MCCS EXPERT GROUP

DECARBONIZED DEFENSE

THE NEED FOR CLEAN MILITARY POWER IN THE AGE OF CLIMATE CHANGE

A VOLUME OF

THE WORLD CLIMATE AND SECURITY REPORT 2022

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INTERNATIONAL MILITARY COUNCIL ON CLIMATE AND SECURITY

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The IMCCS is a group of military leaders, security experts, and security institutions across the globe dedicated to anticipating, analyzing, and addressing the security risks of a changing climate. The IMCCS is co-led by:

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The IMCCS Expert Group consists of IMCCS leaders committed to driving analysis, policy and communications on climate and security, including through the development, publication and endorsement of the World Climate and Security Report, as well as other timely analysis driven by demand signals from the IMCCS.

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- The Center for Climate and Security (CCS), an institute of the Council on Strategic Risks (CSR)
- The Planetary Security Initiative at the Netherlands Institute of International Relations (Clingendael)
- *The Hague* Centre for Strategic Studies (HCSS)
- The French Institute for International and Strategic Affairs (IRIS)

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Cover Photo: Photovoltaic solar power plant at Nellis Air Force Base. Credit: USAF

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EXECUTIVE SUMMARY

The risk of climate change worsening security risks is well documented and recognized by security and foreign policy communities worldwide. NATO Allies and EU member states have prioritized climate action in economic and industrial policies and have made a start with decarbonization efforts in the military. Accelerating this effort would help to modernize militaries and reduce costs and operational vulnerabilities related to fossil energy. It would be a logical contribution to the wider effort to combat climate change and phase out fossil energy, also in view of Russia using it as a weapon in the war in Ukraine.

Emissions reduction targets for the military are considered a national choice, even in countries firmly committed to climate neutrality in 2050. In the past, military decarbonization has often been dismissed because of fear that greener solutions may weaken operational effectiveness, thereby compromising national security. High financial costs associated with renewable transition constituted another reason for pushback. However, militaries are nowadays more often forced to respond to climate-induced crises and doing so whilst emitting and thereby contributing to the problem is in itself, contradictory. Further, new technologies and clean energy approaches can provide operational benefits to militaries that make them more resilient and adaptable to 21st century threats.

This report discusses why reducing carbon emissions in the military is a sensitive issue, what a methodology for monitoring its emissions could look like, where technological challenges are the greatest, how NATO and EU are currently responding and what more they can do, and how they could cooperate on this issue.

A methodology for emission mapping

Despite efforts by the European Defence Agency, and several NATO Allies, there is currently no commonly agreed upon way for militaries to measure and report their emissions. Where emissions are measured, the data is often concealed out of fear of giving away strategic information on military activities, particularly those abroad. This justified an exemption from reporting obligations under the Kyoto Protocol and the Paris Agreement to the UNFCCC and still hampers transparency even when aggregate data do not really conceal much. The chapter proposes to distinguish between two types of emissions: emissions from standard operations, generated by civil and administrative operations, and emissions from non-standard operations, those from military operations, law enforcement and other operations. This approach is already being tested in the US and Canada.

Technological challenges to overcome

With regard to technology, the potential for a reduction of standard emissions is more straightforward than a reduction of non-standard emissions. Contributing to climate mitigation in defense buildings, day-to-day transport and other facilities is a similar challenge to the one currently experienced in the civilian sector. It requires political will and budget for heat pumps, electric vehicles, energy efficiency, solar roof panels, etc. Even military bases abroad can be decarbonized. The real challenge is to decarbonize heavy weapons systems such as fighter jets, tanks, warships, and submarines, which require a considerable amount of fuel to operate; at the same time supplying them also makes military operations and their fossil supply lines extra vulnerable. The high-tech innovations needed to shift to low-carbon alternatives could very well jumpstart modernization and lead to societal co-benefits.

NATO: climate ambition in the absence of legislative powers

While NATO – notably under Secretary General Jens Stoltenberg's leadership – has formally embraced the need for Allied militaries to reduce their emissions, the Alliance works by consensus. The level of ambition and willingness to prioritize military decarbonization varies among its 30 member states. Moreover, following the outbreak of the war in Ukraine, collective defense dwarfs all other issues. Nevertheless, since 2011 NATO has been striving to improve energy efficiency in its headquarters and Allied military forces in the form of various smart energy solutions. It is currently developing a mapping methodology to help Allies measure their military emissions. NATO can further incentivize military decarbonization through different standardization agreements, by setting net zero and sustainable targets for defense planning, or by shifting away from its single fuel policy towards more sustainable alternatives. With its successful track record as a standard setter, NATO taking climate mitigation even more seriously can have a normative influence on NATO Allies as well as partners world-wide.

EU to link carbon footprint to its Green Deal, industrial and green tech agenda

The EU is very ambitious in the field of climate action with steep emission reduction policies and an integration of climate objectives into many budgets and programs. The twin transition of green and digital tops its policy agenda, as well as the need to quickly abandon fossil fuel dependency on Russia. There is ample scope to link decarbonization of defense sectors to its policies on strategic autonomy and green tech as a spearhead of its industrial policy and budgets. The EU's Strategic Compass requires EU member states to pay more attention to climate security in the military, with the Climate Change and Defense Roadmap providing guidance in this regard. The next step is the real inclusion of the defense sectors in the European Green Deal with meaningful targets and an increase of already existing funding programs by the Director General for Defense Industry and Space (DG DEFIS) and the European Defense Agency (EDA) for decarbonization, as well as a greening of public procurement standards applying to, for instance, the European Peace Facility.

Middelgruden Offshore Wind Farm in Denmark. Credit: UN Photo/ Eskinder Debebe

Military decarbonization: A topic for NATO-EU cooperation

NATO and the EU have complementary roles to play in military decarbonization. NATO, which does not have the power to legislate, cannot set binding targets or enforce investments in green technologies. The EU is better placed to leverage the legal and normative power it holds to galvanize member states into action, but at the end of the day defense remains a national prerogative. What is clear is that both organizations depend on their political masters. NATO and the EU should work together to convince those in charge of military operations that lower fossil fuel use, coupled with sustainable technologies, will improve operational effectiveness and in the long term is a political need.

The two organizations could coordinate their ambitions, with a common methodology and feasibility studies on target setting. NATO and the EU could further coordinate technological innovation programs between their members, and help steer investments towards energy efficiency and sustainable technologies, lowering the risk of a carbon lock-in. Decarbonization could first focus on standard operations, starting with their buildings and transport means at home, as well as military bases abroad. Going forward, both military stakeholders and civil society actors should be included in the ideational and implementation stages of military decarbonization.

Using the war in Ukraine as turning point for sustainable change

There is a risk that the Russian invasion of Ukraine and the need to strengthen our collective defense against the threat that Russia poses will overshadow ongoing debates about military decarbonization. At the same time, increasing defense spending – supported by public opinion – presents an opportunity for R&D in favor of more modern, effective and more fossil fuel independent capabilities. As NATO Allies and EU member states increase their defense budgets, and before contracts with defense manufacturers have been signed, change can materialize into new requests for low carbon considerations and energy efficiency standards factored into new procurement processes, research and innovation.

INTRODUCTION:
TOWARDS A MILITARY CONTRIBUTION TO COMBATING CLIMATE CHANGE

LOUISE VAN SCHAIK, DOUWE VAN DER MEER, AKASH RAMNATH, KATARINA KERTYSOVA

Today, military operations are still largely powered by fossil fuels, but with the objectives of the EU, the United States and others to become carbon neutral by 2050, this is set to change. Militaries, moreover, have long realized the vulnerability of their energy supply lines. It's been nearly a hundred years since American General Omar Bradley declared "Amateurs talk about strategy, professionals talk about logistics." Today, that manifests itself in the susceptibility of fossil fuel supplies and supply lines to attack. For instance, the Russian army attack on a fuel storage facility in Odessa in April 2022 disabled Ukrainian troops to fight the Russians near the front line at Mikolayev.[1] In Afghanistan, American and British troops suffered heavy casualties due to attacks on their slow-moving fuel transports.[2] In the European context, an extension of the conflict beyond Ukraine's borders would make Western fuel infrastructure a vulnerable target for attacks.

Military fuel consumption is not only a problem in terms of operational vulnerability. It also involves huge costs and dependency on external suppliers. It adds to the adverse climate impacts caused by emissions that result from burning fossil fuels for energy, and thereby to climate change serving as a threat multiplier by putting increasing stress on economic, social and political systems. The operational vulnerabilities, security threats and carbon emissions linked to military fuel consumption have led major Western international organizations, the North Atlantic Treaty Organization (NATO) and the European Union (EU), to put military decarbonization on their respective agendas.

Despite these issues, defense contributions to decarbonization cannot be taken for granted. Militaries have been reluctant to share data related to their emissions out of concern for revealing strategically vulnerable information. Security concerns led to the exclusion of militaries from the framework of the United Nations Framework Convention on Climate Change (UNFCCC), and military emission reporting has been limited. While climate change has long been recognized as a "threat multiplier" by the international security community, the military's own contributing role is only more recently attracting increased attention.[3] Decarbonization would not only lower the emissions of militaries, but could also increase their operational effectiveness through lowering fuel dependencies. Emission reduction targets are now being considered in earnest, but their adoption is not a given yet.

OUTLINE

This IMCCS Expert Group report will outline the options for NATO members and the EU to reduce their military emissions and fossil fuel dependence consistent with their respective militaries achieving their respective security missions. It will point to the increased interest in the issue within the military, the ongoing efforts to develop a methodology for emission reduction targets, the potential to use green transition technologies to modernize and strengthen the armed forces and the efforts of NATO and the EU in this regard.

After this introduction, the second section focuses on the elements that should be included in a military emissions mapping methodology. The third section covers promising future technologies (military and dual-use) and the potential for decarbonization in the military industrial base, including dual use. In the fourth section, the ways in which NATO can contribute to climate mitigation are detailed. The fifth section outlines options for the EU to catalyze military decarbonization. The sixth section summarizes the main findings, explores NATO-EU collaboration in this field, and concludes with recommendations for both NATO and the EU.

This research was conducted by a team of researchers from the Clingendael Institute, the French Institute for International and Strategic Affairs (IRIS) and the European Leadership Network (ELN) for the World Climate and Security Report 2022, published by the Expert Group of the International Military Council on Climate and Security (IMCCS). It is based on previous research by the three institutes, including specific recent work by IRIS,[4] ELN,[5] and the Clingendael Institute,[6] interviews with relevant stakeholders, engagements with members of the security and defense community, and desk research of recently published policy papers and other studies. Extensive data analysis by IRIS is also included.

Pine Island Glacier's calving front. Credit: NASA/Maria-José Viñas

MILITARY EMISSIONS: MEASURING IS KNOWING

Pierre Laboué

How much greenhouse gas (GHG) do militaries emit? Thirty years after the Rio Conference in 1992, this data is still hard to find, and few reports are available on the subject. This has prompted environmental organizations and researchers to raise concerns over the lack of transparency among militaries. However, new data is starting to be released by some Western countries whose governments have committed to reach climate neutrality by 2050.

This section will map, analyze, and discuss existing methodologies to assess and quantify GHG emissions from the military activities of Western countries. Based on the current data available, this section will also discuss what more these countries can do to track their emissions and contribute to the global effort to reduce emissions and thereby mitigate climate change.

THE CHALLENGE OF DEVISING A METHODOLOGY FOR EMISSION REDUCTIONS FROM THE MILITARY

The challenge of devising a methodology for tracking emissions in the defense sector is that the military considers part of its carbon and energy footprint as strategic information which cannot be put at risk. The fear is that it may reveal vulnerabilities to the enemy, particularly with regards to operations abroad (see Box 1). Since the UN climate regime clearly attributes emissions to the country of origin, extra-territorial emissions were not included in the nationally determined contributions (NDCs) to the Paris Agreement. Concretely, this means that the deployment of the military abroad is not included in national statistics. However, with the inclusion of the international aviation and maritime sectors in global climate mitigation policies and with greater attention being paid to imported carbon emissions caused abroad, military emissions are unlikely to be kept off the radar forever.

Normally, a methodology for emission reductions distinguishes between sectors and sees what potential contribution they can make. This allows for a more targeted approach compared to simply trying to get the overall fossil energy consumption down with a generic target. For the military, a distinction could be made between navy, air and land forces, and between emissions linked to buildings, infrastructure, mobility or weapon systems.

Both sharing emissions information linked to activities abroad and connecting them to specific sectors domestically are sensitive, since this could reveal information about the scope and size of military efforts and the specific territories they operate in. It could showcase, for instance, where and at what scale submarines, special forces and ships are operating. A U.S. Executive Order on Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability, adopted in December 2021, contains a provision which would allow agencies to request an exemption for any "particular agency activities and related personnel, resources, and facilities from the provisions of this order when it is in the interest of national security, to protect intelligence sources and methods from unauthorized disclosure, or where necessary to protect undercover law enforcement operations from unauthorized disclosure".[7] However, as of this writing, there is no public information to suggest any agency has requested such an exemption, and the Pentagon's Chief Sustainability Officer (CSO) has said the Department of Defense will not do so.[8]

There is also wider hesitation, as making emissions publicly known could lead to a reduction target, potentially hindering the efficacy, robustness and speed of certain operations or activities. This means that to be acceptable to the military, a methodology preferably would need to include a system for relative target setting, in which the target is compared to the overall amount of military activity that is decided based upon national and global security concerns, as well as existing capabilities to adjust without a significant drawdown in capacity.

NATIONAL INVENTORY REPORTS: A METHODOLOGY FULL OF LOOPHOLES

The best-known methodology to monitor GHG emissions is based on National Inventory Reports that countries submit to the United Nations Framework Convention on Climate Change (UNFCCC).[2] Each National Inventory includes a specific category available to report emissions from military fuel use, subcategory "1A5 Other (Non-specified elsewhere)". This is further broken down into **stationary emissions** (1A5a), for fuel use in buildings, and **mobile emissions** (1A5b), for fuel use in vehicles. If an Annex I Party (including OECD countries and most post-soviet States) is willing to detail even further its mobile emissions, it would be possible to further distinguish mobile emissions by type of equipment, such as aviation (1A5bi) or vessels (1A5bii).

In theory, this could have interesting advantages. All National Inventory Reports follow the same structure and methodology, defined by the Intergovernmental Panel on Climate Change (IPCC) in its "*2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*". This ensures that all inventories are comparable and reliable. All data reported by Parties to the UNFCCC are openly available on the UNFCC's website. The data could be aggregated to sum up the Western countries' emissions, benchmark individual country emissions, compare emissions from the military sector with other sectors, and understand the structure of the military sector emissions by subcategories (stationary and mobile).

In practice, however, National Inventory Report data on the military sector emissions are not useful for assessing and quantifying military emissions. The methodology is not designed to be applied to specific organizations (i.e. defense agencies, ministries or departments). It does not cover emissions generated outside the national territory, in international waters and airspace. The subcategories dedicated to military fuel use emissions include other types of civilian emissions not specified elsewhere, making the data unreliable. As data from the military sectors in the National Inventory Reports are thus incomplete, they remain not particularly useful.

2 National Inventory Reports are the official documents aimed at assessing and quantifying a country's greenhouse gas emissions. It is part of the annual greenhouse gas (GHG) inventory submitted to the United Nation Framework Convention on Climate Change (UNFCCC) by the countries part of the Convention (called the Parties). Out of the 30 NATO members, 27 must submit a National Inventory Report to the UNFCCC each year because they are considered Annex I Parties (members of the OECD in 1992 or countries with economies considered 'in transition' or emerging' (from the former Soviet bloc). 3 NATO members, Turkey, Cyprus and Malta, are Non-Annex I Parties and do not have to report their national GHG emissions each year.

Plenary session in the main hall of the Kyoto International Conference Center, December 1997. Credit: UN Photo/Frank Leather

The Kyoto Protocol's exemption addendum (Box 1)

During the 1997 negotiations, the U.S. delegation lobbied for the inclusion of *"a national security or national emergency provision"* in the Kyoto Protocol, with an initial proposed phrasing as *"this agreement does not apply to emissions related to multilateral operations conducted by militaries for collective self-defense, peacekeeping, peace enforcement, and humanitarian assistance purposes, including operations under United Nations mandates"*.[9] This position was based on the argument that "*This Protocol must not create a conflict between our collective ability to preserve peace and our desire to reduce greenhouse gas emissions*".[10] After long negotiations, the final text of the Kyoto Protocol contained no exemption for the Armed Forces from reporting their GHG emissions.[11] However, a short addendum (FCCC/CP/1997/7/Add.1) was ratified during the 12th plenary meeting and discussed at a night session of the Committee of the Whole.[12][13] The final UNFCCC document contains a page dedicated to "Methodological issues related to the Kyoto protocol" to quantify and assess national emissions. With this addendum, international transportation, also reported as international bunker fuel (including war ships and war planes) and multilateral operations pursuant to the Charter of the United Nations (meaning military intervention) were not included in national totals and thus excluded from reduction target set by the Parties to the Convention. Those two key points are still in force in the *IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*.

CARBON FOOTPRINT: A TAILOR-MADE METHODOLOGY IS STILL DIFFICULT TO BENCHMARK

Several Western defense agencies, whose governments have committed to reach climate neutrality by 2050, have recently started to release new and more complete data on their emissions. Countries are using another methodology, better suited to track an organization's emissions, without revealing classified information: the "carbon footprint" (see Box 2). This is the case with the United States, Canada, the United Kingdom, Denmark and the Netherlands, with other countries publishing some figures on their military emissions, such as Germany and France.

Carbon Footprint of the Military (Box 2)

The carbon footprint is a method of GHG accounting for *"The quantity of GHGs expressed in terms of CO2-e, emitted into the atmosphere by an individual, organization, process, product or event from within a specified boundary".*[14] It includes all emissions generated to sustain an activity based on the concept of "scopes". The different scopes are:

Scope 1 – Direct Emissions: emissions emitted by the organization onsite. For the military, this will be first and foremost energy consumption. It encompasses military fuel use burnt in vehicles to transport people and equipment, fossil fuel used in generators to produce electricity in camps, etc.

Scope 2 – Indirect Emissions: emissions emitted by the organization from the energy produced offsite. It encompasses electricity and heat distributed to military facilities, and produced from fossil-fuel combustion at energy provider plants.

Scope 3 – Induced Emissions: emissions linked to the entire military supply chain. This category is vast. It includes upstream emissions from the production of military equipment by armament companies, as well as downstream emissions from the transportation of goods and services outsourced to an external supplier.

Out of the 30 NATO members, the United States and Canada provided two of the most exhaustive carbon footprints for their respective defense departments, with open-access data sheets. Luxembourg, Norway and Denmark have also conducted a complete assessment of their Defense carbon footprint, with shorter historic data. Several initiatives from other Western countries are ongoing, with the Netherlands, the United Kingdom and, to a lesser extent, Germany and France, providing less detailed estimates of their Defense GHG emissions.

The U.S. and Canadian emissions are categorized by scope (1 and 2) and by end-sector use (building and facilities, vehicles, and equipment). Military emissions are also divided by types of operations: **standard emissions** (generated by civilian and administrative operations) and **non-standard emissions**, defined as those from military operations, law enforcement and other operations for the U.S. or National Security and Safety Operations for Canada.

The data available provides a great deal of information to help analyze Washington's military emissions (see the infographics below). The U.S. Department of Defense (DoD) was the largest emitter of GHGs of all federal agencies. It alone accounted for nearly three-quarters of U.S. government emissions. Non-standard activities, which span combat operations and include vehicles and equipment (planes, ships, tanks, etc.), were responsible for nearly two-thirds of the U.S. Department of Defense's GHG emissions in 2020. However, GHG emissions from the DoD fell by more than a third between 2010 and 2020. This development is directly related to the 27 percent decrease in the total energy consumption of the U.S. armed forces over that period. This decrease is in large part explained by the reduction in U.S. foreign military operations, which is included in non-standard operations. By September 2020, the number of U.S. personnel deployed outside the country's borders had decreased by 50% compared to September 2010 (221,000 compared to 450,000). There is no guarantee for further reductions in the future, however. Given the fact that emissions are largely dependent on deployment, if the number of deployments were to increase in coming years, as is currently plausible given changing security dynamics driven by the Russian war in Ukraine, military GHG emissions would likely rise again.

Similarly, Canada's National Defense Department accounts for the largest share of the total Canadian federal agencies' emissions. National Safety and Security Operations (corresponding to non-standard operations) represented the bulk of the Armed Forces emissions in 2020-21. As for the United States, those emissions have reduced over the last fifteen years.

Exhaust clouds over ships. Credit: Chris LeBoutillier on Unsplash

ASSESSING AND QUANTIFYING MILITARY EMISSIONS OF WESTERN COUNTRIES

Many challenges still lie ahead. The carbon footprint methodology is not universal and the military carbon footprint data from different countries are currently not comparable, not least as they have different perimeters. For example, the United States and Canada's respective carbon footprints encompass emissions from installations and mobility, both for civilian and military operations. But Germany and France only released partial data, excluding emissions from their military activities (considering only buildings). Each defense agency is currently developing its own methodology to quantify and assess its carbon footprint, with its own categories and labels. The level of information provided varies widely. Canada provides extremely detailed carbon accounting, whereas Denmark and the Netherlands deliver more global figures. Obtaining online access to data for military operations often requires digging into non-user-friendly web resources, and some additional calculations on emission data needs to be done. Canada publishes emissions from military mobility in separate documents and does not include it in its defense carbon footprint. Most of the data do not include scope 3 emissions, related to supply chain and procurement, whereas this represents a large share of a defense organization's carbon footprint.[15] Last but not least, the details of the methodology used to produce the data for the countries monitored could not be found in open access from our research.

The prerequisite for comparing and assessing military emissions would be to have a common methodology on energy consumption, at least for scope 1 and 2. Fossil fuel combustion is the main source of military GHG emissions. Different fuels have different emissions factors. For instance, burning coal to produce electricity generates more GHGs than natural gas. In this regard, it is important to know how much and what kind of fuel has been consumed when and for which equipment, to lay the foundation for a common carbon footprint methodology.

Detailing and harmonizing Western countries' emission category names and definitions are critical to developing relevant analysis of carbon footprints. The key categories are end-use sectors (with details for the type of vehicle and installation), standard and non-standard operations, and scope. Additional categories are useful, such as emission from fuel (jet fuel, distillate diesel, etc.) and by geography (homeland and abroad).

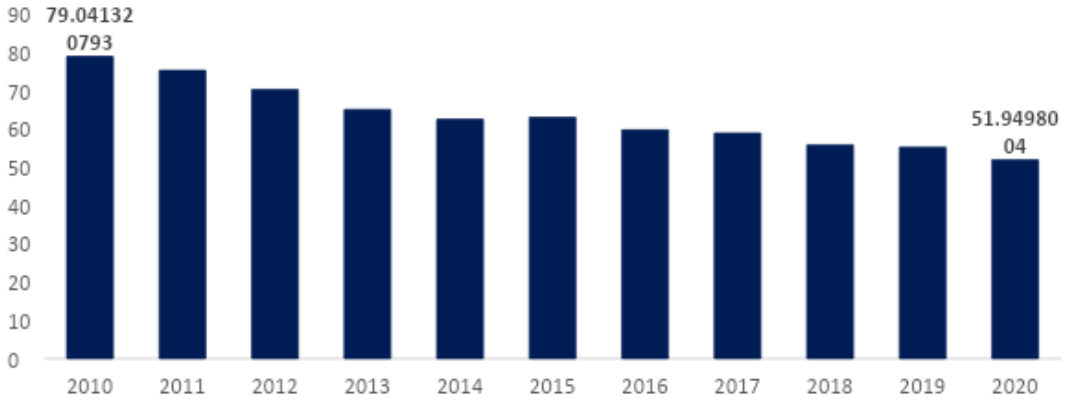
Assessing and quantifying the carbon footprint of all NATO and EU members is critical for the accountability of defense establishments and the credibility of Western governments committed to reaching climate neutrality by 2050. Transparency is also the best way for the military to build trust with civil society. Even large businesses are today releasing their own carbon footprints. Defense agencies release more strategic information to the public than GHGs, such as their number of soldiers, their equipment and their Defense budget. Further, carbon emissions information is generally not detailed enough to reveal classified information. It corresponds to data aggregated by end-use sector and type of operation, published with one to two years of delay. Covert operations are too small a percentage of the overall GHG emissions of a defense agency to be noticed in the totals. If the operations are larger, other means of surveillance will be used by foreign intelligence to spot them. The fact that a country like the United States, among several others, released the carbon footprint of its defense agency is an incentive for other countries to follow suit. Carbon accounting often costs time and energy to conduct, but it can bring benefits for Western countries to be leaders in a global common cause for peace.

U.S. Department of Defense's share of U.S. government federal agencies' greenhouse gas emissions in 2020

Unit: % share of total volume of GHG

Evolution of total GHG emissions reported by the U.S. Department of Defense (*)

Unit: million tons of CO_2 equivalent

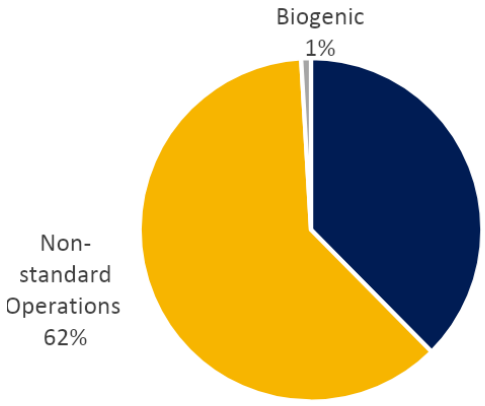


(*) Scope (1) and (2): Emissions directly emitted by the department's buildings and equipment (1) and emissions indirectly emitted by the department via its purchases of energy produced by third parties (2)

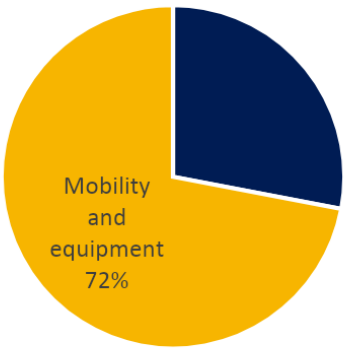
Structure of U.S. Department of Defense reported GHG emissions in 2020

Unit: share in % of U.S. Department of Defense volume emissions

by type of operation



by end-use sector



Editing: IRIS / Source: U.S. Department of Energy

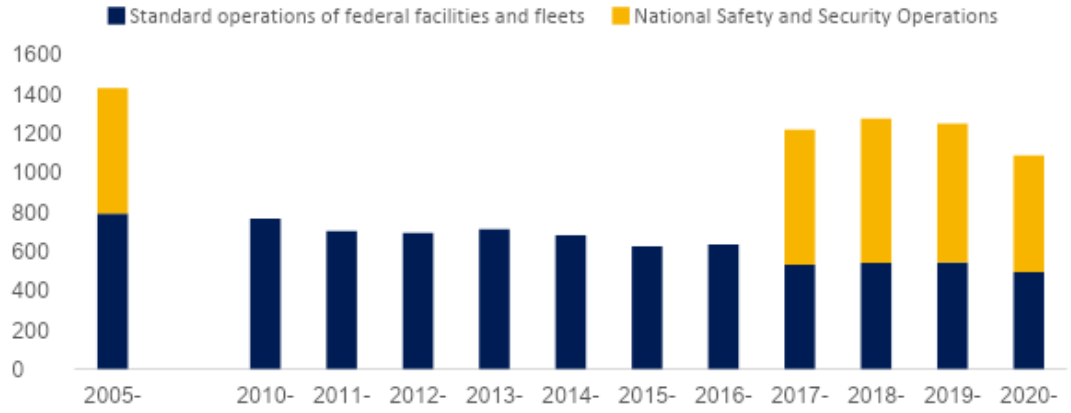
Share of security agencies in total Canadian federal agencies emissions in 2020-21

Unit: share in % of total emissions, including emissions from the national security vehicle fleet

(*) NSS: a fleet of national security vehicles, which includes aircraft, ships and land vehicles for non-civilian use.

Evolution of Canada's National Defense Department GHG Emissions (*)

Unit: thousand tons of CO_2 equivalent

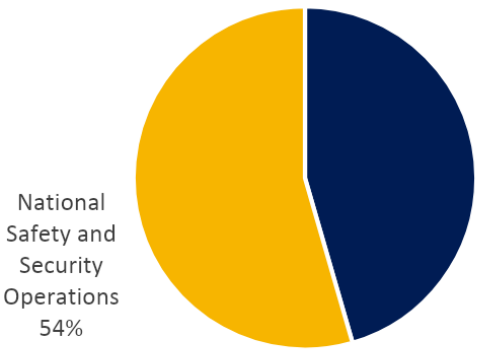


(*) Greenhouse gas emissions from National Safety and Security (NSS) fleet, facilities, civil vehicle fleet and vehicle fleet. Data do not include the Royal Canadian Mounted Police or the Canadian Coast Guard.

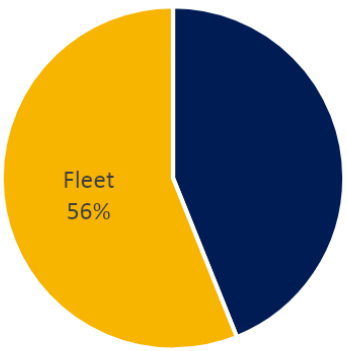
Canadian Department of National Defense reported GHG emissions in 2020-21

Unit: share in % of volume emissions

by type of operation



by end-use sector



Editing: IRIS/ Source : Government of Canada

TECHNOLOGICAL INNOVATION: WHERE THE HARD PART BEGINS

Pierre Laboué

Today, fossil fuels are at the core of all military activities. Military jets, tanks and vessels all use petroleum products, and military buildings and facilities are usually heated with coal or gas. Although green alternatives are developing fast, military requirements and technologies differ from those in the civilian sector. Militaries often operate in difficult environments, and military equipment has to withstand extreme weather, rough terrains and combat situations.

So far, worries about the potential loss of operational effectiveness have outweighed the willingness of militaries to invest heavily in decarbonization. Their arguments against investments in sustainability resemble those historical positions of hard-to-abate heavy industries such as cement, steel, plastics and aviation. In these sectors, decarbonization requires large investments that would make companies less profitable in the short term, risking their competitiveness.[16] However, governments, including through climate-related legislation, are reducing the exemptions made for this reason.

This section aims to identify and assess the needs of militaries with regards to the energy transition and climate neutrality, highlighting key challenges, technology needs, gaps and bottlenecks with their respective operational benefits. There is potential to use green technology to modernize and strengthen Western militaries, but this requires a serious research and design (R&D) effort and higher ambition levels.

DIFFERENTIATING MILITARY NEEDS BY TYPE OF OPERATIONS AND CATEGORIES

Different sectors of the military have different needs when it comes to decarbonization. Military GHG emissions can be differentiated by end-use sectors (building & facilities versus mobility & equipment) and by type of operations (standard operations common to all civilian agencies and non-standard operations specific to the militaries). According to Table 1, the bulk of the U.S. military emissions have been due to mobility and equipment (such as aircraft, vessels, tanks) used in non-standard operations (including military operations, law enforcement and other operations). Decarbonizing military mobility is thus the key to mitigate Defense's carbon footprint. However, transportation is among the hardest to abate sectors. Moreover, military aviation, navy and land-vehicles must not suffer a reduction of their combat capability. Finally, military needs for non-standard operations are extremely specific and subject to rapid changes in situational requirements. Military vehicles have to operate in isolated areas, in tough environments (extreme temperature, explosions, ballistic impact, shocks), and with a strong focus on energy security to guarantee the operational independence of units, especially those on the frontlines. Technologies developed in the civilian sector for standard operations are not specifically designed to meet such requirements. As such, the key challenges and technological needs of militaries need to be identified and assessed separately for both standard and non-standard operations.

Table 1: U.S. DoD GHG emissions by end-use sectors and type of operations

	Building & Facility & others	Mobility & Equipment	TOTAL
Non-Standard operations (military operations, law enforcement, and other operations)	Example: Camps in foreign countries **<1 Mt (1%)**	Example: Aircraft, vessels, tanks, etc. **34 Mt (60%)**	**34 Mt (61%)**
Standard operations (civil and administrative operations)	Example: Office, bases in national country **20 Mt (37%)**	Example: Cars, Heavy trucks **>1 Mt (2%)**	**21 Mt (39%)**
TOTAL	**20 Mt (38%)**	**35 Mt (62%)**	**55 Mt (100%)**

Note: Data provided in this section is mainly focused on the United States for two main reasons. The U.S. has by far NATO's largest and most active military force and, consequently, is the largest GHG emitter among Western countries. If reducing GHG emission of the U.S. Department of Defense is feasible, it will be possible for other countries, with fewer military operations to deal with, to do so too. Moreover, the data provided by the United States is among the most detailed found so far. Finally, conclusions drawn for the U.S. are still valid for other Western Defense agencies, including the Canadian, British, Dutch, and Danish militaries, for which military mobility also represents the bulk of their GHG emissions.

SOLUTIONS AT HAND FOR STANDARD OPERATIONS

A significant share of standard emissions from military installations are caused by on-site fuel consumption in the defense estate (scope 1). For example, in the United States, this category represented approximately 10 percent of the total Department of Defense emissions at federal facilities in 2020. Military facilities located in isolated areas often have their own energy systems powered by fossil fuels to generate heat and/or electricity. Moreover, some old buildings and facilities connected to the grid still use fossil fuel equipment for space heating, water heating and cooking. The good news is that **solutions are available to decarbonize buildings** and *"that transformation relies primarily on technologies already available on the market"* according to the International Energy Agency.[17] The implementation of energy efficiency measures (e.g. improved insulation, better equipment energy efficiency, behavior changes, smart control solutions), electrification (e.g. replacing oil, coal and gas boilers by other solutions such as high efficiency electric heat pumps) and local renewable power generations (e.g. solar and wind energy, supported by battery storage and smart grid system) could greatly reduce emissions.[18]

Yet, most of the standard emissions from buildings are due to electricity purchased from external providers (also known as scope 2 emissions) (see Box 2). This accounted for around 13 metric tons of carbon dioxide equivalent (Mt CO2e) of the U.S. DoD emissions in 2020 (24 percent of total reported emissions). **The good news is that simply purchasing decarbonized electricity from the grid would already directly reduce military emissions.** The unwelcome news is that if local electricity providers do not decarbonize their energy supply, defense agencies are stuck with high scope 2 GHG emissions. However, these agencies can also incentivize their providers and use public tenders to purchase green electricity. The U.S. Department of Defense has a legal obligation to green its purchases, imposed by the U.S. Code (42 U.S.C§ 15852(a)), which requires since 2013 all U.S. federal agency buildings to consume a minimum of 7,5% renewable electricity. The latest U.S. presidential executive order, "Catalyzing America's Clean Energy Economy Through Federal Sustainability," directs all federal agencies to purchase "100 percent carbon pollution-free electricity (CFE) by 2030, at least half of which will be locally supplied clean energy to meet 24/7 demand".[19]

Standard emissions from mobility represent a minor share of total defense emissions (just 2 percent of GHG emissions from the U.S. DoD in 2020). A**lternatives to fossil fuels are developing for short and medium-range road transportation solutions.** For light-duty vehicles, the main solution is coming from the rapid technological transition towards electric mobility, with electric battery vehicles. For heavy trucks, biofuels can offer an alternative to diesel fuels in the short term, and emerging battery and fuel cell electric equipment could provide new alternatives in the medium term.

Overall, decarbonizing the defense standard operations could be technically feasible. Accelerated R&D efforts are swiftly needed to improve the energy efficiency of buildings and local renewable energy consumption on military bases. Such efforts could be expensive, but they could significantly reduce carbon emissions from the defense sector without constraining the operational capability of militaries.

THE TRICKY PATH FOR NON-STANDARD OPERATIONS

Non-standard emissions accounted for 60 percent of the U.S. DoD total GHG emissions in 2019. They are mostly generated by aircraft, followed by vessels and to a lesser extent land-based vehicles.

Decarbonizing transportation, whilst an arguably inevitable step, requires the greatest effort. One of the main reasons is that liquid hydrocarbon fuels, such as diesel and gasoline, still present the best energy density. Energy density consists of the energy available within a given unit of volume (volumetric energy density) and weight (gravimetric energy density) of fuel. The greater the gravimetric energy density of its fuel is, the greater the number of kilometers an aircraft, a ship or a tank can travel. The greater the fuel volumetric density, the less storage is required per unit, providing more space for soldiers and equipment. Those qualities make fossil fuels currently critical in military operations and war. They enable large armies to travel long distances. They facilitate logistic supply chains and improve the autonomy of the Armed Forces in isolated and hostile areas. According to the U.S. Energy Information Administration, *"few transportation fuels surpass the energy densities of gasoline and diesel".*[20] However, Research and Development programs and pilot projects are ongoing to test innovation breakthroughs, based on battery and hydrogen technologies, so in the future more alternatives may become available.

The energy alternatives closest to being readily available are based on alternative fuels, such as biofuels and synthetic fuels, which can be deployed for aviation (also known as sustainable aviation fuel or SAF), maritime and land-based mobility. Alternative fuels can be blended with fossil fuels as drop-in fuel. This easy-to-use solution does not require propulsion systems to be adapted, limiting the investment costs. Further, alternative fuels can be stored and transported as are fossil fuels. The U.S. Department of Defense dedicated a full presentation of its "Alternative Fuels Initiative" in its latest Operational Energy Annual Report (Fiscal Year 2020). The DoD is developing alternative fuels from hydrocarbon-producing algae and another from waste cellulosic biomass. It is supporting and financing two companies, Fulcrum Sierra Biofuels and Red Rock Biofuels, for the construction of plants to produce 10 million gallons per year of military specifications (MIL-SPEC) biofuels.

Still, alternative fuels might not be enough to decarbonize military non-standard mobility. First, alternative fuels can only be used as a substitute for a fraction of the fuel used (using 100% biofuel would require changing the engine). Secondly, production capacity is still relatively low. The European Union Renewable Energy Directive (EU) 2018/2001 (RED II) defined complex sustainability criteria based on how much biofuel can count as renewable energy.[21] The issue with biofuels is that they are still produced mainly from agricultural products (such as palm oil for biodiesel) and the extension of cropland surface can be detrimental to other lands (such as forests, which are important carbon sinks). As indirect land use change (ILUC) releases substantial amounts of carbon dioxide, biofuels can negatively contribute to the rise of GHG emissions.

Advanced biofuels and synthetic fuels have a lower carbon footprint, but their production costs are higher, limiting demand and thus investment, which will in turn limit the production. Moreover, militaries might not be the only ones trying to purchase the limited volume of biofuels available. Civilian aviation, shipping and road-transportation companies will also try to secure fuel supplies to run their businesses. In the end, militaries might not have sufficient alternative fuels to decarbonize their non-standard military transportation.

New solutions, with dual-use application, are being developed for military land-vehicles, though this category accounts for a small share of military emissions (especially compared to aircraft and naval vessels). Some military initiatives based on battery solutions are beginning development. Electric battery vehicles present a better thermal and sound signature than combustion vehicles, improving stealth in operations. Electric vehicles also have a greater energy efficiency. From an industrial point of view, investments from the civil sector in R&D programs are quickly improving the performance of lithium-ion battery technology. Next generation batteries are expected at the end of the 2030, such as the solid-state battery - a breakthrough technology that could be a game changer and boost the energy density of battery technologies. But military operations often take place in areas without electricity supply (such as in the Sahel region) or in places with a damaged electricity grid, preventing the capability to reload the batteries of a military fleet. For this reason, military R&D initiatives are oriented towards hybrid vehicles, to keep the possibility to use both options: petroleum fuels and electric traction. In France, the military company Arquus is expected to develop a hybrid armored vehicle, called the Gryffon, by 2025 for the French Armed Forces.

The development of fuel-cell powered military vehicles is still at an early stage, but there is a rising interest from militaries. Fuel-cell performance is more suitable than batteries for heavy-duty vehicles, given its shorter fuel injection time. The U.S. Army Combat Capabilities Development Command investigates the potential of hydrogen for several applications, including two concepts developed by American General Motors: the Colorado ZH2 (an off-road-capable vehicle) and the Silent Utility Rover Universal Superstructure (SURUS) (a flexible platform adapted for military uses). French military company Arquus is conducting R&D activities in partnership with the French Alternative Energies and Atomic Energy Commission (CEA) on fuel cells.

Swedish SAAB JAS 39 Gripen fighter aircraft in pre contact refueling position with the Multirole Tanker Transport (MRTT) aircraft's hose and drogue unit. Credit: NATO

Wind turbines on snowy hill in Greece. Credit: Jason Blackeye on Unsplash

R&D programs on battery and fuel cell vehicles for the military could catalyze dual-use innovation for the civilian sector. Several initiatives from industrial groups are developing. President and CEO of Korean Kia (Hyundai) announced in September 2021 that it will first develop hydrogen technology for the military, starting with command vehicles, heavy trucks and weapon-equipped vehicles, before launching vehicles for the civilian market.

Finally, military bases in operational environments present specific needs which are not addressed by the civilian sector. Such bases are often in harsh environments and off the grid, where the usual renewable technologies do not work. Wind turbines freeze in the Arctic. Intense winds blowing sharp grains of sand damage photovoltaic panels in the Sahel region. But R&D investment can unlock new opportunities. The Canadian Department of National Defense is conducting a research project to develop energy systems for northern and remote infrastructures, including advanced microgrids aimed at helping achieve zero emissions in the Arctic, and cold climate air-source heat pumps.[22] The French Armed Forces are promoting the concept of an EcoCamp to help move towards the autonomy of camps deployed in military operations. The civil sector could benefit greatly from dual-use innovation developed by the militaries for installations facing non-standard operational constraints, such as communities located in isolated areas (e.g. Alaska) or industries operating in difficult environments (such as mining companies).

There is still a lot of potential for energy efficiency improvements in military equipment, but this requires massive investment in R&D programs to reduce the energy consumption of aircraft, maritime vessels and land-based vehicles (e.g. optimized design, low-weight material). Apart from a handful of countries, the overall ambition within militaries for decarbonization is currently low, but in light of current high energy costs, this might change. The goal of reaching net zero by 2050 could spur strategic innovation and modernization and thereby prove a strategic advantage in combat.

TOWARDS A GREENER ALLIANCE: NATO'S ENERGY EFFICIENCY AND MITIGATION EFFORTS

Katarina Kertysova[2]

The war in Ukraine has re-invigorated NATO and underlined its importance as the cornerstone of Euro-Atlantic security and defense. In response to Russia's actions, NATO has reinforced its eastern flank with a major new deployment of four battlegroups, it has activated its defense plans, and a majority of NATO members have committed to investing more in defense. The alliance's collective defense will likely assume an even more important place in the new Strategic Concept, which is up for formal adoption at NATO's Madrid Summit in June 2022. While Russia's activities pose a real threat to NATO's member states, the Alliance should not lose sight of security risks emanating from transnational, actorless threats like climate change, which continue to shape our security environment. The war in Ukraine highlights the intersection of conflict, environmental degradation and societal instability, as well as the need to reduce NATO's reliance on fossil fuels, all of which make Allied armed forces more vulnerable.

This chapter will look at NATO's efforts to reduce reliance on fossil fuels and enhance the efficiency of Allied military forces to date. With the Madrid Summit on the horizon, where the first Climate Change and Security Progress Report will be delivered, this section will also discuss what more NATO can do to contribute to global mitigation efforts and ways in which the organization can further support Allied militaries in their emissions reduction efforts.

2 The author is grateful to Sir Graham Stacey and Sir Adam Thomson for their review and comments on the earlier draft of this chapter.

NATO'S CLIMATE SECURITY AGENDA

NATO, for the first time, acknowledged the link between climate change and security in its 2010 Strategic Concept. The focus of Allied efforts has been, first and foremost, on adaptation to the negative effects of climate change on military installations, operations, equipment and force readiness. In the area of mitigation, the need to reduce reliance on fossil fuels and improve the energy efficiency of Allied military forces has been driven primarily by vulnerabilities associated with the provision of energy to front line operations – the frequent targeting of NATO fuel supplies, the high cost of transporting fuel to the battlefield, and the risk to troops involved in fuel logistics – rather than explicit climate change considerations.

Over the past two years, references to mitigation and the need to embrace a net zero transition have found their way into NATO's public statements. At NATO's Brussels Summit in June 2021, the NATO 2030 agenda and the Climate Change and Security Action Plan were adopted. In an important shift from earlier climate discussions within NATO, members of the Alliance pledged to "significantly reduce greenhouse gas emissions from military activities and installations," tasking the Secretary General with the formulation of "a realistic, ambitious and concrete target for the reduction of greenhouse gas emissions by NATO political and military structures and facilities and assess the feasibility of reaching net zero emissions by 2050."[23]

In line with this commitment, the Climate Change and Security Action Plan outlines mitigation as one of the four lines of NATO's climate change efforts – in addition to enhancing awareness, adaptation and outreach efforts.[24] As part of announced mitigation measures, NATO has started to develop a mapping methodology to help Allies measure their military emissions, which could contribute to determining voluntary cuts.

NATO's decarbonization efforts were most recently reaffirmed at the UN Climate Change Conference (COP26) in Glasgow. In an interview following his public remarks, NATO's Secretary General Jens Stoltenberg acknowledged that "there [was] no way to reach net zero without also including emissions from the military." Recognizing that the Alliance works by consensus, which continues to evolve, Stoltenberg added: "this is the aim but of course I am dependent on agreement among 30 Allies."[25]

CURRENT MITIGATION EFFORTS PRIMARILY FOCUSED AT ENHANCING ENERGY EFFICIENCY

Both the consumption and the movement of fuel supplies have always been a critical yet challenging and dangerous part of any military operation. Large convoys of fuel transporters, which are required to provide energy on the battlefield, have often come under attack. It is estimated that between 2003 and 2007, 3000 US soldiers were killed or wounded in attacks on fuel and water resupplies in Afghanistan and Iraq – about one casualty for every 24 fuel convoys.[26] Large quantities of ammunition and equipment are moved around too, which necessitates additional fuel.

Recognizing the vulnerability surrounding fuel supplies for deployed forces, in 2011 NATO's Emerging Security Challenges Division started working on enhancing energy efficiency in NATO under the banner of "smart energy".[3] At the Chicago Summit in May 2012, Allies unanimously agreed on the subject of smart energy, stating their determination to "work towards significantly improving the energy efficiency of [their] military forces." This commitment was reiterated in the Wales Summit Declaration in September 2014.

Ever since, NATO has been supporting projects that aim to reduce fossil fuel dependence in military camps, enhance renewable energy usage, and incorporate innovative technologies and approaches within military capability. Following the Chicago Summit Declaration, a **Smart Energy Team (SENT)** was established in 2013 with a two-year mandate to identify and spotlight best practices and opportunities for collaborative multinational smart energy projects. SENT was tasked with six concrete deliverables,[4] all of which were achieved. SENT's Comprehensive Report, published in 2015, concluded that a number of NATO and Partner nations had successfully implemented smart energy technologies and had established strategies, policies and standards for smart energy use in the military. In spite of a desire and willingness for collaboration and knowledge sharing, the Report acknowledged that there was however a lack of cooperation between defense, academia and industry within as well as among NATO nations, with most national initiatives having been carried out in isolation. The report further identified that there was a lack of energy efficiency requirements in military procurement, and that policies, procedures, standards and the overall knowledge and awareness on smart energy across the Alliance were insufficient.[27]

In addition to SENT, NATO's Science for Peace and Security (SPS) Programme also supported Serbian-led research into biofuel production from algae in 2017-2020,[28] as well as the "Camp Energy Efficiency" project, launched in 2018 in Canada, which sought to develop interoperable monitoring kits for energy data collection with the aim to identify and address wasteful energy consumption in deployed military camps.[29]

Since 2013, NATO has been holding **Capable Logistician exercises** with the aim of testing and demonstrating various energy-saving technologies, as well as their interoperability, in the field. "Smart energy" camps, showcased during the exercises, included solar panels and energy saving LED lights, hybrid energy system grids, insulation for tents, intelligent power storage and management capabilities, and water purification systems.[30]

3 Smart Energy Team (SENT) defined smart energy as "the methods of providing energy to the user in a practical, effective, sustainable and environmentally responsible manner." See: The Smart Energy Team (SENT) Comprehensive Report, 6 May 2015.

4 1) project proposals, 2) a comprehensive report, 3) field trip assessments, 4) contributing a component to Exercise CAPABLE LOGISTICIAN 2013, 5) raising public awareness and 6) establishing an information sharing internet platform. See The Smart Energy Team (SENT) Comprehensive Report, 6 May 2015.

THREE PILLARS OF NATO'S GREEN DEFENCE FRAMEWORK

Reinforcing efforts of NATO bodies	Facilitating Allies' efforts	External engagement: Improving NATO's "green" profile
• Identifying a focal point within existing structures to improve overall coordination and streamlining of activities • Development of "green" accounting and benchmarks to measure progress • Comprehensive database on energy consumption of NATO operations • Factoring green defense into NATO training, education and exercises	• Creating a platform for sharing of lessons learned, best practices and nationally-developed "green" technologies • Incorporating questions about national Green Defence activities in the Defence Planning Capability Survey (DPCS) • Exploring projects on "green" capabilities and equipment • Promoting environmental protection and developing STANAGs in this area	• Improving cooperation with partner nations and the private sector • Better communication with the general public • Leveraging various public diplomacy tools (incl. through relevant NATO COEs) • Coordinating with other international organisations to avoid unnecessary duplication, including through mutual briefings • Using NATO activities as test beds for new technologies

The **Green Defence Framework,** adopted in February 2014, was an important step forward as it provided NATO staff and national experts with a broad basis for cooperation on green solutions for defense.[31] The Framework made a number of innovative suggestions to reduce the energy consumption of Allied armed forces, as well as a proposal to apply "green standards" across NATO's political and military structures and facilities (See Table below). The momentum for mainstreaming green solutions was interrupted by Russia's illegal annexation of Crimea in March 2014, which took place only weeks after the Framework was adopted. NATO's renewed emphasis on collective defense is believed to have impeded a more systematic pursuit of the various innovative initiatives proposed in the Framework.[32]

Energy efficiency has also been reflected in NATO policies, namely the Policy on Power Generation for Deployed Forces Infrastructure and NATO Military Principles and Policies for Environmental Protection, which currently constitute two umbrella documents for further development of NATO standardization in the area of smart energy.[33]

Finally, the NATO Energy Security Center of Excellence, located in Lithuania, has devoted a large share of its activities to enhancing the energy efficiency of Allied armed forces.[34] Since its establishment in 2012, the Center has generated knowledge, expert advice and solutions for development of energy efficient forces, as well as training courses that either concentrate on or at least feature "smart energy" modules.[35] The planned NATO accredited Center of Excellence on Climate and Security, which Canada has offered to host, is also expected to support NATO's mitigation efforts. While the Center's design is yet to be completed, once established, the Center could serve as a hub for the exchange of best practices and lessons learned, help address the above-mentioned lack of knowledge and awareness of the operational benefits of green solutions through courses for all levels of the NATO command structure, and make NATO's "green" profile more visible through public communications campaigns and public events.[36]

Even though NATO's primary objective has been to reduce reliance on fossil fuels when in the field, and to make Allied militaries more energy efficient, the above-mentioned activities also help reduce CO2 emissions from military operations and, as such, contribute to global mitigation efforts.

LOOKING AHEAD: WHAT MORE CAN BE DONE WITHIN NATO'S MANDATE?

It is important to bear in mind that NATO does not have the power to legislate and cannot impose binding emissions reduction targets on Allied militaries, which is a national competency. In the words of Dr. Michael Ruehle, Head of Climate and Energy Security Section at NATO, "NATO is not a first responder to climate change. This role is played by other international bodies, in particular those who can set limits on CO2 emissions."[37] NATO instead seeks to become "the leading international organization when it comes to understanding and adapting to the impact of climate change on security," as the NATO 2030 agenda confirmed in 2021.[38] Even though the Alliance does not seek to position itself as a "first responder to climate change," it nevertheless has a range of tools in its toolbox that can support Allied emissions reduction efforts, both directly and indirectly.

At NATO's Brussels Summit in June 2021, NATO set out to develop a **methodology** to help Allies measure their emissions from military activities and installations. This methodology will draw on the best practices of Allies and expertise residing in partner nations and other international organizations, including the EU. To this end, NATO is currently compiling a **best practices compendium** in order to better understand how different Allies approach emissions mapping and which models could be replicated across the Alliance.[39] Once military emissions are known, NATO could set voluntary targets for their reduction. The Secretary General has already been invited to formulate a realistic target and assess how feasible it would be for Allied militaries to reach net zero emissions by 2050. For voluntary targets to work, they will need to be accompanied by a robust and agreed reporting mechanism.

NATO Secretary General Jens Stoltenberg; Alexander De Croo (Prime Minister, Belgium); NATO Deputy Secretary General Mircea Geoană at NATO's Brussels Summit, June 2021. Credit: NATO

Next, NATO could **shift away from single fuel policy (SFP)** towards more sustainable alternatives, like biofuels or synthetic fuels.[40] Under SFP, which is designed to simplify the logistic effort and enhance equipment interoperability, NATO forces aspire to use only one fuel on the battlefield – F-34 to be precise. In an effort to reduce the negative environmental impacts of their military activities, Allied militaries are already increasing the use of sustainable aviation fuel. The US began the process over a decade ago with the "Green Hornet" biofuel-powered flight, and the UK followed suit in 2020 when it changed its aviation fuel standards to allow substitution by sustainable fuels up to 50 percent in all military aircraft.[41] The Dutch Ministry of Defense aims to ensure that by 2030 all military aircraft will fly on a 20 percent addition of biofuels, and a 70 percent biofuel blend by 2050.[42] In addition to alternative fuels, NATO could also lead the way in research and development of **alternative propulsion systems** for military applications.

Through the NATO Defense Planning Process (NDPP), which identifies the capabilities required by the Alliance and ensures coherence in their development, NATO could develop **green minimum capability requirements** for each Ally to meet.[43] This could serve as an incentive for Allied nations to reduce their military emissions and shift to sustainable technologies. While capability requirements set out in the NDPP do not constitute a legally binding commitment, they do drive national defense planning. In addition, NATO has a successful track record as a standard-setter. NATO can **update existing policies and standardization agreements** (STANAGs), as well as introduce new ones. According to Dr. Susanne Michaelis, former Science Officer at NATO's Emerging Security Challenges Division, new standards in the area of smart microgrids would constitute a quick win for reducing the fuel consumption of field camps.[44] Even though the Alliance cannot mandate interoperability of national forces, units and/or systems, STANAGs are binding on Allies that ratify and implement them. In general, NATO standards get a lot of support in the logistics community and are recognized and generally adhered to in manufacturing practices, too. This is due to the fact that STANAG's offer a bigger market (30 nations), and are a sign of quality for export.[45]

At this moment, NATO has limited collective financial means in the civilian budget to do more on climate change. Given that NATO member states' commitment to spend at least 2 percent of GDP on defense is up for review in 2024, the NATO 2030 Young Leaders Group proposed to **reimagine what counts as a defense contribution** moving forward. According to the Group, the reformed 2 percent target after 2024 should also account for investments in areas such as climate security, economic resilience or anti-hybrid warfare, helping Allies achieve resilience across the board.[46] The Defense Investment Pledge endorsed in 2014 also calls for Allies to spend 20 percent of total defense expenditures on major new equipment and R&D.[47] Some of this could be directed towards the d**evelopment of sustainable technologies** (both military and dual use). In addition, former NATO Deputy Assistant Secretary General for Emerging Security Challenges Dr. Jamie Shea suggested setting up a **NATO Green Fund** that could help finance trials and demonstrations and assist less advanced Allies in greening their militaries.[48]

The use of more sustainable technologies forms an important part of the mitigation solution. Deliveries by drones or 3D printing of weapons systems, components and ammunition at the point of use offer significant savings in terms of the logistics burden and fuel use on the battlefield. Because the private sector drives much of green innovation today, NATO Allies need to work alongside civilian agencies, private-sector companies, and research institutions. Cooperation with civil society and the private sector is also important for NATO's own awareness about the latest technological developments and their societal impact.

NATO's new headquarters in Brussels, Belgium. Credit: NATO

NATO can scale up innovative low carbon technologies through its own procurement practices and buying power. While individual Allies have the power and influence over the procurement of military equipment, NATO as an organization can lead with regard to **common funded infrastructure** (i.e., fixed installations which are necessary for the deployment and operations of the armed forces)[5] and the equipment and technologies that support NATO's Command and Control (C2). For example, sustainability and energy efficiency were integrated within the design of the new NATO Headquarters.[49]

Financing and coordination with innovators from across the Alliance could be achieved through **NATO's Defense Innovation Accelerator for the North Atlantic (DIANA)** and the **NATO Innovation Fund**, both of which are set to be launched by 2023. The Innovation Fund will invest an initial 1 billion EUR (U.S. $1.1 billion)[6] to help early stage start-ups grow and to support NATO's technology needs. DIANA, which comes with more than 10 accelerator sites and 50 test centers in Europe and North America, will help military personnel work more closely with the Alliance's technology companies, start-ups, and scientists to develop technological solutions to existing and future security threats.[50] While the initial focus of these two NATO initiatives will be on seven emerging and disruptive technologies,[7] the innovation sites and funding could conceivably be extended to support research and development of sustainable technologies in the future, as the program develops.

5 NATO's assets include airfields, signals and telecommunications installations, military headquarters, fuel pipelines and storage, radar warning and navigational aid installations, port installations, missile installations, forward storage sites and support facilities for reinforcement forces. Such installations are financed collectively and may be used by each Ally. Source: "Aspects of NATO - Infrastructure and Logistics," NATO, 1 January 1982, https://archives.nato.int/uploads/r/null/1/3/137761/0196_Aspects_of_NATO-Infrastructure_and_Logistics_ENG.pdf.

6 These are public funds that participating nations can allocate, either from their existing defense budgets or established innovation funds.

7 Artificial intelligence, big-data processing, quantum-enabled technologies, autonomy, biotechnology, hypersonics, and space.

THE NEED FOR INCREASED AMBITION AND ACTION

Allied militaries generate considerable emissions in peacetime and even more emissions when they are at war. NATO needs to move beyond merely acknowledging the security implications of climate change and adapting its forces to extreme circumstances. It should also step up its efforts to incentivize Allies to reduce their military emissions and shift to sustainable technologies.

While NATO – notably under Jens Stoltenberg's leadership – has formally embraced the need for Allied militaries to reduce their emissions, target setting falls under the competence of individual member states. NATO cannot set binding targets, nor can it enforce investments in green technologies. Individual Allies have the power and influence over the procurement of military equipment. NATO can nevertheless lead by example and incentivize military decarbonization through different standardization agreements, by setting net zero and sustainable targets for defense planning, or by shifting away from its single fuel policy towards more sustainable alternatives. With its long and successful track record as a standard setter, NATO taking climate change seriously can have a normative influence on NATO's Allies as well as partners world-wide.

According to the Secretary General's Annual Report, 2021 was the seventh consecutive year of rising defense spending across NATO.[51] The outbreak of the war in Ukraine has prompted Allies to invest even more in defense. As Allies increase their defense budgets, and before contracts with defense manufacturers have been signed, they need to think carefully about what capabilities are needed and ensure that fuel and energy efficiency standards are factored into the development of new and more technologically advanced systems and platforms.

Finally, military conflict itself is a significant driver of climate change and environmental damage. Effective deterrence, which is a core element of NATO's overall strategy, plays a vital role in preserving peace and preventing future conflicts and – by extension – future emissions. In addition to boosting its deterrence, NATO needs to improve its early warning and strategic foresight capabilities to better understand the root causes of war and, where possible, address them.[52]

EU MILITARY DECARBONIZATION: A MIRAGE OR A MEANINGFUL GOAL?

Akash Ramnath, Louise van Schaik & Douwe van der Meer

Within the EU, decarbonization of the military is still in its infancy. However, there is potential to link the EU's defense industry to the European Green Deal and tie it to the twin agendas of the green energy transition and digitalization. Moreover, the war in Ukraine has spurred enthusiasm for a quick energy transition across the EU to reduce fossil import dependencies on Russia. At the same time, military expenditures are on the rise and many EU countries are buyers rather than producers of defense equipment. Procurement-wise, boosting military capabilities tops the agenda while concerns about high fossil energy usage within weapon systems in that agenda take a back seat.

Important in this context is an understanding that defense policy is still largely a national rather than an EU competence, in contrast to economic and environmental policy for example, where supranational EU policies and structures subsume national ones. Security and defense are often exempted from EU policies such as promotion of competitive markets and public procurement, even though on these topics more defense cooperation takes place. In previous analyses, we found that EU member states who are considered very progressive regarding climate policy in general, such as Germany and Sweden, hardly have any emission reduction policies in place for their militaries. Only France was found to be a frontrunner in this field with other countries, such as the Netherlands, picking up.[53] This chapter will discuss where the EU stands today and what could be envisaged to strengthen capabilities and frameworks to mainstream emissions reductions and green technologies in militaries.

THE EUROPEAN GREEN DEAL, BUT LARGELY WITHOUT DEFENSE

The EU is serious about emissions reduction policies, at least for its civilian sectors. The European Green Deal comprehensively covers multiple sectors and nexuses of the energy transition and the wider greenification of the European economy. For instance, in trade relations, the Carbon Border Adjustment Mechanism (CBAM) proposal sets out to place a levy on carbon-intensive imports, such as steel and fertilizers and its Taxonomy Regulation sets standards for green investments.[54] Specific measures such as the emissions trading scheme for energy and energy-intensive industries since 2005 ensures real reductions through an emissions ceiling that is gradually reducing, leading to higher CO2 prices across most industrial verticals.

Efforts have recently accelerated with the "Fit for 55" package, which operationalizes the ambition of reducing the bloc's GHG emissions by 55 percent by 2030.[55] This includes targets and specific standards and measures such as the requirement for all new cars made and sold bloc-wide, by 2035, to be net-zero. Additionally, a longer-term EU target of climate neutrality by 2050 is enshrined in the European Climate Law.[56]

To help realize this, a new emissions trading scheme (EU ETS) is also in the works, aimed at covering fossil fuel usage within buildings and transport, which would have knock-on effects for defense assets and planning. Maritime shipping and European naval logistics and auxiliary fleets might be included in the current ETS for energy and energy-intensive industries, taking effect from 2023.[57]

For the aviation sector, the ReFuelEU Aviation initiative announced in 2020 will aim to boost supply and demand for biofuels in the civilian aviation sector, as well as centralizing auctioning mechanisms and introducing fuel blending mandates. Military aircraft are currently exempted, however, due to the 'exceptional nature' of their purpose – a reminder that operational security as a justification against decarbonization still pervades decision-making.[58]

The EU also has multiple financial tools to help fund the civilian transition, such as the Green Deal's InvestEU plan[59] (€1 trillion in financing) and the Neighborhood, Development and International Cooperation Instrument (NDICI-Global Europe); 30 percent of this and all other EU spending must be on green or climate-friendly programming.[60] The COVID-19 economic recovery fund, 'NextGeneration', even requires 37 percent of spending to be on green or climate neutral investments.[61] These developments are likely to have spill-over impacts for the defense sector, as the industry has dual civilian and military end markets and applications.

A GROWING SET OF CLIMATE MITIGATION POLICIES FOR DEFENSE SECTORS

The EU has also attempted to make some progress in directly incentivizing and pushing for military decarbonization. In 2020, the EU published its Climate and Defense Roadmap, which sets out a strategic path to climate-proofing the defense sector. Whilst initiatives have existed previously, the roadmap is a clear attempt to knit them all together and set out a tangible timeline for how decarbonization might look. Examples such as empowering the European External Action Service (EEAS) to start collecting data and best practices on 'energy usage and efficiency' of Common Security & Defense Policy (CSDP) missions demonstrate a clear desire to better understand the state of play regarding emissions (overseas missions have long been missing from military emissions reporting).[62] Other examples include kickstarting the development of Smart Energy Camps, utilizing the Trans-European Network for Transport (TEN-T) and Connecting Europe Facility (CEF) to integrate military applications into their mobility R&D.[63]

The roadmap also acts as a director of workflow for relevant EU bodies within the climate and defense sectors. The European Defense Agency (EDA), responsible for promoting integration between national member state militaries, is tasked with several developmental activities.[8] These include pilot projects on topics such as independent energy generation capacity and the durability of green technologies within active combat.[64] Recently, a project devised by the Consultation Forum for Sustainable Energy in the Defence and Security Sector - Phase III (CF SEDSS III) was awarded funding for a feasibility study by the French Armed Forces, focusing on smart and autonomous grid technologies to power military bases (ENSSURE – Energy Self-Sufficient Resilient military bases).[65] The EDA further launched the Incubation Forum for Circular Economy in European Defence (IF CEED) on 1 October 2021, aiming to stimulate collaborative innovation projects by different stakeholders in the European defense sector.[66]

Within the EDA, the EnE Captech (Energy and Environment Capability Technology Area) works to identify technological gaps and proposes collaborative projects in the fields of operational energy, energy efficiency and the climate change and environmental impact of military activities.[67] Along with this, the EDA has also been implementing independent developmental programs, focusing on water and waste energy management (Smart Blue Water Camps) and energy management methodologies (TEEMCAF).[68] [9] In 2016, the EDA initiated an energy data collection program called EDCAS, which aimed to establish a Standard Operating Procedure (SOP) for monitoring emissions and energy usage on an annual basis; this was expanded and consolidated as their competency in the roadmap.[69] Clearly, from an integration perspective, research and development is already ongoing, with the real challenge now being how to scale up and integrate new innovations into real-world military environments.

8 In particular, the Consultation Forum for Sustainable Energy in the Defense and Security Sector (CF SEDSS) and Incubation Forum on Circular Economy in European Defense (IF CEED) are the main ideation forums.

9 These initiatives are housed under the Energy and Environment Capacity Technology Areas (EnE CAPTech)

The roadmap also empowers the European Defense Fund (EDF), under the auspices of the European Commissions' DG DEFIS, to finance more research, especially into energy resilience and management for activities, both at home and abroad. The recent 2021 call for funding included specific areas for research including the development of deployable solar panels, hybrid electric generators and synthetic fuel refineries. This tranche of research is valued at €133 million out of a total yearly EDF budget of over €1 billion (total 2021-27 budget is €7.9 billion). In addition, there is another tranche of work, focusing on energy-efficient propulsion systems, especially for air combat systems; the EDF has allocated up to €109 million, with a keen desire to see 'green modular' vehicles such as fuel trucks and self-propelled artillery picked up by research organizations.[70] DG DEFIS has announced that the funding call for 2022 will include advanced deployable water systems, as well as a tender for the incorporation of green and energy efficient technologies within the development of a new battle tank.[71]

Another green shoot of progress through which emission reductions could be achieved is the Energy Operation Function, which is one of the integrated projects through the Permanent Established Structured Cooperation (PESCO). It is designed to allow any EU member state military to access the closest European energy source. This again builds on the roadmap which empowers PESCO to start investigating solutions for energy savings and the interoperability capabilities of individual militaries.

The roadmap also connects to the EU's Strategic Compass, designed to act as a guiding framework and shared assessment for the EU's security and defense policy, including threat assessments and concrete options for improving EU security and defense policy.[72] The Compass, adopted in March 2022, clearly states that 'by the end of 2023... Member States will develop national strategies to prepare the armed forces for climate change', which should be based on the proposals set out by roadmap.[73] Moreover, by 2025, all CSDP missions will have a dedicated environmental advisor and are expected to fully report on their 'environmental footprint'. Whilst there is a lack of detail on specific climate or emissions mitigation strategies, the saliency of the Compass as forming the nexus of the EU's strategic security and defense policy means that mainstreaming climate mitigation strategies more generally could act as a kick-starter for national militaries to take emissions reductions more seriously.

French Air Force personnel unfold photovoltaic solar panels connected to a green-to-grid portable trailer at the NATO Smart Energy Training and Assessment Camp, at the Drawsko Pomorskie training area in Poland. Credit: NATO

OBSTACLES AHEAD FOR EU DECARBONIZATION

Unfortunately, fully implementing the ambitious scope of the roadmap will still take a while before military energy practices will be affected positively. The data collection efforts on CSDP missions and Smart Energy Camp development will only start off in 2024, meaning they are unlikely to consider historical energy usage, potentially limiting the efficacy of the modeling. Moreover, many of the research initiatives set out by the EDA and EDF are still in the feasibility or ideation stages, delaying scalability and integration into practical applications. Additionally, the EDF, being the primary funding vehicle for R&D in the sector, only has approximately €8 billion, of which only €133 million has been spent on sustainable energy so far. This is hardly enough to support and coordinate a transition across 27 militaries.[74] The EDF was the fourth largest military R&D investor after some of the EU member states, but since many are now increasing their budgets, the relative share of the EU contribution may go down. There is no overview of whether the R&D investments of EU member states are promoting decarbonization, and the share of the EDF budget is currently still lower than the 30% for climate-related activities that applies to other EU budgets.

Another problem the EU runs into is a lack of codified emissions targets for militaries and limited capacity to generate or gain firm commitments from member states towards decarbonization. The old adage still holds that the defense sector is the prerogative of nation states and despite the coordination efforts of EDA, reporting standardization is almost non-existent on a practical level. Regarding EDCAS, despite promises by the EDA to set up a public database for military energy usage, nothing has of yet materialized and there are questions as to whether the data can be standardized or is even complete. Moreover, the SOP which the roadmap proposed is yet to see the light of day. The EU's Monitoring Mechanism Regulation (EU MMR), a part of the reporting mechanism for the UN Framework Convention on Climate Change, does not require military emissions to be included either.[75] Finally, there are also no standards that EU militaries must follow in terms of specific activities to report, with external operations and activities mostly absent from reporting.[76]

Another relatively new development in European defense cooperation is the European Peace Facility (EPF). Established on 22 March 2021, the EPF is a fund worth €5 billion in the period from 2021-2027, used for funding support for third countries.[77] While it was originally envisaged that the EPF would mainly be used to fund assistance for African countries, the bulk of the money spent so far (€2 billion since February 2022) has been used for joint purchases of weapons for Ukraine.[78] At the moment, no sustainability standards apply for such joint purchasing.

WHAT MORE COULD THE EU DO TO DECARBONIZE ITS MILITARY?

A first step could be to develop **a common framework for reporting emissions**. The EU has a detailed system in place for the monitoring and reporting of civilian emissions. If making defense energy and emission patterns public is considered strategically too sensitive, the EU could use classified processes, such as the Coordinated Annual Review on Defense (CARD), which currently is used by the EDA to monitor defense plans and inform better coordination of defense spending and technological collaboration.

The next step would be to focus on **target setting** for the emissions of defense activities and assets, at home and abroad. Currently, targets are patchy and not uniform within EU militaries; France plans to cut military emissions by 40 percent and the Netherlands aims to reduce defense fossil fuel consumption by 20 percent, but many others do not have any targets.[79] Whilst at this stage it might be difficult to agree upon common targets for defense activities, this might become part of a new EU climate package for 2040. To ensure greater buy-in and realistic targets, military officials and planners should be involved in the designing of the targets, as well as the reporting procedures and new policy developments.

Vital to reducing military emissions will be **substantial increases in R&D investments** that aim to reduce fuel consumption, increase fuel efficiency, enhance the uptake of renewable energy, and introduce new hardware that is less fossil fuel dependent. The EDF 2021-2027 budget could spend more on such R&D efforts, and at least sync with the 30 percent climate spending objective that applies to all other EU funding. The link with the Horizon Europe program of €95.5 billion (2021-2027) that funds non-military R&D could also be strengthened. Despite Horizon funding being strictly limited to civilian applications, many defense industry sectors involved operate in both defense and civilian sectors, enhancing chances of cross-fertilization.

Another key area to watch is how Germany's €100 billion one-off defense fund will be spent, with Germany now likely to become the EU's largest defense spender. Whilst it is expected that most of it will be spent on immediate upgrades and expansion of material capabilities, there is likely enough capital, if political will exists in Berlin, to invest in R&D projects focusing on clean energy propulsion systems or along similar lines. In the short run decarbonization may not help much to immediately boost military capabilities, but it will help to lower fuel consumption and fuel-related operational vulnerability.

Additional areas could be the development of **net-zero military bases,** with the introduction of super-capacitors or pumped hydro facilities on site to help better store energy from wind or solar generation.[80] The roadmap initiated calls for the development of Smart Energy Camps and DG DEFIS is already looking at this through the EDF. Being at the forefront of the development of new innovations in this sector helps toward military decarbonization. It also helps the EU in fulfilling key ambitions to become a global leader in future technologies and materials, as per the 2021 Strategic Foresight Report.[81] [10] However, ownership has been transferred back to the EDA amidst scalability issues. To tackle this, net-zero military base developments could be linked to PESCO and the Innovation Fund, which could leverage technological developments and expertise of non-EU members. The UK, for example, has already made good steps down this track, with the Royal Air Force base in to become the first fully operational net-zero base in Europe by 2025.[82] This could also be an area where the new German fund could be applied.

10 There are several pilot projects on this topic, including the Smart Energy Camps Technical Demonstrator (SECTD), which was rolled out during the EU Training Mission to Mali (EUTM) at Camp Koulikoro.

Guidelines for **PESCO** projects could also be an option, such as requirements for a certain number of projects to focus on climate-related issues. Moreover, whilst the **EPF** is designed to support immediate financing of lethal and non-lethal capacities in third countries, **green compliance** measures could also be implemented here. The facility includes monitoring (Integrated Methodological Framework) for civil society access and upholding of international law when supplies are used, so implementing regulations on emissions when European-supplied equipment is transferred to third countries would be able to use an established framework, as initially called for by the roadmap. Whilst the EPF's governance structure rests with the EU Council, which decides where the weapons go, procurement is in the hands of a dedicated EPF committee, which could be more stringent when it comes to **green procurement**, another key area where the roadmap calls for greater action.

An updated framework would therefore have green compliance measures for weapon procurements and the distribution and usage of weapons, including in the EPF. Whilst getting bloc-wide regulations for green procurement rules might be difficult, it may generate clarity for the defense industry and give them a competitive edge.

Other ways of operationalizing the movement towards military decarbonization includes **financing and support for EU militaries with smaller budgets and less spending leverage to buy or invest in greener technologies**.[83] This is especially prevalent now that EU member states are attempting to significantly increase defense capabilities amidst a present Russian threat; the rush to buy new equipment may cause a surge in demand for existing carbon-based technologies, worsening carbon lock-ins. This might have to be achieved through increasing EDA or EDF contributions or the creation of a separate instrument to manage it.

The fuels used to heat and power military buildings and transport at home may still be subjected to a small part of the EU's climate policy - namely the new emissions trading scheme that is proposed for these sectors. It is not clear yet if this proposal will eventually be adopted, but EU member states will have to reduce their emissions in these sectors more rapidly, with knock-on effects for the military.[84]

The next section will recap the themes and commonalities from the entire report and propose recommendations for NATO and EU policymakers about how to better accelerate and coordinate their work on military decarbonization.

A FULL DECARBONIZATION OF WESTERN MILITARIES?

Louise van Schaik, Katarina Kertysova, Akash Ramnath & Douwe van der Meer

Emissions reductions from military activities and installations are critical to tackling climate security risks and reaching net zero by 2050. Before military emissions can effectively be managed, they first need to be measured. While several NATO Allies – such as Canada, Luxemburg, Norway and the United States – already release such estimates, the metrics are not consistent which makes it difficult to examine and compare data across the EU and NATO. A methodology that is currently being developed by NATO will help Allies measure and report their emissions in a transparent, comparable and reliable manner, as well as to set voluntary targets for their reduction.

In the past, the greatest concern surrounded decarbonization potentially increasing operational vulnerability. Today, there is a growing recognition that lower fossil fuel use, coupled with sustainable technologies, can improve military readiness – rather than degrade it – all while providing strategic competitive advantage.

Innovation forms an important part of the mitigation solution. Many of the technological solutions that can help NATO and EU militaries lower their fuel use and logistical burden already exist, such as drones, 3D printing, sustainable fuels or hybrid electric vehicles. Improved energy efficiency of buildings constitutes another low-hanging fruit. Additional investment in R&D programs will be needed to reduce the energy consumption of heavy-weapons systems. Departments of defense can lead technological change by creating

enough demand signals to spur innovation and enable the private sector to bring low-carbon solutions to the market. High energy costs and the need to shift away from fossil fuels to cut Euro-Atlantic dependency on supplies from Russia might further accelerate green innovation. Increasing defense spending – supported by public opinion – presents an opportunity for R&D in favor of more modern, effective and more fossil fuel independent capabilities.

Since 2011, NATO has been striving to improve energy efficiency of Allied militaries in the form of various smart energy solutions. These efforts have been driven primarily by the long-standing vulnerabilities associated with fuel logistics rather than explicit climate change considerations. References to mitigation and the need to embrace net zero transition have only become apparent over the past two years. NATO's Brussels Summit in June 2021, where Allies pledged to work towards reducing their military emissions, marked an important shift in this regard. Nevertheless, NATO as an Alliance of 30 countries works by consensus and the level of ambition and willingness to prioritize military decarbonization varies across the Alliance – even more so following the outbreak of the war, and the renewed emphasis on collective defense.

The EU is increasingly interested in this topic too and has a considerable potential to incentivize military decarbonization through its R&D spending, established frameworks for shared defense coordination and changes in security doctrine and risk prioritization. The recently adopted Strategic Compass recognizes both climate change and energy dependencies as large vulnerabilities. The war in Ukraine makes the linkage between military fossil fuel usage and strategic dependency all the more clear.

To date, emissions reductions in the military have been largely exempted from European Green Deal policies. By trying to take bolder steps such as including defense installations in a new ETS or expanding green procurement and usage compliance measures during the transfer of arms within the European Peace Facility, the EU can accelerate the process without having to create or rapidly adapt its financing and competency structures. Given the EU's determination to accelerate the green energy transition and reduce its reliance on fossil fuel imports from Russia, it can only be a matter of time before security sector emissions are included and addressed directly.

In the remainder of this concluding chapter, we will assess the state of EU-NATO climate cooperation to date, different assets that each organization can contribute to international climate efforts, and specific areas where the EU-NATO cooperation could be deepened, all while avoiding duplication of effort.

Pipe near Melitopol', Zaporizhia Oblast, Ukraine. Credit: Rodion Kutsaev on Unsplash

IDEAS FOR EU-NATO COOPERATION AND DIVISION OF LABOR ON MILITARY DECARBONIZATION

The security of the EU and NATO are interconnected. With 21 members in common, more than 90 percent of EU citizens live in a NATO country, share the same neighborhood and face similar threats and challenges, including that of climate change. Two more EU member states, Finland and Sweden have recently applied for NATO membership.

As part of its outreach efforts – which constitute one of the four pillars of action defined in NATO's Climate Change and Security Action Plan – NATO's stated objective is to enhance its engagement with the EU on climate-related security issues. During an online event with the European Parliament in June 2021, NATO Deputy Secretary General Mircea Geoană confirmed that NATO's Brussels Summit had set "a new level of ambition" for NATO-EU cooperation, "including in areas such as resilience, new technologies, climate change, or strategic competition."[85] In its latest resolution on EU-NATO cooperation, the European Parliament called for enhanced EU-NATO cooperation on climate security, too.[86]

NATO and the EU have different instruments at their disposal and each brings a unique set of strengths to the table. The EU at first face is better suited to play a leading role, because it can legislate and impose binding emission reduction targets. However, defense and security are areas of national competence unlike most other policy areas of relevance for emission reductions, where the EU can agree upon legally binding policies that have direct effect or need to be implemented by EU member states. Nevertheless EU defense cooperation is making headways and is supplemented with substantial financing packages. Climate action in the civilian sector, such as pricing fossil fuel used in buildings and transport, as well as standard-setting, is relevant for the military assets at home.

NATO can also contribute to standard-setting, even if not in a legally binding way, and provide normative guidance. In addition to developing a mapping methodology to help Allies measure their military emissions, which is currently underway, NATO can incentivize military decarbonization through different standardization agreements, by setting net zero and sustainable targets for defense planning, or by shifting away from its single fuel policy towards more sustainable alternatives. With its long and successful track record as a standard setter, NATO taking climate change seriously can have a normative influence on alliance members as well as partners world-wide. The two organizations should combine their strengths and work in full synergy and coordination moving forward.

As NATO develops a common methodology for measuring CO2 emissions, it can learn from and leverage EU's expertise in this regard. The EDA already collects and analyzes national defense related energy data and, since 2014, the Agency has been supporting defense agencies and ministries in their CO2 emissions reduction efforts – by managing energy and environment considerations and defining technology and capability requirements.[87] EDA's participation in NATO's Capable Logistician exercises provides a good example of the already existing efforts to exchange expertise and discuss logistic procedures as well as technological developments in the evolving training landscape.[88]

With regard to capability development, the NATO Defense Planning Process (NDPP) and EDA's Capability Development Plan (CDP) could be better synchronized and made equally binding.[89] In developing green minimum capability requirements, NATO should closely coordinate with the EU/EDA.

In terms of funding, NATO has limited collective financial means in the civil budget to do more on climate change. The EU, however, has such funding mechanisms in place, through PESCO, EPF, EDA programs and the EDF. The EU funding for EU-NATO dual use projects (currently the mobility initiative) could also be extended to greening NATO (or at least EU) militaries.[90]

NATO and the EU should also align on stimulating green innovation and R&D. Given the limited funding that is available, it is imperative that the work of NATO's newly established Defense Innovation Accelerator (DIANA) and NATO Innovation Fund is complementary with existing EU efforts and that there are no duplicative programs. EDA, which serves as a hub for technology and innovation in defense, should facilitate closer EU-NATO cooperation in this regard, and ensure that instruments of both organizations are interlinked.[91]

Preventing future conflicts will also help limit additional carbon emissions. There is much scope for the deepening of EU-NATO cooperation in the area of conflict prevention, too. While both the EU and NATO already collect environmental data, there has been no systematic data sharing between the two organizations to date. Improved sharing of environmental data and cooperation on strategic foresight and environmental impact assessments would enable NATO and the EU to better track and understand environmental pressure points that can contribute to conflict and, where possible, address them. Under the Copernicus Program, the EU is able to monitor ocean warming, desertification and land degradation. NATO could benefit from the EU's satellite capabilities for its own situational awareness.[92]

NATO and the EU currently cooperate in more than 70 areas of work.[93] However, environmental and climate-change considerations are not included in the EU-NATO Joint Declarations, nor is climate change listed among the 74 concrete actions in which NATO and the EU hope to advance their collaboration. It is important that the security implications of climate change, including efforts by the military to reduce GHG emissions, feature prominently in the third EU-NATO Joint Declaration, which is currently being negotiated and which will supplement both the EU's Strategic Compass and NATO's Strategic Concept.[94]

Full synergy and EU-NATO coordination on military decarbonization would help ensure that powerful non-EU NATO members such as the US, Turkey and the UK, are well connected to efforts undertaken in the EU, and vice versa. This would ensure that equipment and procedures remain interoperable in the future.

TARGETED AND OPERATIONAL POLICY RECOMMENDATIONS FOR NATO AND THE EU

This report has extensively discussed the issue of military decarbonization. It has pointed to the advantages of reducing fossil fuel dependencies in operations, and to the inconsistency of the military acknowledging climate as a security risk, but not sufficiently contributing to global mitigation efforts by bringing its own emissions down.

Challenges with regards to establishing a methodology for the carbon and energy footprint and military technologies for transport and weapon systems that require a lot of energy currently coming from fossil fuels need to be overcome. This may very well also be beneficial for operational effectiveness and help to modernize Western armies. Below we make several specific recommendations to accelerate decarbonization:

- Coordinate and develop consistent messaging from both EU and NATO leadership on the importance of reducing the amount of oil and gas used by the military on operational, tactical and strategic autonomy. This would be aimed at the military establishment, national policymakers and the general public. The security implications of climate change, including efforts by the military to reduce GHG emissions, should feature prominently in the third EU-NATO Joint Declaration.

- Begin discussions on a common methodology and start conducting a feasibility study on how relative target setting could look. NATO's upcoming best practices compendium could serve as a starting point for this. The EU could use EDA's Coordinated Annual Review on Defense (CARD) to monitor defense emissions. A methodology might make a distinction between scope 1, 2 and 3 emissions and standard and non-standard emissions. The military could also be included in the EU's Monitoring Mechanism Regulation.

- Try to avoid carbon lock-in now that military expenditures go up rapidly by encouraging EU and NATO member states to reserve increases in budget for spend in green energy-saving technologies and systems. Further green spending by NATO members could be incentivized by including investments in climate security and economic resilience into the reformed 2 percent target after 2024.[95]

- Set ambitions for specific programs, technologies and investments into energy efficiency and renewable energy R&D and discuss with member states in which specific areas they can take the lead/start to integrate greener technologies. Make transparent to what extent member states are contributing to green R&D in their own R&D programs. The EU and NATO should use their buying power and factor energy efficiency standards into new procurement processes. NATO could lead the way with regards to common funded infrastructure, while green procurement rules could also be set for the European Peace Facility. Sharing of best practices and lessons learned among EU and NATO member states that already develop and implement green technologies is key.

- Consider establishing green compliance measures for EU defense spending instruments; this could start with the European Peace Facility and then can move onto other areas such as the PESCO, and style them based on rule of law compliance measures that already exist for the instrument. NATO could

Drone aerial view of the NATO Smart Energy Training and Assessment Camp (SETAC), at Ziemsko Airfield in Poland. Credit: NATO

also stimulate green innovation for future defense systems by developing green minimum capability requirements under the NDPP.

- The European Defense Fund should spend more and at least 30% on green R&D that helps to decarbonize defense. The same applies for national R&D programs of EU member states. The link with the Horizon Europe Research and Innovation program for dual use and civilian industry innovations could be explored and utilized more.

- Facilitate cooperation on low carbon innovation among smaller/less funded militaries to allow them to procure/access future green technology; within the EU this can either be achieved through funds managed by EDA and/ or by expanding the European Defense Fund.

- The EU should include the military in the European Green Deal, for instance by including buildings, camps and transport means into a new or existing ETS. This means that governments will have to report emissions from their activities; whether all emissions globally will be recorded or only those of 'domestic' installations and operations is up for debate.

- Start the first step of evaluating the feasibility of transforming to net-zero domestic military bases. Since 2013, NATO has been holding Capable logistician exercises with the aim of testing and demonstrating various energy-saving technologies, as well as their interoperability, in the field. DG DEFIS is also doing research on the development of Smart Energy Camps through the EDF, while a project devised by CF SEDSS III focusing on smart and autonomous grid technologies to power military bases was awarded funding for a feasibility study by the French armed forces.

- In order to decarbonize non-standard operations, NATO needs to shift away from single fuel policy (SFP) towards more sustainable alternatives, and could also lead the way in research and development of alternative propulsion systems for military applications. The EU could support a substantial increase in R&D investments that aim to lower fuel dependence.

- With the objective to decarbonize, NATO can review and update existing policies and standardization agreements (STANAGs), as well as introduce new ones.

- Because the private sector drives much of green innovation today, the EU and NATO militaries need to work alongside civilian agencies, private-sector companies, and research institutions. Both organizations should ensure that the establishment of all of the above includes military stakeholders, as well as civil society actors, in the ideation and implementation stages, including target setting.

ENDNOTES

1 Bethan McKernan, "Russian missiles strike fuel depot in key Ukraine port of Odesa," *The Guardian*, April 3, 2022, https://www.theguardian.com/world/2022/apr/03/russian-missiles-thought-to-have-hit-odesa-fuel-depot.

2 Michael Birnbaum, "Militaries are among the world's biggest emitters. This general wants them to go green," *The Washington Post,* December 30, 2021, https://www.washingtonpost.com/climate-solutions/interactive/2021/climate-change-military-emissions-security/.

3 Military Advisory Board, "National Security and the Threat of Climate Change," *CNA Corporation*, 2007.

4 "Décarbonation et transition énergétique des armées. Tour d'horizon des stratégies de défense : Allemagne, Australie, Canada, Danemark, États-Unis, Pays-Bas, Royaume-Uni," *IRIS*, Oktober 20, 2021, https://www.iris-france.org/161669-decarbonation-et-transition-energetique-des-armees-tour-dhorizon-des-strategies-de-defense-allemagne-australie-canada-danemark-etats-unis-pays-bas-royaume-uni/.

5 Sherri Goodman & Katarina Kertysova, "NATO: An unexpected driver of climate action?," *NATO Review,* February 1, 2022, https://www.nato.int/docu/review/articles/2022/02/01/nato-an-unexpected-driver-of-climate-action/index.html.

6 Louise van Schaik & Akash Ramnath, "A European Green Deal for militaries to strengthen Europe's Defence," *Clingendael*, April 2022, https://www.clingendael.org/sites/default/files/2022-04/PB%20A%20European%20Green%20Deal.pdf.

7 The White House, "Executive Order on Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability," December 8, 2021, https://www.whitehouse.gov/briefing-room/presidential-actions/2021/12/08/executive-order-on-catalyzing-clean-energy-industries-and-jobs-through-federal-sustainability/.

8 Association of Defense Communities, Democratic Lawmakers Press DOD on Climate Rule Adherence, January 31, 2022, https://defensecommunities.org/2022/01/democratic-lawmakers-press-dod-on-climate-rule-adherence/.

9 Cable, State Department, State 202013, to U.S. Del Mark Hambley and All NATO Post Collective, Subject: National Security Exemption on Climate Change, October 26, 1997 [Confidential], https://nsarchive.gwu.edu/document/27354-document-1-cable-state-department-state-202013-us-del-mark-hambley-and-all-nato-post.

10 Statement, United States Delegation to the Conference of Parties to the United Nations Framework Convention on Climate Change Subsidiary Body Meetings, as delivered to Russian Delegation, October 31, 1997 [Classification Unknown]

11 UNFCCC (1998) Kyoto Protocol to the United Nations Framework Convention on Climate Change, https://unfccc.int/resource/docs/convkp/kpeng.pdf.

12 UNFCCC (1998) Report of the Conference of the Parties on its Third Session, held at Kyoto from 1 to 11 December 1997, Addendum, Part Two: Action Taken by the Conference of the Parties at its Third Session, https://unfccc.int/resource/docs/cop3/07a01.pdf

13 U.S. Department of State FOIA (1997) Memorandum, Mark G. Hambley, USDEL/Kyoto, Subject: Third Conference of the Parties, Supplement to Update No. 9: December 8/9, 1997, December 9, 1997 [Classification Unknown]

14 Pandey, D., Agrawal, M. & Pandey, J.S. Carbon footprint: current methods of estimation. Environ Monit Assess 178, 135–160 (2011). https://doi.org/10.1007/s10661-010-1678-y.

15 The best investigation available so far has been conducted by the Conflict and Environment Observatory and Scientists for Global Responsibility research. See: SGR-CEOBS (2021) Under The Radar The Carbon Footprint of Europe's Military Sectors, available online: https://ceobs.org/wp-content/uploads/2021/02/Under-the-radar_the-carbon-footprint-of-the-EUs-military-sectors.pdf.

16 "Getting to net-zero for hard-to-abate sectors," *Strategic Sustainability Consulting*, June 2, 2021, http://www.sustainabilityconsulting.com/blog/2021/6/1/getting-to-net-zero-for-hard-to-abate-sectors.

17 IEA (2021), Net Zero by 2050, *IEA*, Paris, p.141, https://www.iea.org/reports/net-zero-by-2050.

18 Ibid, pp141-146.

19 The White House, "FACT SHEET: President Biden Signs Executive Order Catalyzing America's Clean Energy Economy Through Federal Sustainability," December 8, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/08/fact-sheet-president-biden-signs-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability/.

20 "Few transportation fuels surpass the energy densities of gasoline and diesel," *U.S. Energy Information Administration,* February 14, 2013, https://www.eia.gov/todayinenergy/detail.php?id=9991.

21 European Commission, Biofuels, Internet page, as April 2022, https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/biofuels_en.

22 Government of Canada, Energy systems for northern and remote infrastructures, Internet page, as of April 2022, https://www.nrcan.gc.ca/energy/energy-offices-and-labs/canmetenergy/canmetenergy-varennes/northern-remote-infrastructures/24119.

23 "Brussels Summit Communiqué," *NATO*, June 14, 2021, https://www.nato.int/cps/en/natohq/news_185000.htm.

24 "NATO Climate Change and Security Action Plan," *NATO*, June 14, 2021, https://www.nato.int/cps/en/natohq/official_texts_185174.htm.

25 Mark John, "NATO chief: Armies must keep pace with global climate efforts," *Reuters*, November 2, 2021, https://www.reuters.com/business/environment/nato-chief-armies-must-keep-pace-with-global-climate-efforts-2021-11-02/.

26 "NATO and its partners become smarter on energy," *NATO*, April 7, 2015, https://www.nato.int/cps/en/natohq/news_118657.htm.

27 The Smart Energy Team (SENT) Comprehensive Report, May 6, 2015, https://www.nato.int/science/project-reports/Smart-Energy.pdf.

28 "NATO-funded Serbian researchers develop biofuel from algae," *NATO*, August 18, 2017, https://www.nato.int/cps/en/natohq/news_146424.htm.

29 "New NATO scientific project to reduce energy consumption of deployable camps," *NATO*, October 2, 2018, https://www.nato.int/cps/en/natohq/news_158964.htm.

30 See for example: "NATO Smart Energy: Capable Logistician 2015," *NATO*, May 6, 2015, https://www.nato.int/nato_static_fl2014/assets/pdf/pdf_2017_08/20170808_Smart-Energy-Ex-Capable-Logisti.pdf.

31 "Green Defence Framework," *NATO*, February 2014, https://natolibguides.info/ld.php?content_id=25285072; The Smart Energy Team (SENT) Comprehensive Report, *NATO*, May 6, 2015, https://www.nato.int/science/project-reports/Smart-Energy.pdf.

32 Michael Ruehle, "Scoping NATO's environmental security agenda," NDC Policy Brief, No. 6, March 2020.
33 Smart Energy Team (SENT) Comprehensive Report, *NATO*, May 6, 2015, https://www.nato.int/science/project-reports/Smart-Energy.pdf.
34 "NATO Energy Security Centre of Excellence: About," https://enseccoe.org/en/about/6.
35 Susanne Michaelis, "How NATO is making progress in energy efficiency for military forces," *Eyvor Institute*, February 27, 2018, https://eyvor.org/how-nato-is-making-progress-in-energy-efficiency-for-military-forces/.
36 Selected takeaways of the Expert Engagement Workshop titled "Informing Design of a NATO Climate and Security Center of Excellence," Government of Canada, April 26, 2022 [online].
37 Michael Ruehle, "Scoping NATO's environmental security agenda," *NDC Policy Brief,* No. 6, March 2020.
38 *NATO 2030 Factsheet*, June 2021, https://www.nato.int/nato_static_fl2014/assets/pdf/2021/6/pdf/2106-factsheet-nato2030-en.pdf.
39 Remarks by Michael Ruehle, "Climate insecurity and geopolitics in the Arctic," *European Policy Centre (EPC)*, February 16, 2022, https://www.epc.eu/en/events/Climate-insecurity-and-geopolitics-in-the-Arctic~4582ec.
40 See *Energy Highlights,* NATO Energy Security Centre of Excellence, 2021, https://enseccoe.org/data/public/uploads/2021/10/d1_military-aspects-of-energy-security.pdf.
41 "Green Hornet", *US Department of Defense*, https://www.defense.gov/Multimedia/Photos/igphoto/2002002645/; "Sustainable fuels to power RAF Jets," *GOV.UK*, December 12. 2020, https://www.gov.uk/government/news/sustainable-fuels-to-power-raf-jets.
42 "Duch Ministry Implements Biofuel into Military Aviation," *Biofuels International*, January 23, 2019, https://biofuels-news.com/news/dutch-ministry-implements-biofuel-into-military-aviation/.
43 Susanne Michaelis, "Smart Energy: Less Fuel, More Power," in *Sustainable Peace and Security in a Changing Climate: Recommendations for NATO 2030*, NCWES, April 30, 2021, https://www.brusselsdialogue.net/more-about-the-report/inside-the-report.
44 Susanne Michaelis, "How NATO is making progress in energy efficiency for military forces," *Eyvor Institute*, February 27, 2018, https://eyvor.org/how-nato-is-making-progress-in-energy-efficiency-for-military-forces/.
45 Interview results, April 8, 2022.
46 NATO 2030 Young Leaders Group, "NATO 2030: Embrace the change, guard the values," *NATO*, February 2022, https://www.nato.int/nato2030/young-leaders/.
47 "Funding NATO", *NATO,* April 1, 2022, https://www.nato.int/cps/en/natohq/topics_67655.htm.
48 Jamie Shea, "NATO and Climate Change: Better Late Than Never," *GMFUS*, March 11, 2022, https://www.gmfus.org/news/nato-and-climate-change-better-late-never.
49 "NATO Headquarters," *Skidmore, Owings & Merrill (SOM)*, https://www.som.com/projects/nato-headquarters/.
50 "NATO sharpens technological edge with innovation initiatives," *NATO*, April 7, 2022, https://www.nato.int/cps/en/natohq/news_194587.htm.
51 "The Secretary General's Annual Report 2021," *NATO*, March 31, 2022, https://www.nato.int/cps/en/natohq/opinions_193590.htm.
52 NATO 2030 Young Leaders Group, "NATO 2030: Embrace the change, guard the values," *NATO*, February 2022, https://www.nato.int/nato2030/young-leaders/.
53 Louise van Schaik, Dick Zandee, Tobias von Lossow, Brigitte Dekker, Zola van der Maas & Ahmad Halima, "Ready for take-off? Military responses to climate change", *The Clingendael Institute,* March 2020, https://www.clingendael.org/sites/default/files/2020-03/Report_Military_Responses_to_Climate_Change_March_2020.pdf.
54 Council of the European Union, "Draft regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism", Regulation 2021/0214, March 15, 2022, https://data.consilium.europa.eu/doc/document/ST-7226-2022-INIT/en/pdf.
55 Council of the European Union, "Fit for 55", March 16, 2022, https://www.consilium.europa.eu/en/policies/green-deal/eu-plan-for-a-green-transition/.
56 European Parliament & Council of European Union, "Establishment of a framework to facilitate sustainable investment", Regulation 2020/852, June 18, 2020, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0852&from=EN.
57 Jonathan Saul & Kate Ablett, "EU proposes adding shipping to its carbon trading market", *Reuters*, July 14, 2021, https://www.reuters.com/business/sustainable-business/eu-proposes-adding-shipping-its-carbon-trading-market-2021-07-14/.
58 European Commission, "ReFuelEU Aviation - Inception Impact Investment", Ares (2020) 1725215, 2020: 3, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12303-Sustainable-aviation-fuels-ReFuelEU-Aviation_en.
59 European Union, "InvestEU", 2022, https://europa.eu/investeu/home_en.
60 European Parliament & Council of European Union, "Establishing the Neighbourhood, Development and International Cooperation Instrument – Global Europe", Regulation 2021/947, June 9, 2021, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0947&from=EN.
61 DR2 Consultants, "Next Generation EU and National Recovery Plans", May 5, 2021, https://dr2consultants.eu/next-generation-eu-and-national-recovery-plans/#:~:text=The%20Next%20Generation%20EU%20is,for%20green%20investments%20and%20reforms.
62 European External Action Service, "Climate Change and Defence Roadmap", EEAS (2020) 1251, November 9, 2020: 6, https://data.consilium.europa.eu/doc/document/ST-12741-2020-INIT/en/pdf.
63 European External Action Service, "Roadmap", https://data.consilium.europa.eu/doc/document/ST-12741-2020-INIT/en/pdf.
64 Ibid, 8.
65 European Defence Agency, "New Energy Consultation Forum project to promote low carbon military camps", February 17, 2022, https://eda.europa.eu/news-and-events/news/2022/02/17/new-energy-consultation-forum-project-to-promote-low-carbon-military-camps.
66 European Defence Agency, "The Incubation Forum for Circular Economy in European Defence", October 29, 2021, https://eda.europa.eu/docs/default-source/brochures/if-circular-economy-eda.pdf.
67 European Defence Agency,"CAPTech Energy and Environment", 2022, https://eda.europa.eu/what-we-do/all-activities/activities-search/energy-and-environment-programme.

68 Ibid.
69 European Defence Agency, "Defence Energy and Environment Projects", 2021, https://eda.europa.eu/docs/default-source/posters/6---defence-energy-and-environment-projects.pdf.
70 European Commission, "Commission Implementing Decision on the Financing of the European Defence Fund", C(2021) 4910 FINAL, June 30, 2021: 19, https://ec.europa.eu/defence-industry-space/system/files/2021-06/edf-wp2021_en.pdf.
71 European Commission, "DG Defence Industry and Space: Management Plan 2022", Ares (2022) 291956, January 14, 2022: 7, https://ec.europa.eu/info/system/files/defis_mp_2022_en.pdf.
72 For more information about the Strategic Compass see: Dick Zandee, Adája Stoetman & Bob Deen, "The EU's Strategic Compass for security and defence", May 31, 2021, https://www.clingendael.org/publication/eus-strategic-compass-security-and-defence#:~:text=Commissioned%20by%20the%20Ministries%20of,for%20capability%20development%20and%20the.
73 Compass, 2022, 41.
74 European Commission, "European Defence Fund", 2021, https://ec.europa.eu/defence-industry-space/eu-defence-industry/european-defence-fund-edf_en.
75 Parkinson & Cottrell, "Under the Radar", 10, https://left.eu/issues/publications/under-the-radar-europes-military-sectors-dodge-scrutiny-under-european-green-deal/.
76 Ibid, 15.
77 European External Action Service, "The European Peace Facility", April 2022, https://www.eeas.europa.eu/sites/default/files/documents/EU-peace-facility_.pdf.
78 Reuters, "EU to provide new 500 million euro military aid to Ukraine – Borrell", May 13, 2022, https://www.reuters.com/world/europe/eu-provide-new-500-million-euro-military-aid-ukraine-borrell-2022-05-13/.
79 van Schaik et al., "Ready for take-off?", 42, https://www.clingendael.org/sites/default/files/2020-03/Report_Military_Responses_to_Climate_Change_March_2020.pdf.
80 European Defence Agency, "Guidance Document: CF SEDSS II Results and Recommendations for Sustainable Energy in the Defence and Security Sector", *Consultation Forum for Sustainable Energy in the Defence and Security Sector Phase II (CF SEDSS II) 2017-2019*, July 2019: 83, https://eda.europa.eu/docs/default-source/events/eden/phase-ii/guidance-document/cfsedssii-guidance-document.pdf.
81 European Commission, "Strategic Foresight Report 2021", September 2021: 10, https://ec.europa.eu/info/sites/default/files/strategic_foresight_report_2021_en.pdf.
82 Sir Mike Wigston,"CAS RAF NetZero Ambition", UK Ministry of Defence, November 24, 2021, https://www.gov.uk/government/speeches/cas-raf-netzero-ambition.
83 Louise van Schaik & Akash Ramnath, "A European Green Deal for militaries to strengthen Europe's Defence", *The Clingendael Institute*, April 2022: 2, https://www.clingendael.org/publication/european-green-deal-militaries-strengthen-europes-defence.
84 European Commission, "Directive of the European Parliament and of the Council establishing a system for greenhouse gas emission allowance trading within the Union", COM(2021) 551 FINAL, July 14, 2021: 53, https://ec.europa.eu/info/sites/default/files/revision-eu-ets_with-annex_en_0.pdf.
85 "Deputy Secretary General: new ambitions for NATO-EU cooperation," *NATO*, June 28, 2021, https://www.nato.int/cps/en/natohq/news_185546.htm.
86 Antonio López-Istúriz White, "Report on EU-NATO cooperation in the context of transatlantic relations," European Parliament – Committee on Foreign Affairs, June 2, 2021, https://www.europarl.europa.eu/doceo/document/A-9-2021-0192_EN.html.
87 "Climate Change and the Role of the Military," EUROMIL in association with the Global Military Advisory Council on Climate Change (GMACC), February 25, 2022 [virtual event].
88 "EDA projects involved in major international logistics exercise," *NATO*, June 21, 2019, https://eda.europa.eu/news-and-events/news/2019/06/21/eda-projects-involved-in-major-international-logistics-exercise.
89 Sven Biscop, "European Defence and PESCO: Don't Waste the Chance," EUIDEA Policy Papers, No. 1, May 5, 2020, https://www.egmontinstitute.be/content/uploads/2020/05/euidea_policy-paper1-SvenBiscop-mei2020.pdf?type=pdf.
90 Interview results, January 6, 2021.
91 "Ministers call for innovation cooperation, warn against duplication," *European Defence Agency (EDA)*, December 7, 2021, https://eda.europa.eu/news-and-events/news/2021/12/07/ministers-call-for-innovation-cooperation-warn-against-duplication.
92 "Climate insecurity and geopolitics in the Arctic," *European Policy Centre (EPC),* February 16, 2022 [virtual event], https://www.epc.eu/en/events/Climate-insecurity-and-geopolitics-in-the-Arctic~4582ec.
93 "EU-NATO Cooperation – Factsheet," https://www.eeas.europa.eu/eeas/eu-nato-cooperation-factsheets_en.
94 Jamie Shea, "NATO and Climate Change: Better Late Than Never," *GMFUS*, March 11, 2022, https://www.gmfus.org/news/nato-and-climate-change-be on tter-late-never.
95 See NATO 2030 Young Leaders Group, "NATO 2030: Embrace the change, guard the values," *NATO*, February 2022, https://www.nato.int/nato2030/young-leaders/.

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