from Norway alone), NATO and its European allies should also make efforts to shield and strengthen the physical core of Europe's energy security.

The recent energy crisis caused by Moscow proved that Europe's energy security lies in building more clean, domestic energy generation and storage capacity, expanding its regional transmission systems, while maintaining some hydrocarbon import deals with reliable partners, especially within NATO.

The Risks of AI in the Energy Sector

By **Alan De'Ath, UK Department for Energy Security & Net Zero**

The use of Generative Artificial Intelligence (AI) in the energy sector has the potential to revolutionise the way we generate, distribute and consume energy. As the world strives to transition to a sustainable and decarbonised energy system, the potential of AI to optimise operations, enhance efficiency, and enable smarter decision-making is becoming increasingly evident. However, with this new technology comes a range of risks that need to be carefully considered. In this article, we will explore the risks associated with the use of AI in the energy sector, but first will touch on the opportunities AI can provide.

The urgency brought about by climate change to achieve net zero by 2050 – a goal for many developed countries – requires a huge transition to renewable energy sources. This is in conjunction with an increasing global demand for energy. Achieving green energy production and distribution at scale, whilst meeting that growing energy demand, however, is challenging to resolve in only 25 years with current technology. AI has a wide variety of potential use cases that will be crucial for energy decarbonisation.

AI provides a transformational opportunity to rapidly deploy and optimise a new clean energy system, improve security capabilities and help to defend critical energy infrastructure from hostile actors. With the likelihood that AI will make assets more efficient, there is the potential to reduce operational costs of next generation technologies.

Argonne National Laboratory published the report, 'Advanced Research Directions on AI for Energy' suggesting the key to meeting both energy demand and reductions in carbon emissions by 2050 may be AI. [1] According to the report, AI systems could reduce project schedules by approximately 20% for new clean energy designs, potentially resulting in huge cost efficiencies. Though the opportunities and benefits of AI in the energy sector are still being understood, there is the potential for unseen benefits and uses over time.

By **Alan De'Ath, National Security and Response, DESNZ**

Alan De'Ath is Assistant Head of National Security & Response in the Department of Energy Security and Net Zero. Alan has previously held roles in the Cabinet Office as a Cyber Defence Policy Advisor, and in the Foreign, Commonwealth and Development Office in the Iran Bilateral Team.

Current understanding of the opportunities of AI include Energy Decarbonisation; Integration and Operational Efficiency; and Security and Resilience:

1. ENERGY DECARBONISATION

Dynamic Grid Management. AI is already being deployed to improve system operations, which has the potential to enhance demand and supply forecasting (e.g. from solar and wind output). AI can therefore manage grid electrical loads dynamically which will be a crucially important application for AI, especially as electric vehicle adoption increases electricity demands at rates that may exceed the capacity of infrastructure.

Critical Minerals and New Technologies. It is predicted AI can analyse critical minerals and geothermal reservoirs for geothermal electricity production and heat, in addition to the development of materials crucial for the advancement of alternate energy technologies, such as future battery designs and new reactor technology.

Climate Impact Prediction. If AI can harness large scale population and weather data, it can be used to accurately predict the impact of climate change and mitigate damage to energy infrastructure by serious weather events, whilst potentially assisting with resilience planning.

2. INTEGRATION AND OPERATIONAL EFFICIENCY

System Integration. Integrating energy systems across grid operations could lead to significant efficiency savings. This integration can automatically optimise both generation and demand-side needs, with autonomous operations offering monitoring, control, and maintenance across the energy sector. Across the operations and maintenance lifecycle, AI capabilities can transform safety, efficiency, and innovation within energy production and distribution infrastructure.

Prosumers and Digital Infrastructure. Advancements in digital infrastructure can help develop solutions that are less reliant on high-end technological infrastructure or that can operate with limited connectivity. This greater visibility provided gives consumers the opportunity to become 'prosumers,' i.e. take a more proactive role in their energy consumption and generation, for their own benefit but also supporting system flexibility, in turn enhancing grid reliability and agility.

Distributed Energy Technologies. As the power load shifts to being distributed across consumer-sited technologies, new intelligence will be integrated into the system through electric vehicles, storage solutions, smart buildings, and smart appliances. This means that as more energy production and consumption occur at the consumer level (e.g., homes and businesses with solar panels, electric vehicles, and smart devices), these technologies will contribute to a smarter, more responsive power grid. Integration of consumer-site controllability will therefore be required.

3. SECURITY AND RESILIENCE

Cyber and Physical Security. AI can be a crucial tool in improving security, whether in the cyber domain or in the monitoring of physical infrastructure. However, the energy sector's strong safety and risk-averse security culture has resulted in a current low take-up of advanced AI, though this is likely to change in the future with recognition that AI has the potential to improve and enhance safety and security.

Resilience. Rapid changes in energy generation and demand will require resilience planning and secure operational controls. AI has the potential to incorporate physical infrastructure, human behaviour, and climate/weather impacts to enhance energy resilience.

RISKS OF AI

Despite the huge potential of AI, it is important with any new technology that will have such a wide-ranging impact, that the risks are understood and mitigated. The UK Government Department for Energy Security and Net Zero (DESNZ) alongside the Department of Science, Innovation and Technology (DSIT) have been actively working to understand the risks and opportunities of AI within the sector in order to ensure support this innovate technology in achieving the departments net zero ambitions, whilst developing appropriate and proportionate mitigations. At the start of 2024, DESNZ collaborated with London Economics to conduct a thorough analysis of the potential risks, which have been grouped into the following broad categories: [2]

Human-AI Gap: One of the key risks identified is the gap between humans and AI. This includes risks such as lack of transparency, AI-augmentation leading to worse performance, and data biases. AI decisions may fail to consider unique situations and the complexities of the real-world, which could potentially lead to unintended consequences without appropriate human oversight and expertise. Though there are concerns AI may fail to consider non-negotiable maintenance frequencies, this is unlikely when AI operates within clear parameters. As models become more sophisticated, it becomes more likely that humans will not be able to explain how an outcome has been reached, impacting on the ability to plan and understand the level of preparedness for critical incidents. In addition, the potential for AI to generate inaccurate outputs based on fictitious and/or inaccurate information, known as hallucinations, can be difficult to detect and may pose risks to the supply of energy if they go unnoticed. The need for appropriately qualified personnel to validate outputs and detect any errors or biases is crucial to harnessing the full potential of AI while mitigating risks to the energy sector.

Skills: Another significant risk is the lack of understanding and skills related to AI technologies. The successful integration of AI in the energy sector requires a workforce equipped with the necessary skills and understanding. Without adequate AI-related skills, there is a risk of overreliance on AI systems, which may lead to errors or unexpected outcomes that could impact the stability and reliability of the energy system, as well as enabling other risks to materialise. This could be heightened if companies introduce AI prematurely without the appropriate training, skills and processes in place. If a company chooses to outsource AI capabilities to suppliers, this could exacerbate supply chain dependencies for critical services. Upskilling and training programmes are therefore required for the current and future workforce needs.

Interconnected AI Risks: The interconnectedness of AI systems poses systemic risks to the energy sector. When independent AI agents are interconnected, such as through a common platform, there is a potential for unintended consequences. For example, if AI algorithms used in electric vehicles make similar charging decisions, it could lead to "herding" behaviour and result in excessive demand on the power grid. How AI systems and algorithms interface with each other could also raise issues, resulting in a lack of robust solutions, due to a lack of coordination and integration between algorithms used by different companies and suppliers. The communication and compatibility with existing (often legacy) infrastructure will be crucial to prevent operational disruptions. Another interconnected risk is where the same AI system is deployed in multiple contexts, as this creates a single point of failure, due to suppliers using the same system rather than different systems trying to work together. Managing the risks associated with interconnected AI is crucial to maintaining the stability and resilience of the energy system.

Security Risks: The use of AI systems in the energy sector mean they are more vulnerable to cybersecurity threats, physical threats, and other malicious attacks by hostile states and non-state actors, through increasing adversary capabilities and exploiting and exacerbating existing vulnerabilities. Developments in AI more broadly has the potential to increase cyber risk in existing systems regardless of whether AI is being used. Robust cybersecurity measures to protect AI systems and the energy sector more generally from potential attacks that could disrupt the supply of energy are crucial. The Alan Turing Institute identified promising areas to focus on for future research and development on AI for security, including anomaly-based intrusion detection and protection systems, hardening and predictive maintenance. [3] Whilst AI tools can be used to improve security, research by the Alan Turing Institute has shown that introducing AI and intelligent automation cybersecurity tools would not be sufficient to address resilience needs. AI will provide solutions for protective cyber security; however, the energy sector will need to take a more holistic approach to security to enable them to be appropriately resilience. Ensuring the integrity and security of AI systems is paramount to safeguarding energy infrastructure from malicious actors. In the UK, operators need to maintain wider cybersecurity best practices as set out by the National Cyber Security Centre (NCSC) and follow guidance on secure-by-design and secure development principles in the development life cycle of an AI system.

Market Risks: The use of AI in energy trading can create risks for market participants as AI algorithms used in trading decisions could impact market prices and create imbalances in supply and demand. Using AI to autonomously trade energy stocks (i.e. algorithmic trading) could affect prices, introducing volatility and disrupting energy supply chains and impacting consumers. This could also impact autonomous agents adjusting demand in response to price signals, causing demand patterns to shift more decisively. However, as AI needs to be trained on historic data, the fact that edge cases (very high or low/negative prices) are rare, mean that the models do not perform as well as humans in these periods. Other considerations include smaller companies lacking the ability to implement AI solutions due to cost, potentially impacting on their ability to compete and therefore being forced out the market. This could exacerbate market dominance and power discrepancies in the longer-term. Companies may also be wary of utilising AI, due to the lack of specificity and continued development of regulations. Careful oversight and monitoring of markets and competition, alongside continued regulation of AI-driven trading activities are essential to mitigate market risks, manipulation and unfair market practices.

Operations/Performance: AI systems used in operational infrastructure, such as failure detection or demand/supply optimisation, can introduce risks if they fail to perform as expected. For example, if an AI system fails to detect a serious problem in the energy grid, it could potentially lead to outages. However, the strong safety and security culture in the energy sector makes this highly unlikely. The benefits of AI in operations far outweigh the risks, and instead are a potential solution to reducing those risks, particularly with the risk-averse culture in the sector. Other issues that could arise from overreliance stem from hallucinations, where AI could produce inaccurate output that is difficult to detect. Energy system operators will need to take responsibility for providing AI with valid data, monitoring potential biases to ensure an AI system meets its intended objectives and reduce the likelihood of inappropriate outputs. Operators will need to adequately test AI systems before use and carry out impact assessments as part of the integration process, continuously testing any AI systems with the potential to impact operations for errors or vulnerabilities thereafter. Therefore, the use of AI in industrial control systems, such as SCADA systems, should be carefully considered.

Optimisation: The use of AI for tasks such as demand/supply optimisation and long-term planning decisions can introduce complexities and risks. Incorrect demand predictions could result in insufficient supply leading to price spikes, excessive use of energy reserves, or potentially carrying the risk of downstream disruption. Where AI optimises different outcomes to what designers had intended, this could indirectly impact other outcomes. The decisions that AI makes to bring the energy system back into balance in case of disruption must be agreeable [or consider broader implications], for example, it must still avoid the use of carbon intensive peaking plants where possible. AI models need to account for long-term trends, uncertainties, and regulatory reforms to ensure optimal decision-making. AI currently has limitations in capturing future technological advancements, changes in consumer behaviour, or regulatory reforms. While not limited solely to the use of AI, failing to consider these factors could result in suboptimal investments in infrastructure and capacity expansion, which in turn can create risks to long-term energy security. This illustrates the need to combine appropriate human involvement with AI to ensure the benefits of the technology are maximised.

Supply Chain Risks: The use of AI along the energy supply chain introduces dependencies on AI systems that have replaced human expertise. Lacking an understanding or awareness of where AI is being used along the supply chain can result in companies and transmission/distribution grid operators not knowing how it has been trained and validated. This could potentially prevent companies being able to build robust mitigations measures or reduce awareness of what mitigations are in place. Lack of transparency and oversight of AI use along the supply chain can lead to unknowing overreliance on AI, which may pose risks to the optimal balancing of supply and demand. Ensuring transparency and accountability throughout the supply chain is crucial to mitigating supply chain vulnerabilities.

In summary, as explored in this article, there are a range of potential risks to the energy sector as a result of AI. As AI adoption increases and legacy systems adapt to the new environment, the risks may increase. However, the energy sector operates under well-understood security standards and has a strong safety culture.

As the world embarks on its journey towards a sustainable and decarbonised energy future, the integration of AI in the energy sector holds immense promise. It is therefore essential to navigate the risks associated with AI adoption effectively, recognising that AI works best when combined with appropriate human involvement. Policymakers, industry stakeholders, and researchers need to work together to address these risks and ensure the responsible and secure use of AI. By doing so, we can unlock the full potential of AI in the energy sector while safeguarding the security and reliability of our energy supply.

The energy sector has a unique opportunity to lead the way in harnessing the power of AI for a sustainable future. By embracing AI technologies responsibly and proactively managing the associated risks, Europe can pave the way for a smarter, greener, and more resilient energy system that benefits both present and future generations.

Disclaimer: The information on risks provided in this article is sourced from the "Risks to supply of the use of 'novel' AI in the energy sector" report for the Department of Energy Security and Net Zero, produced in collaboration with London Economics.

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2023: Ten years of China's Belt and Road Initiative - The fate and future of energy infrastructure projects in some NATO member states

By **Dr. Jutta Lauf** and **Dr. Reiner Zimmermann**

In 2013, the People's Republic of China (PRC) launched, with great fanfare and money, a global infrastructure initiative: the Belt and Road Initiative (BRI). The objective of this initiative was to significantly increase its global political and economic influence as well as to increase the Gross Domestic Product (GDP) of the PRC. After more than ten years it's time to look back from a European perspective and evaluate the success or failure of some joint projects in Europe and the current status and the future of the BRI as a whole. To this end, the article will look at the PRC's motives and objectives, the current BRI members and it will present the status of four joint BRI infrastructure projects with European partner nations.

BACKGROUND INFORMATION: THE PEOPLE'S REPUBLIC OF CHINA

The People's Republic of China (PRC) was founded in 1949 after a civil war which lasted from 1927 until 1949 – only interrupted by World War II – by the Chinese Communist Party (CCP) on the mainland of China. The PRC is a unitary one-party socialist republic lead by the CCP. It is the world's second most populous country (1.4 billion people). The national capital is Beijing, while the biggest city and largest financial centre is Shanghai. The opposing nationalist Kuomintang party retreated to Taiwan island. Both parties claiming to be the sole legitimate government of China. The United Nations has recognized the PRC of that status since 1971. The number of countries recognizing Taiwan as the representative of China is small and dwindling.

BEGINNINGS AND OBJECTIVES OF THE BELT AND ROAD INITIATIVE

The Belt and Road Initiative is the global infrastructure development strategy deployed by the PRC since 2013. "Belt" stands for the "Silk Road Economic Belt"


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which is referring to the proposed overland routes for road and rail transportation passing through landlocked Central Asia along the historic Silk Road trade routes. "Road" stands for the "21st Century Maritime Silk Road", referring to sea routes and ports throughout the Indo-Pacific, Southeast Asia, South Asia, the Middle East and Africa. [1]

Since 2013 the cumulative BRI engagement amounts to US$ 962 billion in construction contracts and US$ 389 billion in non-financial investments. Constructions projects are typically implemented by Chinese companies and workers. Non-financial investment refers to projects, which will only be profitable in the long run e.g. mining concessions for rare earth mines or acquiring of intellectual property. Although, buying existing facilities and running them is also part of the BRI investment strategy and portfolio. [2]

In addition to transport infrastructure, BRI also engages significantly in energy related investments (financial and non-financial). Between 2013 and 2022 up to US$ 40 million were spent annually on renewable and fossil fuel projects. Coal related projects were phased out in 2020 but re-emerged in 2022. The share of renewable energy related projects (solar-, wind- and hydropower) varied between 23% and 55% from 2013 to 2022. [2]

The BRI projects are financed mainly by private companies, Chinese banks and by the international Asian Investment and Infrastructure Bank (AIIB). The PRC has founded the AIIB and is its single most influential member. The AIIB is seated in Beijing. [3]

The PRC currently holds the largest amount of foreign exchange reserves globally. Mainland China (without Hong Kong) in 2022 owned an equivalent of approx. US$ 3.1 trillion () in currencies, bonds, shares etc. It uses these reserves for stabilising its own currency, the Renminbi, and for financing BRI projects, among others. In comparison, the second largest holder of foreign exchange reserves is Japan with US$ 1.1 trillion. [4]

MEMBERS OF THE BELT AND ROAD INITIATIVE

As of March 2022, 147 countries had signed a Memorandum of Understanding (MoU) to the BRI. The signatory states are from Asia, Africa, Middle and South America, and Europe. They mostly joined during the second half of the 2010 years. An overwhelming share of states is classified as low and middle income countries (Figure 1). [5] [6]

Maps from Chinese sources, though never officially sanctioned, always show India as being part of the BRI. However, both countries have not yet signed an MoU. [7] India is highly dependent on Chinese imports, [8] but also has an ongoing border conflict with the PRC with many casualties in recent years. [9] [7] In August 2023 the PRC even unilaterally redrew the poorly defined Himalayan demarcation line between both nations in its favour. [10]

Several NATO member countries have signed MoUs with the PRC with varying success in terms of project completion (Table 1). Italy for example, has not prolonged the MoU with the PRC after ten years of cooperation in December 2023, because its current government considered the terms and conditions as unfavourable. [11] [12]

The ups and downs which BRI projects have experienced in Europe can shed some light on the probable future of the BRI in the coming years. This article presents

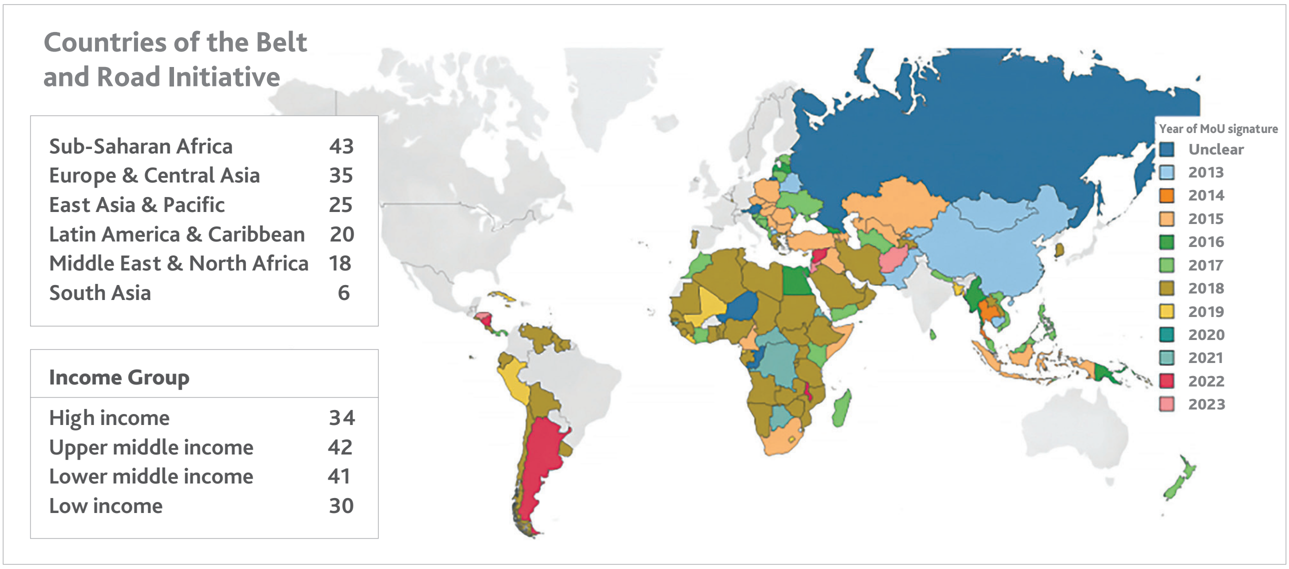

Figure 1: Countries of the Belt and Road Initiative which had signed a Memorandum of Understanding by March 2022 [1] [5].

Table 1: NATO member countries as of 2020 (NATO 2020) without and with Memorandum of Understanding with the People's Republic of China on the Belt and Road Initiative (MoU) as of March 2022 [5] [1] and for Italy as of Dec 2023. [12]

Countries without current MoU	Countries with MoU
Belgium	Albania
Canada	Bulgaria
Denmark	Croatia
Estonia	Czechia
France	Greece
Germany	Hungary
Iceland	Luxemburg
Italy	Montenegro
Latvia	North Macedonia
Lithuania	Poland
The Netherlands	Portugal
Norway	Romania
Spain	Slovakia
United Kingdoms	Slovenia
United States of America	Türkiye

four BRI projects in Europe which were (co)-financed by PRC and various partners. These projects were hailed as promising investments but have undergone various troubles.

A large harbour project in Greece was selected for discussion owing to the growing global importance of maritime hydrocarbon transportation, with 63% of fossil oil [13] and 10% of natural gas [14] being transported by ship. Similarly, a motorway project in Montenegro was chosen to demonstrate the challenges among road projects – key enablers of the delivery of goods to and distribution from ports. For air transport, a BRI airport project in Albania was chosen and, to extend beyond exploration of mid-stream projects, the construction of a battery production plants for cars in Hungary provides insight into the PRC's investment in production sites.

PORT INFRASTRUCTURE: INVESTMENT OPPORTUNITIES AT THE PORT OF PIRAEUS (GREECE) DURING THE AUSTERITY POLICY FOLLOWING THE FINANCIAL CRISIS IN 2008/2009

The port of Piraeus is the largest commercial port in the Mediterranean Sea, and it connects to Europe, Asia, and Africa. It was the fourth largest harbour among all European ports in terms of container throughput in 2019 and 2020. Due to the vicinity to the Suez canal and compared to North European ports, Piraeus offers a highly competitive alternative in terms of transport duration, frequency of service and cost for shipments from the Far East to Europe. [15]

Figure 2: Location of the Hellenic Republic (Greece) and the Port of Piraeus in the Mediterranean Sea. [16]

BACKGROUND INFORMATION: THE HELLENIC REPUBLIC

Greece – officially called the Hellenic Republic - is a country in Southeast Europe on the southern tip of the Balkan peninsula (Figure 2) with a population of 10.5 million people. Its capital is Athens, and its main commercial port is in Piraeus near Athens. In 1952 Greece joined NATO. Before the Russian invasion of Ukraine in 2022, Greece was one of the few countries to surpass its minimum defence spending target of 2% of GDP. Greece joined the EU as its tenth member in 1981.

Shipping is one of the biggest sectors of the Greek economy, contributing about 6.6% to its GDP in 2019. The Greek-owned merchant fleet is the largest in the world, accounting for 15.6% of the global fleet in deadweight tonnage, while vessels controlled by Greeks carry 21% of the global seaborne trade. [15]

The port of Piraeus is also the starting point of the Western Balkans part of the China-Europe Land-Sea Express Route. It leads to Budapest (Hungary) via North Macedonia and Serbia. Motorways and railways are used. Existing transport connections should be improved by the BRI-project to allow for quicker transport. [17]

The China COSCO Shipping Corporation and its predecessor the China Ocean Shipping Company (both named COSCO in the following) first acquired shares in the Piraeus port from the Greek government in 2008. This was during a series of selloffs pressed upon Greece by international creditors following the country's bailout in the aftermaths of the global financial crisis of 2008/2009. COSCO increased its share at the Piraeus port to 51% by 2016. The agreement included the transfer of an additional 16% of shares if COSCO would complete a set amount of investment projects until 2021. Although most of the projects were not finished – or not even had been started – the transfer of the shares took place in 2021 in an escrow deal. COSCO blames the Greek bureaucracy and popular resistance over environmental and labour rights for the delays. The Greek government made clear that it will reclaim the shares if the projects are not completed by 2026. [18]

Chinese military vessels have sailed in the Mediterranean and the Black Sea for many years. The PRC navy has also joined naval military exercises e.g., with Russia and is involved in the UN's Anti-Piracy mission in Somalia. The PRC possesses no naval bases in the Mediterranean Sea, but its military vessels may dock at Chinese owned harbours and wharfs. The possibility of espionage activities must also be taken into account, especially when military facilities of the host country are located in close proximity. [19] [20]

Chinese investors were the only ones willing to buy the Port of Piraeus during the financial crisis of 2008/2009, which Greece had to sell to satisfy its international creditors. Financial considerations of private lenders were paramount during this period. National security and economic independence within the EU and NATO were not primary considerations for these private lenders. As long as COSCO is not willing to sell its share on the port, China basically has the control over one of the Mediterranean's most important ports. This situation is a textbook example of how big international companies with turnovers in the range of nation states – in this case banks and insurance companies and Greece – are able to unintentionally create potentially critical situations in terms of national security.

MOTORWAY CONSTRUCTION: THE DEAD-END SECTION OF THE ADRIA-DANUBE MOTORWAY IN MONTENEGRO

The beginning of the construction of a 160 km long motorway section from the Adriatic harbour of Bar in Montenegro to the border of Serbia in Boljare was hailed as an early huge success of the BRI. The Montenegrin motorway is the starting point of the route which should connect the port of Bar in the Adriatic Sea to Belgrade in Serbia (Figure 3). It was intended as a feeder motorway to the Western Balkan section of the China-Europe Land-Sea Express Route, thus connecting Montenegro's Balkan neighbours and Italy via a Mediterranean Sea port to Budapest in Hungary. [21]

BACKGROUND INFORMATION: MONTENEGRO

Montenegro is a country of 0.6 million people in the Southeast of Europe with access to the Mediterranean

Figure 3: Map of the planned Bar-Boljare motorway in Montenegro. [22]

Figure 4: Display of Chinese and Albanian flags at the Tirana airport in 2019. Photo by Filip Stojanovski [23]

Sea. Its capital is Podgorica. Montenegro is a member of NATO since 2017 and is in the process of joining the EU since 2021.

The motorway in Montenegro was supposed to be built in three sections from 2014 onwards. By 2021 the first section of 40 km length – which starts and ends unconnected to any existing motorway - was completed and the project was stopped by the Montenegrin government over financial issues. The project cost already US$ 1 billion and covered the most difficult part of the motorway to build. It should have been finished within four years but was two years behind schedule. The debts owed to the PRC now exceed 1/3 of Montenegro's annual budget.

Montenegro asked the EU for financial support to pay its debts to the PRC, which the EU declined. A reason for this decision might be Montenegro's many changes in alliances within the last 30 years. The loan was issued in US$, which makes Montenegro susceptible to currency fluctuations. The interest rates were high compared to loans in Euro from the EU. Furthermore, the option of property seizures by PRC in the case of financial default was agreed upon in the original contract. [23] [22]

The funding of the Bar-Podgorica and the Matesevo-Boljare sections of the motorway is currently not secured. Negotiations between Montenegro and the EU were stopped, because of the above-mentioned volatile alliances made by the government of Montenegro in the past.

AIRPORT INFRASTRUCTURE: CAPRICIOUS RELATIONS OVER THE INTERNATIONAL AIRPORT IN TIRANA (ALBANIA)

The purchase of Albania's only international airport in Tirana in 2016 was a high-profile BRI project. China Everbright Limited, a PRC government backed company, bought the airport from a then German consortium ownership for US$ 90 million. The concession to run the Airport was given until 2027 and caused politicians from the EU and its member states to remind Albania, that to close a proximity to the PRC might have adverse effects on its negotiations for EU membership. [24] [25]

BACKGROUND INFORMATION: THE REPUBLIC OF ALBANIA

The Republic of Albania is a state in the Balkans in southeast Europe with a population of 2.8 million in 2022. Its capital is Tirana. Albania joined NATO in 2009 (NATO 2020) and is a close ally of the USA. [23] Albania is in negotiations for a membership of the EU since 2022. [26]

Albania emerged from World War II as the Peoples Republic of Albania. Cooperation with the Soviet Union was intense until the death of Josef Stalin in 1953 but were severed in 1968 after the Soviet invasion of Czechoslovakia. The relations to the PRC were good until the 1970s, when Deng Xiaoping opened-up to western countries. In 1978 all ties were severed. After that, Albania was an isolated country. After the iron curtain fell in 1990, democratic movements led to the establishment of the Republic of Albania in 1991. In the same year diplomatic relations to the PRC were re-established and relationships have improved ever since. [27] [28]

Within a few years the Chinese management profoundly increased the profitability of the airport by significantly increasing passenger numbers – mostly tourists. This increase was partly achieved by a close cooperation with the Albanian authorities for tourism. [25] [24] Soon after China Everbright Limited took over in 2016, it started to display Albanian and Chinese flags at the entrance of the airport (Figure 4). It took until Feb 2019 for the prominent display of these flags to be noticed, sparking controversy among politicians and the public. [28] [23]

In December 2020 China Everbright sold the airport for € 70 million to the Kastrati Group - an Albanian conglomerate - after the Covid-19 pandemic had devastated the profitability of the airport's tourism sector. The transaction may have created a profit for China Everbright. As the main usage of Tirana airport was passenger transport, financial reasons of a private company may have been the sole reason for the sale, although the concession for running the airport was valid until 2027.[24] The fact that PRC was not intervening in the sale might also indicate the minor strategic importance of the Tirana airport for the BRI.

BATTERY PRODUCTION: TUG-OF-WAR IN HUNGARY OVER AN INVESTMENT INTO EUROPE'S LARGEST BATTERY PLANT

In August 2022 the China-owned Contemporary Amperex Technology Co. Limited (CATL) officially announced their intention to build a battery plant with a yearly output of 100 GWh of battery storage capacity on 221 hectares of land in Debrecen in the east of Hungary. Currently CATL is the largest battery producer globally (Figure 5). The investment in partnership with Mercedes-Benz is worth € 7.3 billion. The construction should be finished within five years from approval. The factory would be Europe's largest plant so far and is a key element in the efforts to provide batteries for electric cars produced in Europe. Debrecen is located in the heart of Europe and in close proximity to the production plants of large European car manufacturers like Mercedes-Benz, BWM, Stellantis and Volkswagen. [29] [30] [31] [32]

BACKGROUND INFORMATION: THE REPUBLIC OF HUNGARY

Hungary – officially the Republic of Hungary - is a landlocked country in Central Europe with 9.7 million (106) citizens. Budapest is its capital. Hungary joined NATO in 1999 and the EU in 2004.

Since 2010 Hungary has been ruled by the right-wing nationalistic Fidesz party. The long-time party leader is Victor Orban, head of government since 2010. The president has only administerial duties. Since the end of the 2010s tensions with the EU are rising for several reasons e.g. migration policy, Hungary's sympathies with Russia and the curtailing of rights of journalists.

The Hungarian government is much in favour of the plant as it tightens the already friendly links to the PRC and will provide an economic boost for Hungary. The rest of the EU has distanced itself from the PRC not least for its policy with respect to the Ukraine-Russian war. Public opposition against the plant is forming over concerns of en-

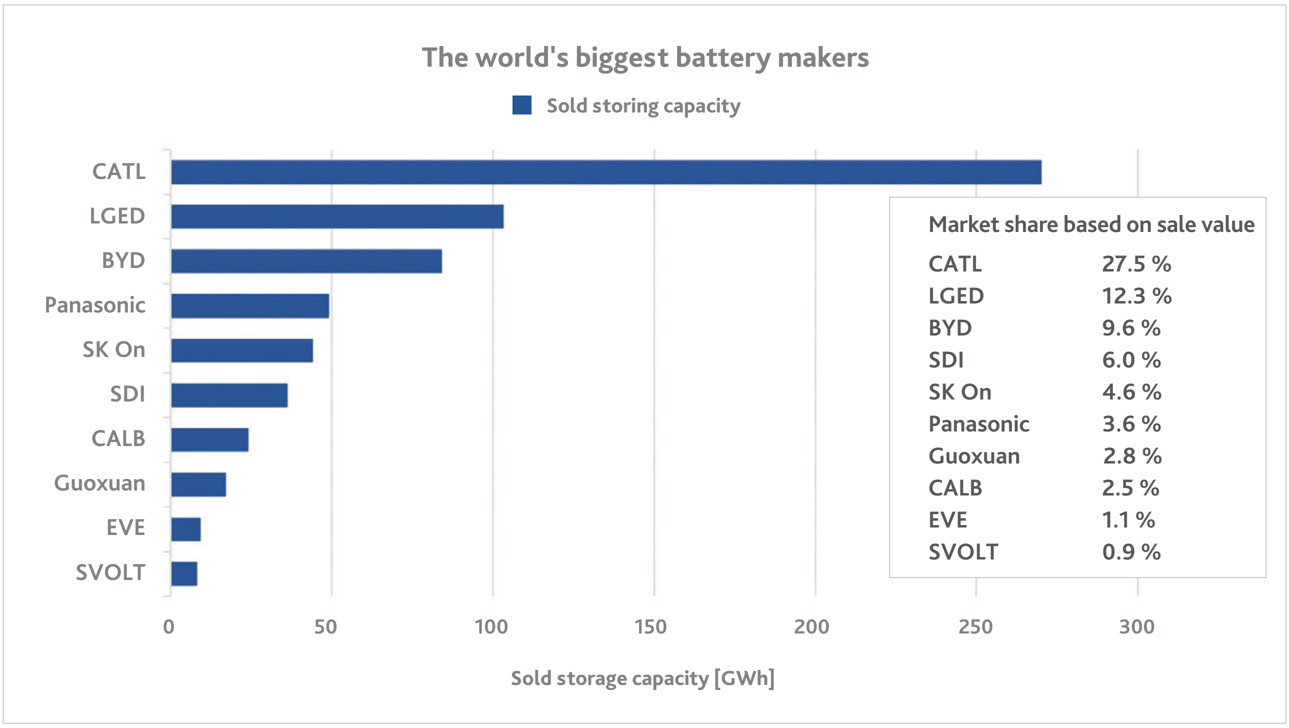

Figure 5: Global ranking of battery producers in annual absolute storage capacity output (GWh) and in market share (%). Modified after SNE Research. [33]

vironmental impacts, the loss of valuable farmland, rising inflation due to increased pressure on limited resources e.g. housing, food etc., workers' rights, and the influx of foreign worker for the plant, as the region has currently full employment. Local citizens, environmentalists, economists, opposition parties and even members of the governing party are forming an opposition movement, which is rooted in many parts of society. Two public hearings on the venture in January of 2023 descended into tumultuous scenes with verbal insults and even fistfights. CATL has not yet addressed public concerns in town-hall meetings. The progress and even the execution of the building project is not yet secured as nearly half of Hungary's population wants the new battery plant banned. Parts of the population also fear corruption in the process of policing state rules. The start of construction is planned to be in 2024. [29] [30] [31] [32]

Reactions to planned investments of CATL vary hugely depending on the country. In the German town of Erfurt, CATL opened a plant in 2022 without facing any civic opposition. The investment was widely welcomed as the population was assured that environmental and labour laws will be respected by effective law enforcement. [29] [30] [31] [32] In contrast, in January 2023 the Governor of Virginia (USA) has taken his state out of the application process for a future battery plant built by CATL in the USA over concerns of national security. [34]

THE CURRENT STATUS OF BRI PROJECTS

These problems in planning, financing, and project execution of these projects, as well as civil, political, and military concerns demonstrate the breadth and depth of challenges faced by the BRI. While generally, most big projects in industrialized countries encounter public resistance for various reasons and most of them are neither finished in time nor within the original budget, the failure of BRI-projects nevertheless matters for the strategic economic success and the reputation of the PRC.

Although the influence of the PRC was rising in some NATO countries due to the BRI, it has been argued that the PRC's decision-makers are lacking political savviness and empathy to handle the multitude of different opinions in democratic societies. [35] In the meantime, western nations withdrew to a position as bystanders due to the financial squeezes caused by the Global Financial Crisis of 2008.

While western nations tried to recover from the financial turmoil of the past decades, the PRC invested US$ 370 trillion globally since 2005 in BRI related projects. [36] Over recent years, and in obvious response to the activities of the PRC, the EU and the USA are issuing their own infrastructure projects in emerging countries. The EU's Global Gateway program aims to mobilize up to € 300 billion in funds by 2027, [36] while the US Build Back Better World program will lend several trillion US Dollars to developing countries in the coming years. [37] This is, however, by no means a match for the much higher investments already realized by the PRC.

In addition to an increasing number of BRI projects, the PRC has evolved since the mid-2010s into a kind of a lender of last resort as more and more of the BRI projects developed financial problems. Between 2000 and 2021 US$ 240 billion in loans were granted to finance BRI projects. [38] The bailout activities of the PRC for BRI projects in financial troubles have largely reduced the lending options for new BRI projects. Rescue loans from the PRC are overwhelmingly given to middle income countries to keep them financially afloat and to enable them to pay back their BRI-related debts. The rescue loans issued by the PRC correspond to more than 20% of the total International Monetary Fund transfers of the last decade. [39] [38]

CHINA AND THE FUTURE OF THE BRI

The BRI, which was created to increase China's GDP, may no longer deliver on this goal. The troubles with BRI, which contributes to a slowing GDP growth, are increasing internal economic problems and controversies within the PRC. This challenges the informal social contract and therefore the social stability of the Chinese society. The informal social contract is built on the promise of the improvement of the standard of living. As long as the Chinese Communist Party can deliver, the citizens of the PRC are willing to abstain from their democratic rights. [40] [41] [42] The apparent economic problems threaten that promise, especially for the younger generations. One member of this generation will have to sustain six retired members of the older generations (two parents and four grandparents) and should care for at least one child. The fear and spectre of the PRC "growing old before growing rich" is rising. As a response, in 2020 President Xi Jinping defined the objective for the PRC to reach the status of a medium developed nation by 2035. This includes a goal of doubling GDP versus 2020 levels, requiring an annual growth of 5%. [43] Whether this very ambitious goal can be achieved is not yet clear as it would require an exponential growth of the GDP, nor are the social implications of failing to achieve it.

The PRC's current economic troubles are of internal and external origin. The crackdown of the CCP on big Chinese tech companies since 2020 - because of their increasing political influence and independence from the CCP - resulted in a drop in well paid jobs and tax revenues, the loss of innovation and growth, and - probably most important - the loss of a whole generation of new entrepreneurs. [41] [44] At the same time, a housing bubble started to burst since 2021. Unfinished urban real estate projects, real estate company's bankruptcies and falling prices have destroyed the savings of the middle class and are one reason for deflationary tendencies in the PRC. [45] [46] [47]

Exports have dropped seriously since the “zero COVID” approach of the CCP and China's status as the “Factory of the World" has diminished. [47][48] The trade war between the USA and the PRC – which started in 2018 - as well as geopolitical tensions are most likely to further decrease exports, with semiconductor production at its focal point. [49] [50] [51]

The economic troubles also show in the rate of youth unemployment within the PRC. In the last officially published statistic from April 2023, it has reached an unprecedented 20.4%, while the overall unemployment rate has decreased to 5.2% in the same month. Since then youth unemployment rates have not been published again. [52]

The ultimate sign of an economic crisis is the decline of national stock market values and the external credit rating. The blue chips index of the most important Chinese companies has fallen to its lowest value in 5 years in December 2023 while simultaneously the international credit rating agency Moody's has lowered its outlook for the PRC. [53] Whether the declining birth rates, the ageing population or the economic reasons mentioned above are a cause, or a result of these trends is not yet clear.

The PRC's situation is not unprecedented. In the 1990's Japan's economy had many of the problems the PRC faces today and has since suffered from three decades of deflation and very low GDP growth. [54]

In free or low regulated market economies problem-solving is largely entrusted to the markets. They were normally sorted out in an economic shock in a short period of time. The Chinese economy is state controlled, with no indications or clues that the CCP will allow the markets to sort out the problems. In this case healing may take decades, probably leading to a long stagnation or downturn similar to the one in Japan.

Therefore, and despite the problems encountered, BRI projects may remain a very important part of the PRC's foreign and economic policy for years or even decades to come. Exporting surplus workforce and generating an income stream by using the BRI projects as a vehicle appears to remain vital for the PRC's economy and political stability. Consequently, NATO nations should be prepared to encounter an increasing number of BRI projects in the years to come, even in their own backyards.

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Military Oil Product Consumption out to 2030 - Spotlight on the US

By **Ben Cook, Subject Matter Expert and Managing Editor, NATO ENSEC COE**

INTRODUCTION

Oil has dominated the military energy landscape for over a century. The global "strategic and tactical hegemony of oil" has prevailed since the Royal Navy transitioned from coal prior to the First World War. [1]

Today, the US military amongst the largest institutional consumers of oil products in the world. [2] Oil products power ships, aircraft, combat vehicles, and permanent and contingency bases. However, as NATO notes, there is an "overwhelming urgency to address the root causes of climate change" considering the "speed and scale at which the climate crisis continues to unfold." [3] In the coming years, Allied militaries' consumption of energy will evolve, as it must. Nations are rushing to capture the benefits of new energy types and technologies, while also reducing the logistics burden through fuel conservation. But, the change will not happen overnight – oil will continue to be a key enabler of military capability long into the future.

This article looks at the historic trends in consumption, the initiatives which will shape it into the future, and the global outlook for oil production and refining. It points to some of the strategic considerations to ensure the supply chain remains robust into the future, and complements efforts to transition to lower carbon emissions.

1. FUEL CONSUMPTION – SPOTLIGHT ON THE US MILITARY

The US Department of Defense (DoD) is amongst the largest consumers of oil products globally. We may be able to derive some insight into the future of oil demand in the military by looking at their historic trends and the policies affecting it.

In fiscal year 2023, the US – by far the largest of Allied militaries – used 73.3 million barrels (mb) of oil products. The DoD accounts this within two categories: operations and estates. Operational energy powers ships, aircraft, combat vehicles, and contingency bases. Estates energy powers permanent infrastructure and includes departmental buildings. Operational energy constitutes the vast majority of consumption and is the main focus of this paper, with estates covered in section 2.4.

The US used 70.8mb of operational fuel across the Air Force, Navy, Army, and Marines, the Air Force being the largest consumer owing to the energy intensity flight.

Data from the Department of Energy is available back to 1975, allowing for a birds-eye view of the changes to consumption. This is accounted for slightly differently, across 'facilities' and 'vehicles,' leading to small differences in demand values. Insightful patterns can be discerned, nonetheless.

by **Ben Cook**

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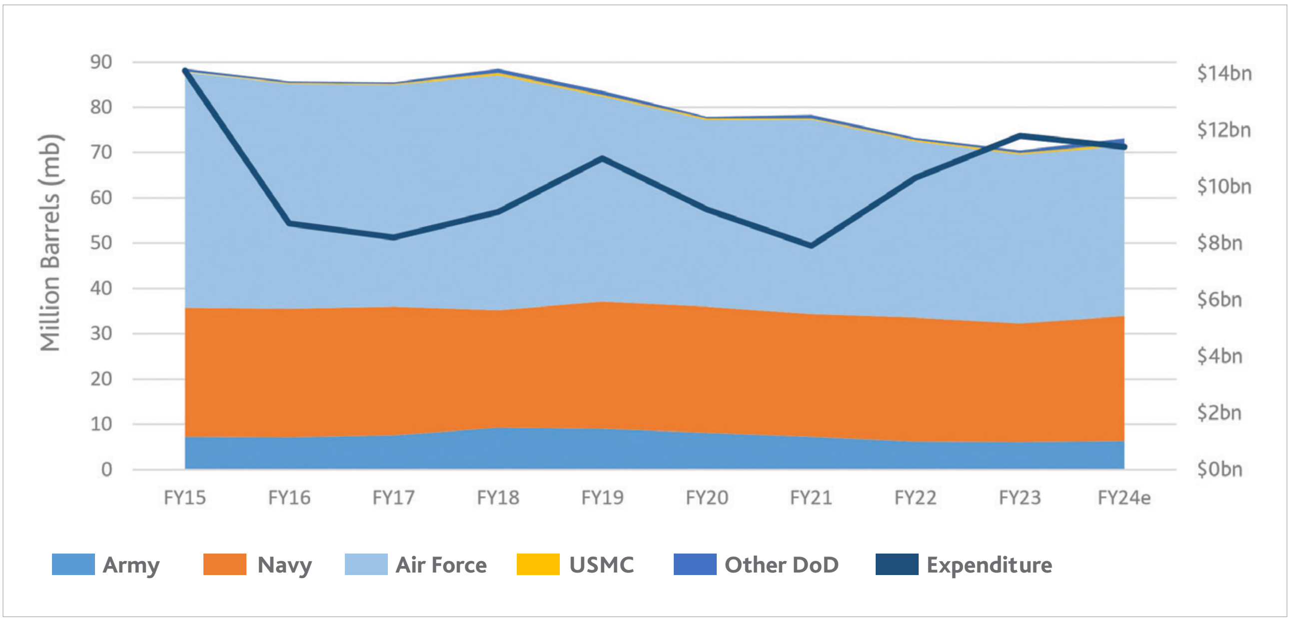

Figure 1: US DoD Operational Energy Demand by Service, Fiscal Year 2015 – 2024 (expected)
Source: US DoD [4]

Owing to its use powering vehicles, operational fuel consumption is determined miles travelled (air, road, water) and the efficiency of the engines used. This is, of course, difficult to predict. It is affected by the intensity of operations in which the military engaged, fuel-consciousness policies, fuel economy & the rate of innovation. Intuitively, it would seem like the first point is most the significant, as has been argued: "total military fuel purchases track US engagement in wars," evidenced by the fact that "purchases declined in recent years as the US has reduced [and ended] operations in Afghanistan and Iraq." [6] Figure 2 supports this for the 21st century – there was a sharp uptick post 9/11, with the consistent decline coinciding with the end of the Iraq war in 2011. However, it paints a more nuanced picture in the 20th century. Despite the absence of major conflicts in the 1980s, [7] vehicular consumption increased on average over the decade. Moreover, 1991, which saw the Persian Gulf War, saw just a 1% increase on peak demand from the previous decade. Consumption is clearly linked to engagement in conflict, but it's not a simple predictor.

Even though the intensity of future operations remains uncertain, two key types of data are available which –

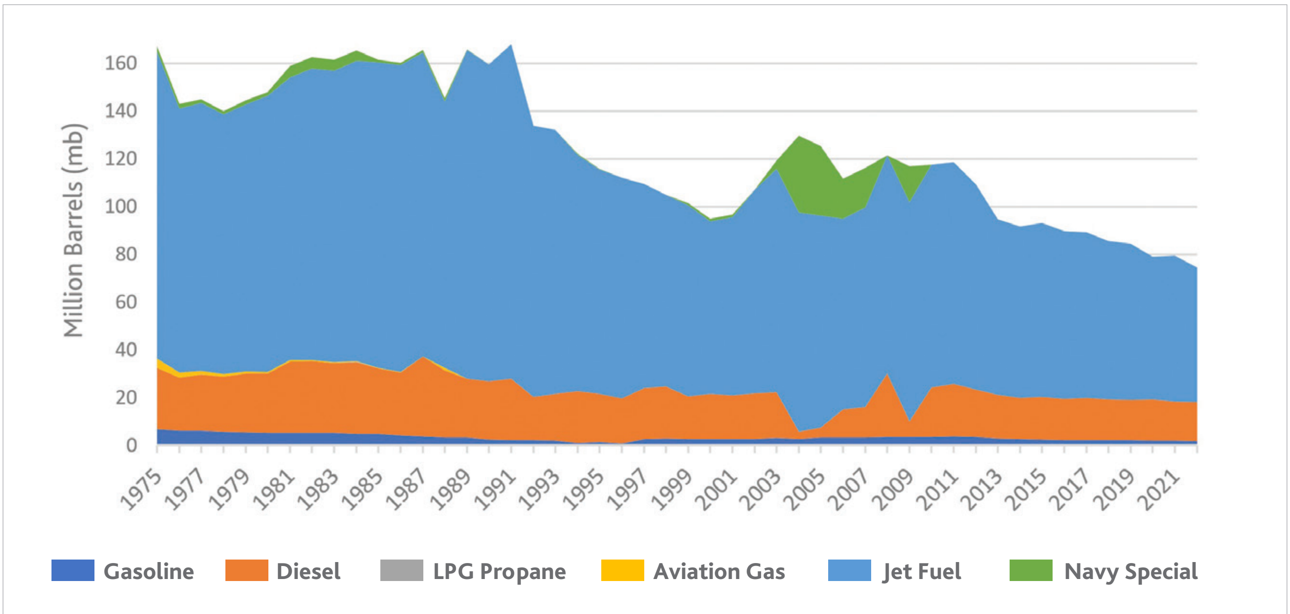

Figure 2: US DoD Vehicular Oil Consumption, 1975 – 2022
Source: US Department of Energy (converted from thousand gallons). [5]

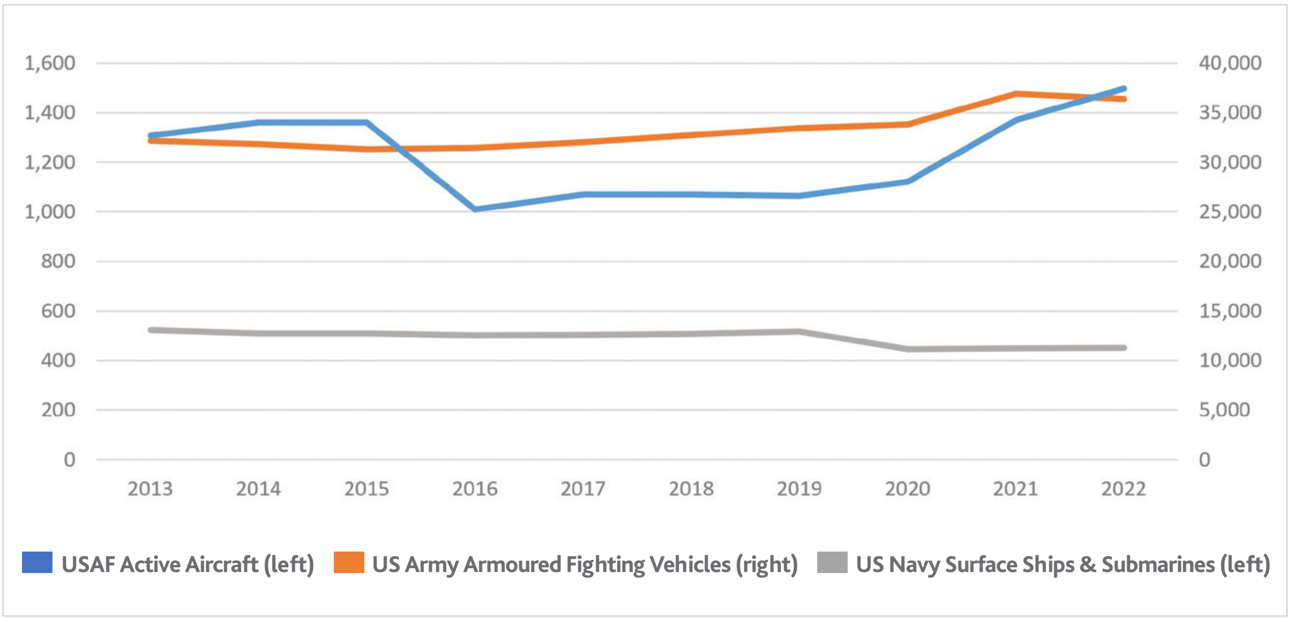

Figure 3: US DoD Equipment Inventory, 2013 - 2022
Source: USAF: Air & Space Forces Almanac (collated); [8] USN/USA: International Institute for Strategic Studies (selected) [9]
Note: values are indicative owing to lack of publicly available primary source data due to sensitivity.

when compared with historic consumption - provide useful indicators for how demand might evolve. The first of which is the quantity of equipment held by the DoD, seen in Figure 3 below. The trend this shows (and the declared future procurement) provides an indication of future consumption. Intuitively, more equipment means greater consumption. The other crucial type of data, however, is the level of investment in demand reduction and fossil substitution measures, shown below. This affects the relationship between equipment and consumption: clean and efficient equipment, and effective fuel consciousness policies, can motivate demand reduction even if total equipment numbers increase.

Together, Figures 2 and 3 demonstrate there is no simple relationship between just the amount of equipment held by the DoD and the level of consumption. While the US Navy equipment inventory has fallen over the previous 10 years, the US Army Armoured Fighting Vehicle figures have fluctuated and ultimately increased, and active fighter/attack aircraft in the US Air Force (USAF) have begun to increase versus the historic lows experienced earlier this century. We must therefore understand the level of investment in fuel demand reduction/substitution policies, together with equipment inventory and historic consumption, to paint a picture of what the future could look like. From here, this paper aims to provide that picture to 2030. It will compare possible future consumption figures to global production and refinery projections. This comparison will be used to identify strategic considerations for ensuring security and resilience into the future.

2. FUTURE MILITARY CONSUMPTION

NATO has made clear that Allies recognise the importance of climate change, [10] as have national ministries. Adaptation to the changing climate is necessary to maintain the strategic advantage in a dynamic security environment. The appropriate mitigation efforts by militaries against climate change – for example, the wholescale switching from fossil fuels to renewables - is arguably more difficult to secure agreement on, however.

Nonetheless, taking the US as an example, military consumption of oil products is on a downward trajectory. This is motivated not only by the recognition of the need to take action against climate change, but also the advantages which come with reducing the logistics burden by conserving fuel – transporting fuel to where it is needed in conflict carries a risk to life, which conservation can mitigate. Total vehicular consumption in the 10 years to 2022 has seen a 21% decrease. While this coincides with the winding down of operations in Afghanistan and Iraq, it also coincides with significant investment in demand reduction and substitution efforts. Considering the relationship between conflict and consumption isn't as a straightforward as first thought – nor is equipment and consumption - it is arguably these fuel policies which have played a significant part in controlling the level of consumption.

The DoD dedicates significant investment to the four objectives outlined in their Operational Energy Strategy. There are 306 active initiatives aiming to drive down energy demand, substitute fossil fuels with cleaner alternatives, improve supply chain resilience, and develop enterprise-wide visibility of distribution and consumption. In fiscal year 2023, investment totalled $2.9bn. For the next 5 years, FY2024-2028, the DoD plans to spend

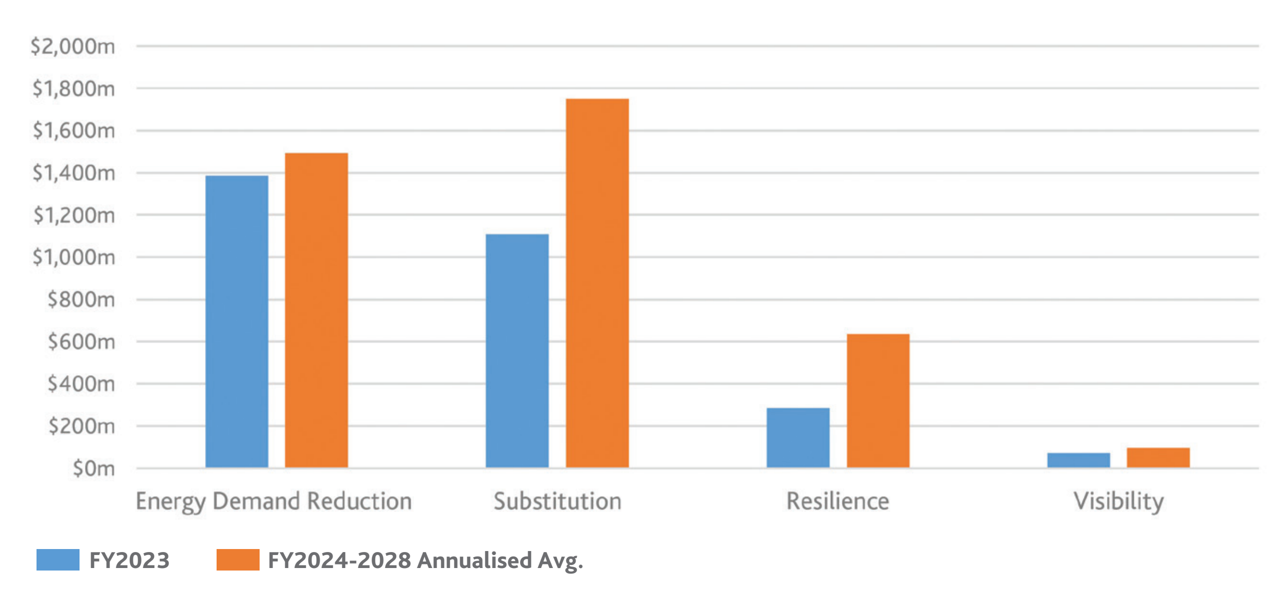

Figure 4: US DoD Investment in Operational Energy Initiatives
Source: US Department of Defense [4]

$19.9bn. This means an annualised average of $4bn, a 39% increase on FY2023. The increasing level of investment in demand reduction (8%) and fossil substitution (58%) provide strong evidence in favour of the continued decline in overall consumption. That is, so long as there is not a significant increase in overseas operations (akin to post-9/11 intensity) out to 2030.

As seen in Figure 2 earlier, DoD consumption has been on a relatively neat downward trajectory for the previous decade. With the evidence that investment will continue to put downward pressure on demand, it is possible to apply a simple linear trajectory using the previous 10 years' of consumption data. This paints an optimistic picture of the rate of decline. On the other hand, using all data from the beginning of availability paints a more conservative picture of the next decade. The 1975- 2022 data includes the peaks and troughs which have accompanied escalation in conflict and variable equipment numbers. As well as total consumption, we can zoom in on the different fuel types and the drivers of consumption, which this paper will turn to below.

2.1 JET FUEL

The definition of jet fuel used within the Figure 2 is wide-ranging, including kerosene-based fuels (Jet A, Jet A1, JP-5, JP-8) and naptha-based (JP-4). Importantly, then, this consumption is split across aviation, ships, ground vehi-

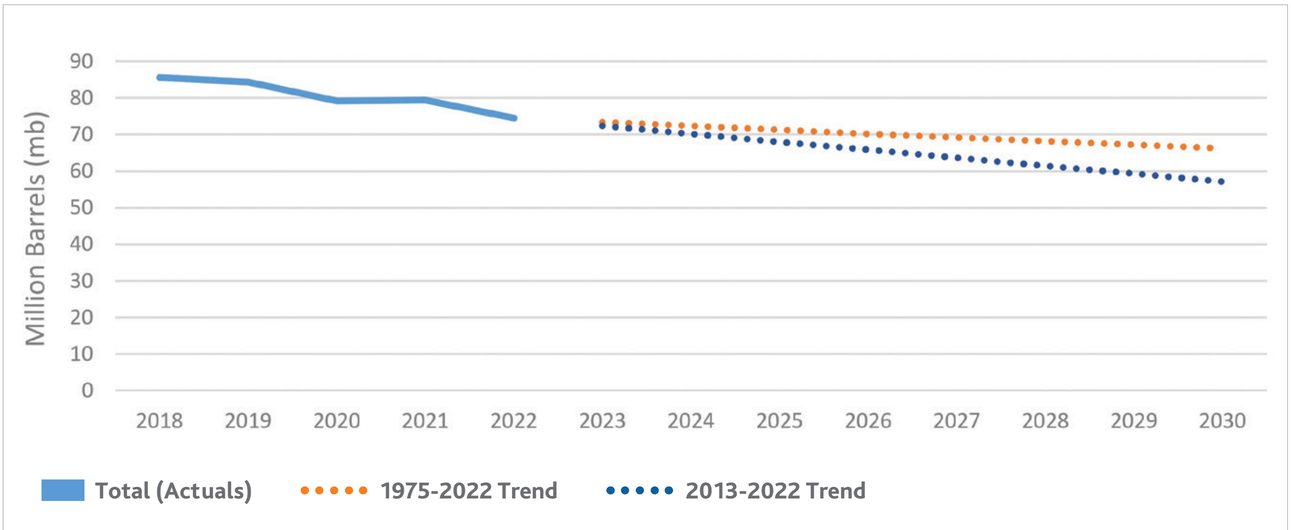

Figure 5: US DoD Actual Vehicular Oil Consumption and Linear Forecast
Source: own analysis of US Department of Energy Data [5]

cles, and generators as NATO's Single Fuel Concept encourages these to be operable with JP-8 ("F-34" in NATO code). [11] Full analysis of jet fuel data must consider its use across this materiel and between Departments. Given the USAF's prominence in consumption, however – 51% of the total – this section will focus on jet fuel for aviation.

Both the number of active fighter aircraft and total jet fuel consumption are on a broadly on a broadly downward trajectory. However, because there are periods where one increases and the other decreases, and vice versa, there is only a weak positive correlation between the two (0.3 coefficient). To some extent, then, fewer aircraft means less jet fuel consumed. Importantly, however, this is not true from 2016 onwards where there's been an uptick in aircraft numbers. The divergence in this relationship is arguably explicable by the demand reduction policies pursued by the USAF in recent years.

Some of the key demand reduction and efficiency measures introduced by the USAF in recent years include: the introduction of software to more efficiently allocate mobility aircraft globally; optimisation of cargo routing; drag reduction measures; and "establishing a culture of fuel consciousness" among airmen, motivating best practice for efficient flying. [4] The DoD's reduction in jet fuel consumption is in stark contrast to the global trend. Commercial airline consumption rose 4% over the period 2013 – 2022. As commercial demand recovers post-COVID, global jet fuel demand is set to rise beyond pre-2019 levels, continuing on an upward trajectory to at least 2030.

The USAF spent $437m on demand reduction measures in FY2023, but plans to spend only $149m each year for the next 5 years. While this may appear to show a decreasing importance in the coming years, it could also demonstrate the expected completion of several key projects. A USAF blended wing body aircraft, which can increase fuel efficiency by 30% with today's engines, is expected to have an initial test flight in September 2027 after years of heavy investment. In addition, the USAF spent $592m on substitution measures in FY2023, and plans to more than double this to $1.2bn for each of the next 5 years. Most of this covers the costly replacement of old TF33 engines in 76 B-52H aircraft. [4]

Again, jet fuel in the DoD is consumed not only by aircraft but also ships, ground vehicles, and generators. The global picture is taken up almost exclusively by commercial aircraft. While this is not a direct comparison, then, it nonetheless sheds light on the level of demand producers and refiners must meet in the future, and the share of the military in global consumption.

Similar to global consumption, DoD jet fuel consumption dipped in 2020 (though to a much smaller extent) before rebounding in 2021. However, unlike global demand, which is continuing to reclaim the losses experienced in COVID, DoD demand fell year-on-year in 2022. Globally, jet fuel demand is expected to surpass pre-COVID levels toward the end of the decade owing to the growing demand for international air travel (with demand slightly offset by efficiency gains in commercial airliners). This growing global demand is the reason for the projected increase in jet fuel yield from refineries, and additional commodity availability on global markets is positive from the perspective of military security of supply.

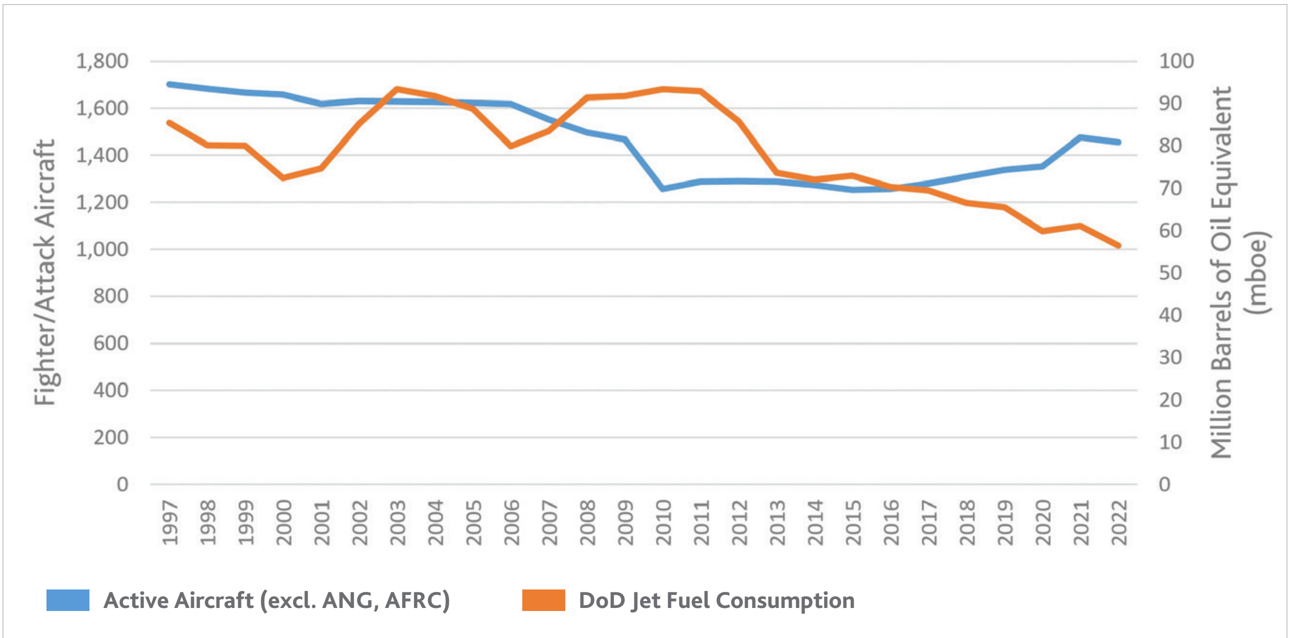

Figure 6: Comparison of Active Fighter/Attack Aircraft and US DoD Jet Fuel Consumption

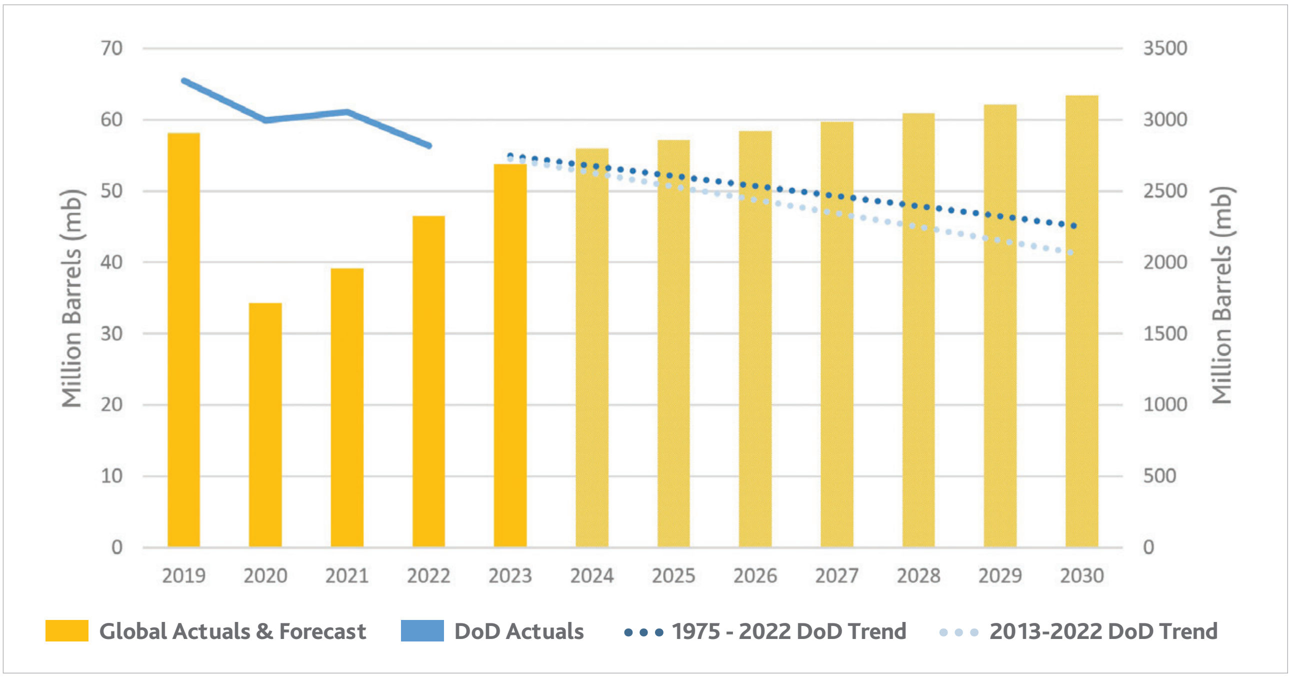

Figure 7: US DoD Jet Fuel Trend versus Global Forecast
Source: Global actuals/forecast: own analysis of Statista [12] and IEA [13]; DoD: own analysis of US DoE data [5]

2.2 SUSTAINABLE AVIATION FUEL

In the coming years, aviation jet fuel consumption may be displaced by the blending of increasing percentages of SAF (also termed biojet). SAF is primarily produced by refining vegetable oils, animal fats (tallow), or used cooking oil into a mixture of hydrocarbons that can be blended with traditional jet fuel. While the tailpipe emissions are the same, by utilising a cyclical production process and avoiding the need for producing additional fossil fuels, SAF can have a lower lifecycle emissions value compared to Jet A1. Jet A1, the primary fuel used in commercial aviation and prominently consumed by the DoD, has a baseline emissions of 89g of CO^2 equivalent per megajoule (CO^2e/MJ). [14] The variety of 'pathways' through which SAF can be produced means that its emissions value can vary significantly. Some of the options which may be globally scalable are outlined in Figure 8 below, including their standard lifecycle emissions factor (LSf). A lower LSf facilitates greater carbon savings when substituting for Jet A1.

Recently, Boeing has released guidance stating their military aircraft can operate on SAF at currently approved limits of up to 50% blend with conventional fuel. [17] Using the pathways of SAF production shown in Figure 8, this would allow a 28-42% reduction in carbon emissions. In addition to this direct emissions reduction, SAF is liable to produce fewer contrails, which significantly exacerbate climate warming due to their greenhouse effect on terrestrial radiation. [18] It is this potential carbon saving which is motivating the US DoD to "identify any infrastructure requirements associated with the use of SAF and pursue investments that support the drop-in compatibility of alternatives fuels with increasing proportions of SAF." [19]

The global picture for biojet fuel production is positive. Globally, announced biojet projects reach a capacity of around 219mb per year in in 2030. [13] Using the approximations above, we could see DoD jet fuel consumption around 40-45mb in 2030. Estimating around half of this being dedicated to aviation, implementing a 50% blend would put DoD biojet demand at c.10mb a year, or 5% of the global total. The challenge, then, is not the technical capability of aircraft to accept SAF blends, but rather the large scale availability of a product which must be cost-competitive with petroleum based jet fuels. [19] On some projections, this will be challenging even in 2050: current production costs for fossil jet fuel are circa USD 0.30 – 0.80 per litre, while electrically reformed SAF is projected to still cost USD 1.00 – 3.00 in 2050. [18] This, however, may change if government intervention influences market dynamics. While we may not see the large scale introduction of SAF particularly soon, it's potential small-scale introduction this decade is further evidence supporting the continued downward trajectory of total jet fuel consumption outlined above.

2.3 GASOLINE & DIESEL

As mentioned above, NATO's Single Fuel Concept encourages ground vehicles to be compatible with JP-8 jet fuel. This means some vehicle demand is captured within the jet fuel values outlined above. Nonetheless, gasoline and diesel together constitute 24% of total DoD oil product demand. The picture of gasoline and diesel consumption since the beginning of data availability has varied quite significantly. 2004-2009 saw particularly acute peaks and troughs in diesel consumption, as seen in Figure 2. In recent years, this has levelled out into a steady decline.

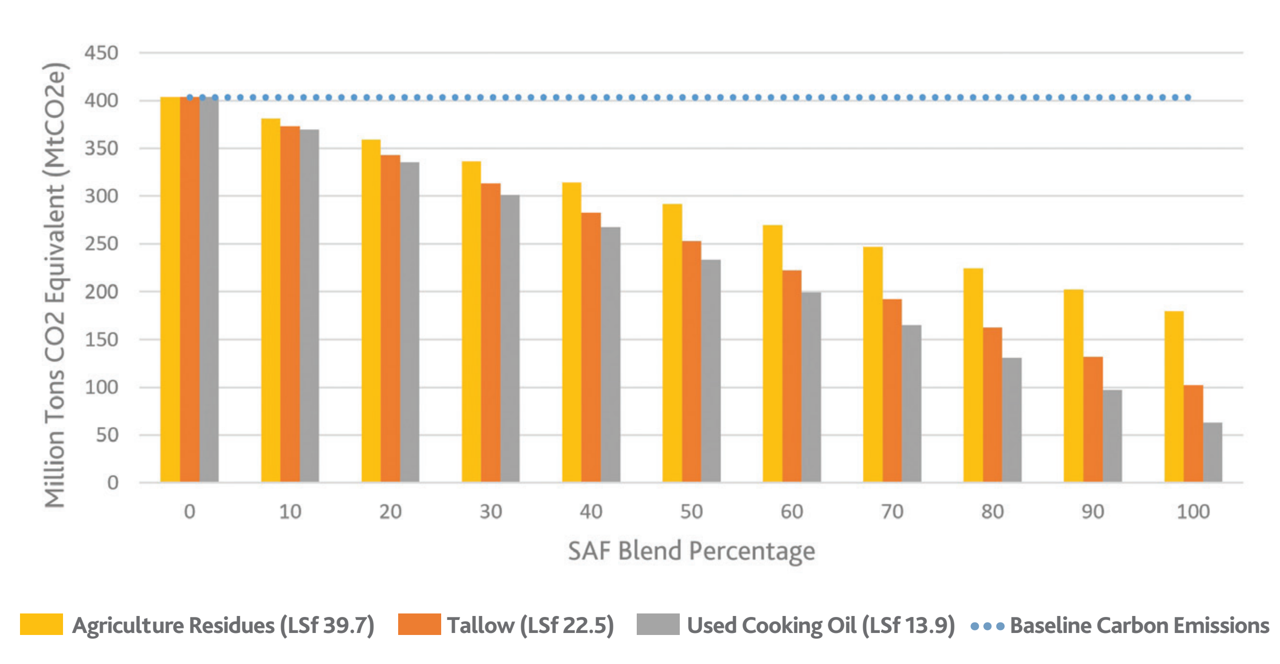

Figure 8: Net Carbon Emissions of Different SAF Types & Blends per Million Barrels of Oil
Source: CORSIA for LSf values, [15] 4AIR for conversion factors [16]

Gasoline in particular has shown a 41% decrease between 2013-2022. A significant driver of this is the DoD's replacement of fossil non-tactical vehicles (NTVs - those used by civilian staff, for example) with hybrids. The Army alone replaced 18,000 of these by 2020, accounting for 0.3mb per year, [20] with other departments implementing similar policies. As this rollout continues, it will put downward pressure on gasoline consumption into the future.

Diesel has shown a less marked decrease owing to its continued use as a back up to jet fuel in tactical vehicles, as well as some smaller vessels and ground support vehicles. The 10% reduction in this time may be explicable by a combination of the winding down of ground operations in Iraq and Afghanistan, alongside initiatives to promote the Operational Energy Strategy Objectives of fuel demand reduction.

Currently, battery technology is not in a position to replace internal combustion engines in tactical vehicles.

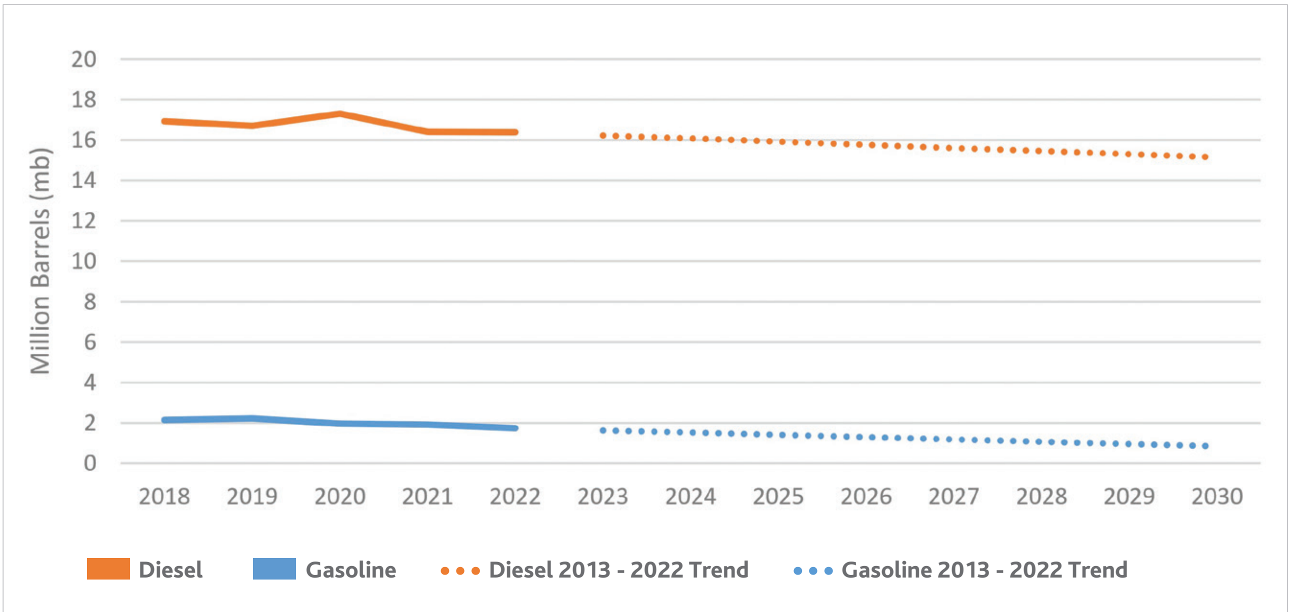

Figure 9: US DoD Gasoline and Diesel Actuals and Trend
Source: Own analysis of US DoE data [5]

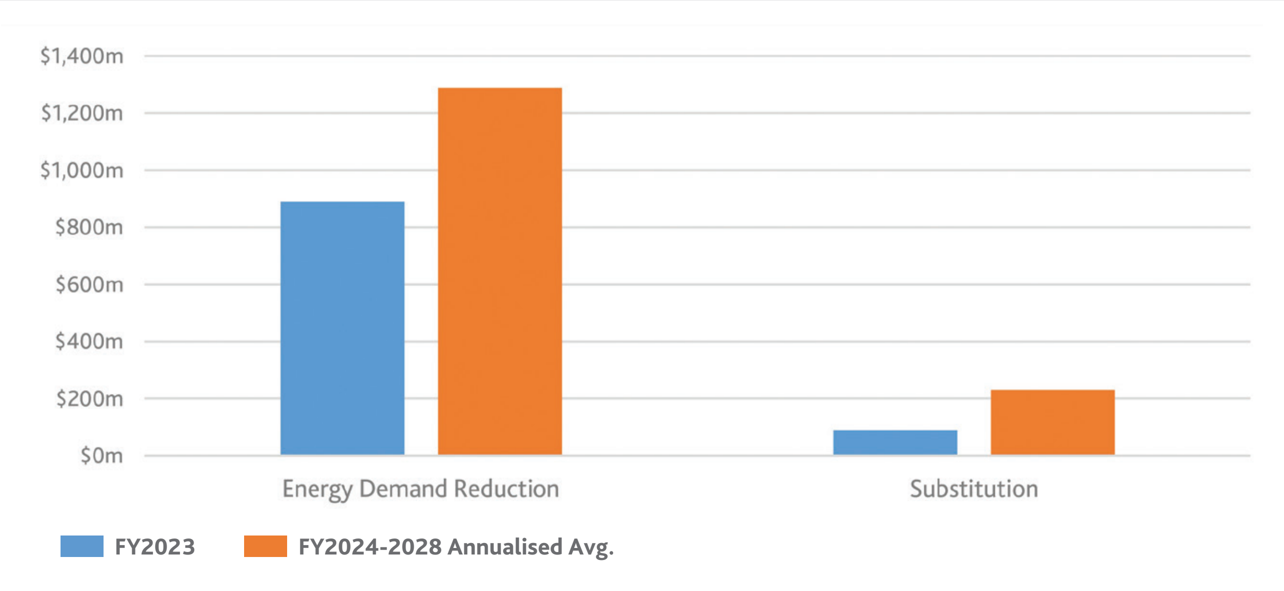

Figure 10: US Army Investment in Operational Energy Initiatives
Source: US DoD [4]

With current fossil technology, 2% of a main battle tank mass, for example, is taken up by fuel storage. To get the same level of stored energy on board (noting the efficiencies offered by electric propulsion) would require around 20% of the platform mass to be dedicated to batteries to allow the same level of power output and endurance. [21] Without green technology which does not hamper capability, we will not see wholescale switching of tactical vehicles from fossil engines.

However, it is worth noting that technology readiness is rapidly developing. The US Army is developing hybrid-electric drives for tactical vehicles, which can reduce fuel consumption by up to 35%. Similar to the overall decline in fuel consumption, this is not only to contribute to climate change mitigation, but also for the tactical advantages which come with it – notably the decrease in audibility and, consequently, detectability of electric drives. Additionally, the Army have provided a demand signal to industry by publicising their target of deploying fully-electric tactical vehicles by 2050. [20] Spending on demand reduction and energy substitution will increase 45% and 149% respectively, as seen in Figure 10.

Global consumption of gasoline and diesel is set to move in the same direction as we have seen in the US DoD. The IEA

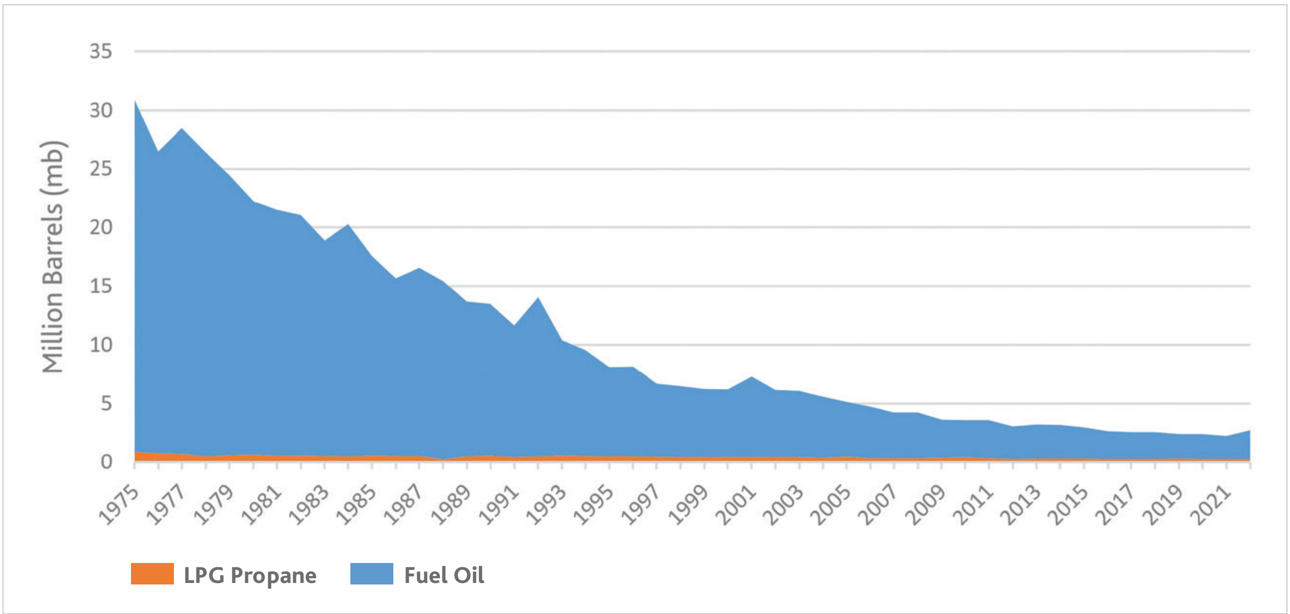

Figure 11: US DoD Estates Oil Consumption, 1975 - 2022
Source: US DoE [5] (converted to mb)

forecasts demand will reduce by 1.7mb/d globally in 2030 as transport is increasingly electrified. This will coincide with 1.1% decrease in yield from refineries who look to divest away from road transport fuels into the more profitable and longer-term petrochemical industry. [13] Possible implications of this global trend is discussed in the final section.

2.4 ESTATES - FUEL OIL AND LPG PROPANE

DoD oil consumption to power estates saw significant reduction between 1975-2015. The largest primary fuel for estates over that time has changed from fuel oil to natural gas. Overall electricity consumption has also increased. Between fiscal years 2016 – 2022, fuel oil consumption plateaued before finally increasing. During this time, the DoD spent $4 billion on performance contracts to enhance energy resilience, reduce energy intensity and address decarbonisation, and incorporate more efficient and cleaner technologies into estates.

Fuel oil plays a significant role in providing back-up generation capacity in the event of disruption, or when renewables aren't available. This role will continue into the future. While there are ongoing projects to develop self-sufficient micro-grids enabled by, for example, nuclear, the DoD is nonetheless working on several projects to increase fuel storage near installations to provide emergency generation capacity. [4] If deployed alongside carbon capture and sequestration technology, this may still be compliant with to carbon neutrality: "fossil energy combined with CCS provides a means of producing low-carbon energy while still utilising the available base of fossil energy worldwide and limiting stranded assets." [22]

Similar to diesel, then, we may see a plateauing of this demand into the future, rather than the continued decline which can be expected of jet fuel and gasoline.

3. STRATEGIC CONSIDERATIONS FOR MILITARY FUEL SECURITY & RESILIENCE

Military energy security of supply is contingent on: sufficient commodity availability (has enough fuel been produced, refined, and made available on the market for suppliers) and transport accessibility (is the entire chain including shipping, road, rail, and pipelines robust).

3.1 COMMODITY AVAILABILITY

The transition to net zero carbon emissions raises strategic questions for commodity availability. Continued production will be determined by producers' assessment of the economic viability of operation into the future, with many seeking to divest away from the fossil fuel industry amidst the uncertain long-term economic picture. In the US in particular, a decision to halt production may come sooner than other nations. Some analysts suggest that "the United States will possess a higher share of uneconomic oil and gas assets compared to other large oil-and-gas producing regions like the Middle East, Russia, and Europe." [23] The degree to which this is reflected by exit of domestic producers from the US market over time and the speed of such an adjustment will determine the level and impact of increased import dependency in the future supply mix. With around half of the US DoD's operational fuel consumed within the US, this scenario is deserving of serious consideration. Similarly, Europe is expected to continue to operate a production/consumption deficit of around 10mb per day out to 2030, continuing its import reliance on North America and the Middle East. Net capacity additions outpace refined product demand growth out to 2030 globally, but the European theatre is set to see net shutdowns of 0.6mb/d. [13] Moreover, alongside

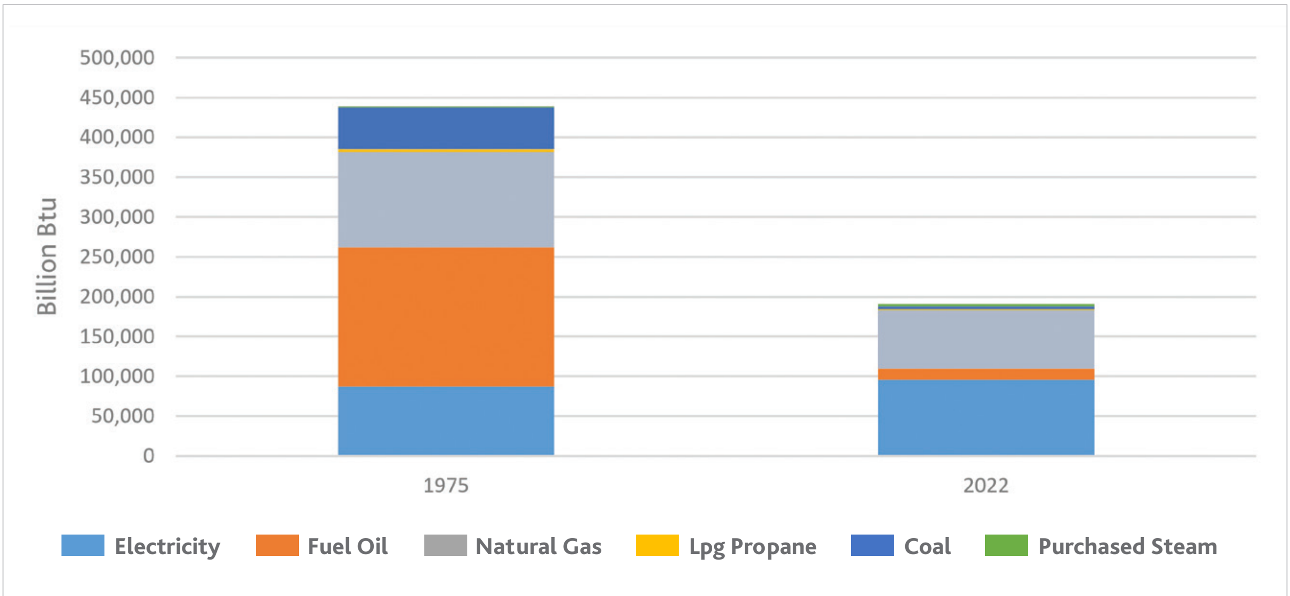

Figure 12: Annual Comparison of US DoD Estates Energy Use
Source: US DoE [5]

this decrease in European refining capacity, utilisation rates – in essence, how busy they are - are expected to show a downward trajectory for the remainder of the decade. This raises the prospect of further capacity closures this decade, increasing the need for imports to reach demand. Overall, Allied operations in Europe may ultimately be dependent on a larger share of imports coming from increasingly far away into the future.

3.2 TRANSPORT ACCESSIBILITY

So, this requires a robust international transport network to ensure refined products reach their demand points in time. Since Russia's invasion of Ukraine and Europe's subsequent diversification away from Russian hydrocarbons, there has been a greater international sea trade for oil products. This is liable to continue into the future considering the role imports will likely pay in the supply mix. This means tankers will continue to play a significant role in transportation, placing emphasis on the importance of maritime security in coming years. With global oil demand rebounding since COVID, tanker owners are taking advantage of favourable market conditions through the development of new builds. [24] This will bolster transport accessibility into the future. However, ships must be able to operate safely.

Perhaps the biggest threat to transport accessibility in the coming years and, consequently, to military fuel supply, is posed by maritime insecurity. Maritime piracy is a global problem that disrupts oil flows and products. [25] Bolstering security protocols, fostering global cooperation, and implementing naval patrols are essential measures to mitigate the risk to global oil trade into the future. Further, the threat of maritime improvised explosive devices (M-IEDs) is advancing in complexity and lethality, [26] with a similar increase in the risk posed by drones. [27] This is in addition to the disruptive potential of cyberattacks, which have recently targeted shipping companies and port operators. [28] Collective NATO investments in innovative surveillance solutions and coordination between nations are needed to mitigate the risk as fuel flows increasingly rely on sea routes.

3.3 SYSTEM PLANNING & RESILIENCE

The ability for militaries to secure the energy they need within a contested logistics environment is dependent on having a holistic view of operational energy supply and demand. The US DoD admits that, "currently, the Department has limited visibility of operational energy distribution and use." [19] It's difficult to ensure there is a resilient supply chain into the future unless there is a complete picture of how fuel reaches its destination, and precisely how it's used. In recognition of this shortcoming, the DoD is ramping up investment in their Operational Energy Strategy Objective of 'Enterprise-wide Visibility' by 33% in the next five years, as seen in Figure 4 above.

Resilience in fuel supply to the military is, similar to civilian sectors, bolstered by accessible strategic reserves. The DoD maintains an inventory of fuels worldwide consisting of JAA, JA-1, JP-5 and JP-8, but also includes lube oils and additives which can modify fuel specifications. The amount of stock available at the end of each fiscal year has decreased by approximately 8% over the period 2013-2022, but this is at a slower pace than the total reduction in the DoD's fuel demand, which has reduced by 21% during this time. This implies that, relative to consumption, stocks have increased. This is positive for resilience in the short-term. However, the prospect of increasing import-dependency coupled with lengthened, more complex supply chains carries risk to the ability to meet short-run demand peaks. Greater consideration must be given to the role that stra-

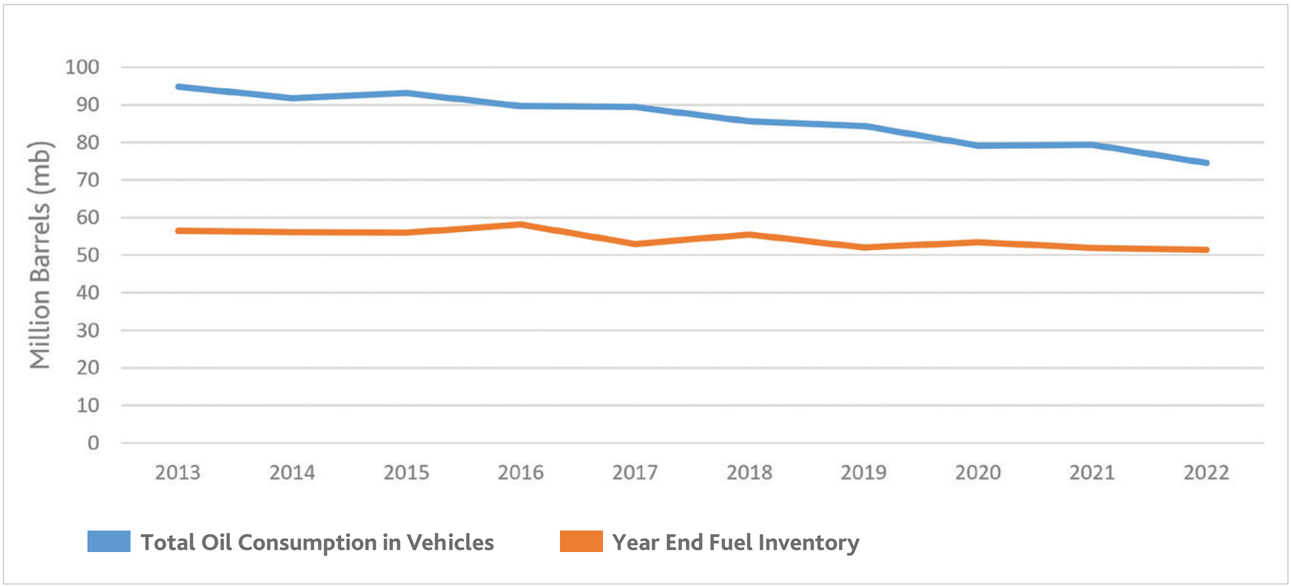

Figure 13: US DoD Oil Consumption Versus Stocks
Sources: Consumption: US DoE4; Inventory: US Defense Logistics Agency – Energy [29]

tegic stockpiles, and quantities thereof, will play in the future to effectively mitigate increased risk exposure.

CONCLUSION

This article demonstrates that, barring significant increase in operations in the coming years, we can expect the continued decline of oil demand within the US Department of Defense. This is particularly true for gasoline and jet fuel, whereby demand reduction initiatives will continue to provide efficiency gains and substitution policies will displace oil consumption with electricity and, eventually, SAF. Fuel oil and diesel are expected to show limited reductions out to 2030, owing to their continued use as a back-up fuel and in hard-to-electrify tactical vehicles, respectively.

In scenarios which limit global warming to 1.5C, the IPCC project that global oil consumption decreases 30-78% to 2050 from 2020 levels. [22] The trends outlined above demonstrate that the US DoD is pursuing effective policies to reduce oil consumption. There is, of course, a long way to go. The levels of investment in reduction and substitution outlined above are promising, nonetheless.

The continual role that oil will play as an enabler of military capability out to 2050 means that supply chains must be robust and resilient. Imports may play an increasing role in the supply mix in future as domestic US production may prove to be uneconomic earlier than international competitors. This emphasises the continued need for maritime security given the role shipping will play in connecting oil producers and refiners to final consumers into the future and suggests added importance of strategic stock holding. Resilience is bolstered by the increasing level of fuel stocks as a percentage of consumption which we have seen over the previous decade.

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Notes

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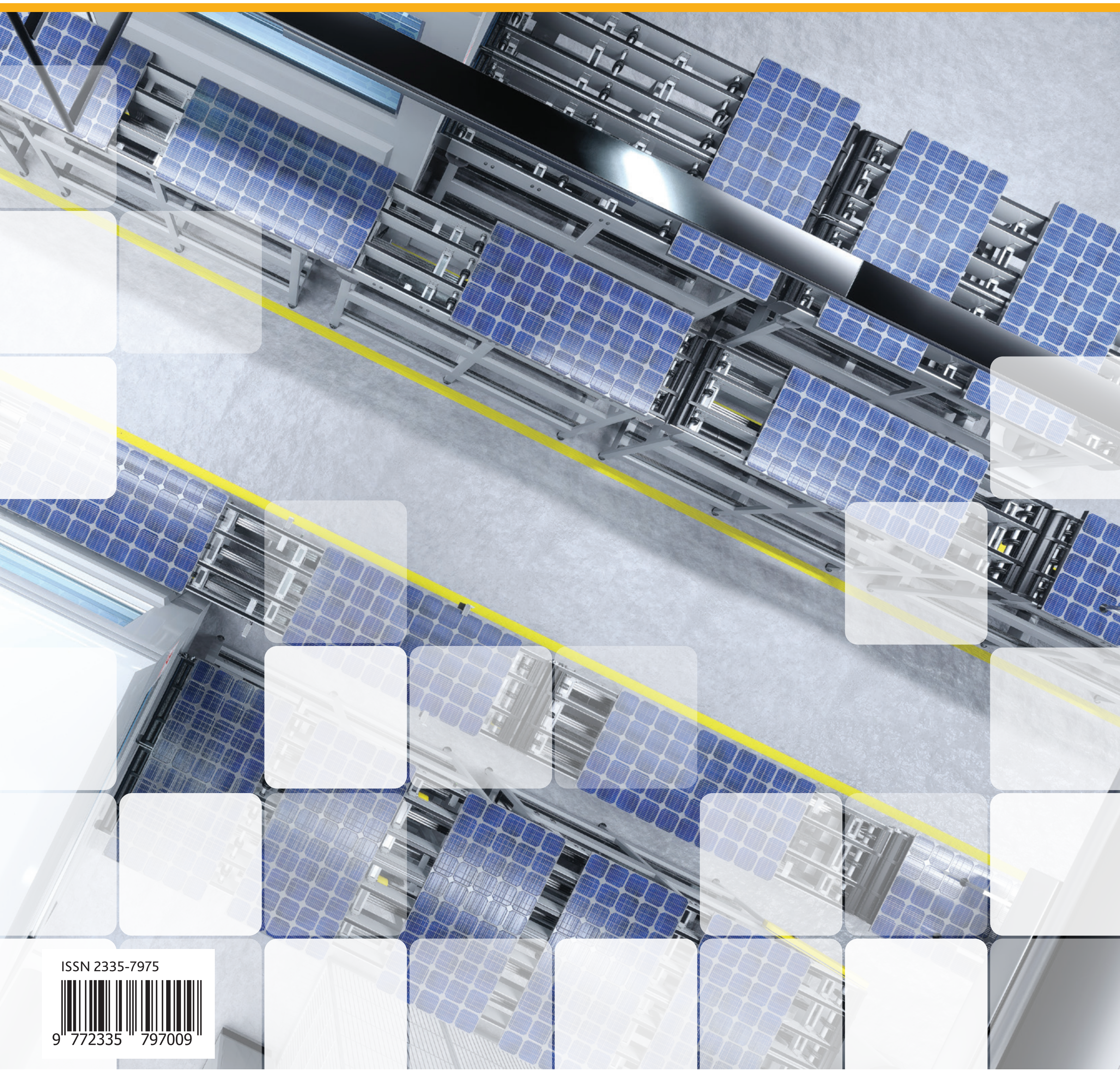

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