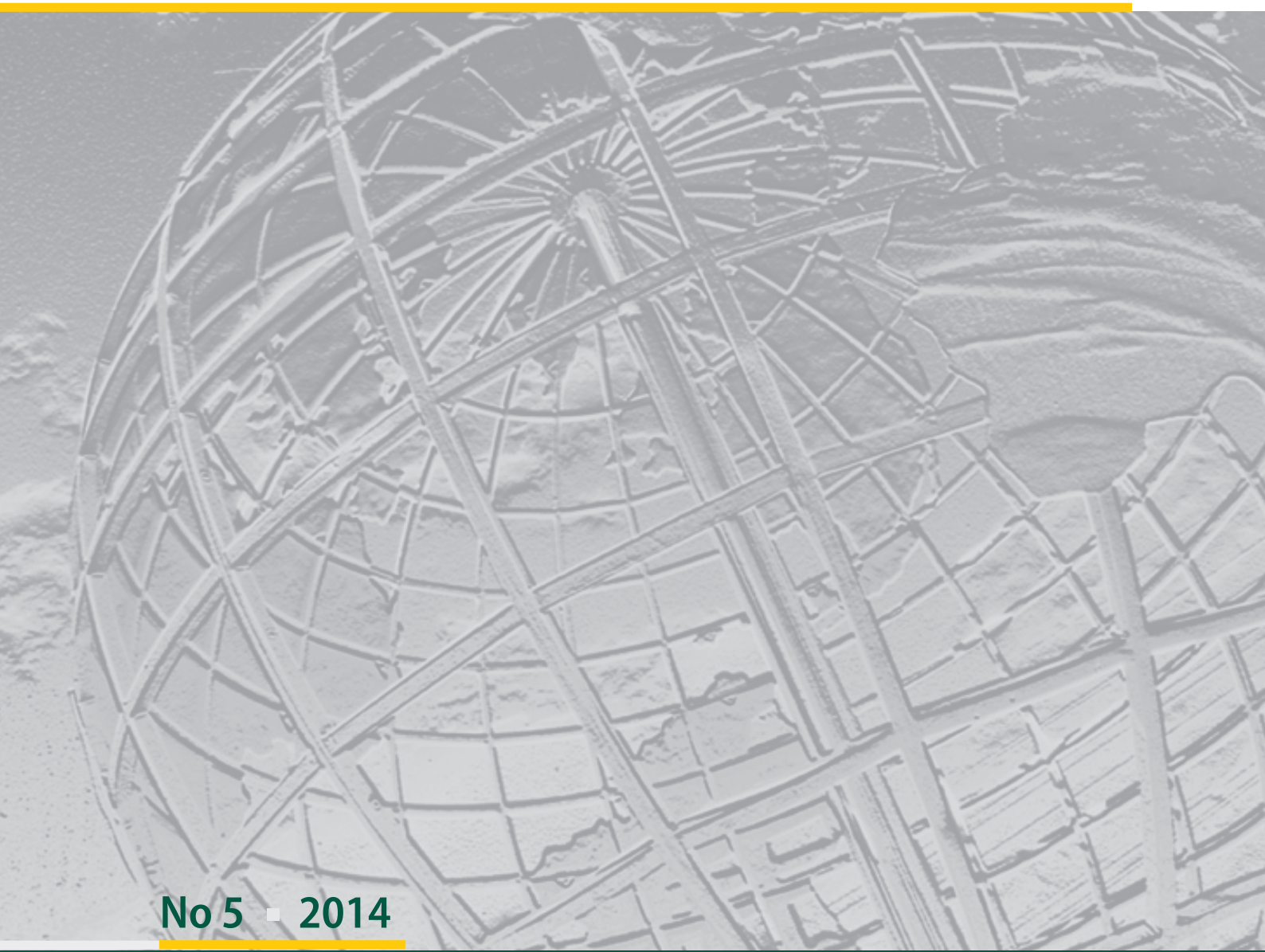
Energy Security: Operational Highlights



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NATO and Energy Security: Current Achievements and Future Challenges

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In the second half of 2013 several important steps were taken to firmly anchor energy security on NATO's agenda: to enhance NATO's training and education efforts, the Emerging Security Challenges Division was given the role of Requirements Authority, while the Energy Security Centre of Excellence became Department Head. At the same time, the Danish-Lithuanian "Green Defence Initiative" raised the visibility of energy efficiency and environmental protection across the Alliance. Did these developments set the stage for a new chapter not only in the cooperation between NATO and the Centre of Excellence, but also for NATO's broader energy security agenda?

The ancient Greek statesman Pericles once said that while it was impossible to predict the future, one should at least try to prepare for it. Pericles' observation fits perfectly well on today's NATO: in a strategic environment that is increasingly shaped by the forces of globalization, the Alliance needs to be prepared for a wide range of contingencies. Many of these contingencies will arise from challenges that have little in common with traditional notions of security: cyber attacks can cause massive damage without a single shot being fired; terrorist attacks can have a psychological impact that far outweighs their immediate physical effect; and the proliferation of Weapons of Mass Destruction can lead to unpredictable power shifts in geopolitically important regions.

The importance of energy

Another factor that can significantly affect our future security environment is energy. Energy is essential for virtually all aspects of modern life – a fact that makes it a truly strategic commodity with numerous implications for Allied security. Indeed, the political, economic and security challenges surrounding energy are both numerous and profound: Europe's increasing dependency on oil and gas imports; the growing energy needs of rising powers such as China and India; political instability in many energy-producing and transit states; territorial disputes involving the quest for energy and other resources; terrorist attacks against refineries, pipelines and power plants; piracy along critical maritime choke points; and cyber attacks against smart power grids and control systems. Finally, there is also the energy challenge of military operations: with military forces deployed far from home, the logistical and financial burden is constantly increasing, thus making the introduction of energy efficiency measures a strategic imperative.

NATO gets involved

NATO is not an energy institution per se, but it is an Alliance that provides protection for almost 900 million citizens. Hence, NATO's link to the energy domain is through the security dimension, where it has a legitimate and relevant role to play in the field of energy security. NATO features a political consultation process, intelligence-sharing mechanisms, civilian and military planning capacities, and a unique network of partnerships with many countries and institutions. This is a fairly wide range of tools that enables the Alliance to contribute to the various dimensions of energy security, including by adding value to other international efforts. Over the past years, as NATO has been refining its role in energy security, the Alli-

ance's specific contributions have become clearer. At the same time, NATO's energy security "toolbox" has become more sophisticated. Compared to 2008, when the Allies at their Bucharest Summit first agreed on the organisation's mandate, major principles and areas of engagement in energy security, NATO today is in a much better position to play a role that is commensurate with its political and military capabilities. The 2010 Strategic Concept, the creation of the Emerging Security Challenges Division, and the accreditation of the NATO Energy Security Centre of Excellence contributed to giving the subject a sharper focus.

NATO's energy security activities can be classified into three areas: raising strategic awareness, contributing to the protection of critical energy infrastructure, and enhancing energy efficiency in the military. Each of these areas requires a different set of tools, yet they all benefit from NATO's unique characteristics: its transatlantic dimension; its seamless continuum of political consultations, political-decision-taking, and military planning; and its huge network of partnerships. Taken together, these features enable NATO to contribute to energy security in a variety of ways.

Raising Strategic Awareness

Energy developments affect global geopolitics. They can change political and military alignments or aggravate existing disputes. The energy dimension of certain political or security developments will often be only indirect, yet this does not make them less profound. To mention just the most obvious example, the boom of unconventional energy in the United States inevitably raises the question as to that country's future engagement with the Middle East and the Gulf and, by extension, Europe's future position vis-à-vis these regions. By the same token, the lower global gas price resulting from the "shale gas revolution" may severely impact on the economies of energy producers, which depend on a high gas price to generate sufficient revenues. Such developments can affect Allied security in many ways. While their exact implications cannot be predicted, it is essential that NATO makes a consistent effort to understand them. "Staying ahead of the analytical curve" (NATO Secretary General Rasmussen) is the precondition for avoiding strategic surprise and for developing proactive approaches.

For all these reasons, raising strategic awareness must be the first step towards a comprehensive NATO's energy security agenda. This encompasses regular consultations among Allies and with interested partners, but also less formal "brainstormings" with outside energy experts. Tailored intelligence products and other in-house strategic analyses are a further means to achieve greater strategic awareness, as are strategic-level training courses in NATO and national educational institutions. Finally, NATO's deepening relations with other international institutions (e.g. International Energy Agency) also contribute to a common view on the strategic implications of energy developments.

Support to the Protection of Critical Energy Infrastructure

Energy infrastructure is subject to many risks: natural disasters (e.g. earthquakes), technical failures, political instability in producing countries, and man-made attacks (e.g. terrorism, cyber attacks, piracy). Energy infrastructure on NATO territory is considered to be rather safe from terrorist attacks. However, as many Allies depend on energy imports from regions outside NATO, terrorist attacks in these regions can have a significant impact and knock-on effect on Allied energy supplies. Some energy producing regions, especially in the Middle East and North Africa, are particularly vulnerable to threats against energy infrastructure and suffer from hundreds of terrorist attacks each year. As the characteristics of the oil industry make oil prices very sensitive to any kind of disturbance, even an unsuccessful attack

against a strategic energy facility can cause major oil price spikes.

For all these reasons, sharing best practices on the protection of critical energy infrastructure remains NATO's most frequently offered cooperation item with respect to energy security. Activities in this regard benefit from NATO's longstanding expertise in crisis and consequence management and from the effective involvement of the private sector, whose unique expertise can be made available to partners through the NATO framework. Given that the protection of critical energy infrastructure is a national responsibility, NATO's role is largely that of a facilitator. However, experience shows that it is the specific NATO context that attracts the attention of stakeholders, notably partner countries and industry. In the years ahead, NATO will also step up its training efforts in this regard. Upon the request of a partner country and agreement by Allies, NATO can also dispatch assessment teams to evaluate infrastructure vulnerabilities or assess damage to energy installations. In the same vein, NATO could also be requested to support the protection of partners' critical energy infrastructures, whether by supporting national communication and intelligence networks or through aerial and maritime patrols. Finally, NATO's counter-piracy operation off the coast of Somalia brings home the importance of navies in keeping the sea lanes open – another important, if indirect, contribution to energy security.

Energy Efficiency in the Military

Energy, like logistics more broadly, has always been a key factor in military operations. Throughout history, superior logistics have decided the outcome of military campaigns. This has not changed. If anything, the logistical challenges have grown. A soldier today uses 10 to 15 times more energy in fuel and batteries than a soldier during World War Two. Indeed, the logistical effort of NATO's Afghanistan mission, notably the provision of sufficient fuel to power vehicles and forward deployed bases, is immense. It is in this operational context that energy efficiency has emerged as another major pillar of NATO's energy security agenda.

The operational experience gathered in recent years demonstrates that the growing fuel requirements of NATO's forces limit the effectiveness of military operations. Since these missions involve long distances and a sustained presence, they require ever larger support structures. Moreover, the more fuel needs to be transported, the more the risk for Allied soldiers increases. Environmental concerns are also playing an increasingly important role. Armed forces are large polluters, and it is in NATO's collective interest that every effort is made to reduce their environmental impact. Like with fuel consumption, small technical improvements can have a huge cumulative effect. NATO Allies therefore need to reduce their dependence on traditional fuels, shrink their logistics footprint (thereby enhancing the security of their troops), and take environmental concerns into account.

Achieving these multiple objectives requires the introduction of new technologies, and modifications in NATO's operational planning. NATO needs to set common energy efficiency standards, offer specific training on how to reduce energy consumption in operations, and organise exercises that confront planners with energy challenges. All these strands of work are currently underway. Spurred by the Danish-Lithuanian "Green Defence Initiative", efforts are being made to better coordinate this ongoing work and, eventually, to integrate it into the NATO Defence Planning Process. NATO has also made great strides in exchanging best practices in energy efficiency. A "Smart Energy Team" (SENT) of experts from several Allies and partner countries shares experience and technological approaches and seeks to identify the most promising approaches for future multilateral projects.

The Importance of the Centre of Excellence

This agenda is both complex and ambitious. It demonstrates NATO's potential to adapt to a changing security landscape, and to develop new answers to new questions. However, it is equally obvious that this agenda cannot be implemented by NATO Headquarters or its Strategic Commands alone. To carry this work forward, additional means have to be explored. Thankfully, such means do exist: the NATO Centres of Excellence (COEs). They are the missing link between NATO's evolving policies and their practical implementation.

Lithuania started to lay the groundwork for its Energy Security Centre of Excellence at around the same time NATO stood up the Emerging Security Challenges Division (ESCD). This parallel evolution has resulted in cordial and trustful relations between both entities. ESCD supported the accreditation of the National Centre as a NATO Centre of Excellence – a critically important step that was achieved in 2012. ESCD also included the Centre as a co-director in the "Smart Energy Team", underlining the need to cooperate closely on energy efficiency issues. In turn, the Centre provides a platform for research, analysis and training that goes far beyond the limited means of NATO Headquarters. With Lithuania as the framework nation, five sponsoring nations (Estonia, Italy, France, Latvia, Turkey), and the United States and possibly several more to come, the Centre is set to grow into a formidable resource to supporting NATO's capability development process, mission effectiveness and interoperability by providing comprehensive and timely expertise on energy security. This work will benefit Allies and partners alike.

Training Landscape Development conference, 2013, Lithuania
Source: NATO ENSEC COE

With the establishment of ESCD as Requirements Authority (RA) and the COE as Department Head (DH) on Training and Education, the stage is now set for a new chapter not only in the cooperation between these two entities, but also for NATO as a whole. As NATO is moving from a "deployed" to a "prepared" posture, an enhanced training effort is the key to maintain interoperability between Allies and with partners. Moreover, education and training, including exercises, can help ensure that the security implications of non traditional challenges, such as energy developments, are being recognised in full. For this reason, ESCD and the ENSEC COE, supported by Allied Command Transformation, are now in the process of identifying energy security training requirements, surveying the existing training landscape and, if required, developing more specific training courses in those areas that are not yet adequately covered. It will be of particular importance to ensure that the training effort is balanced, i.e. that it covers the three main pillars of awareness, infrastructure protection and energy efficiency, and tailors them to the right target audience.

Another reason why NATO benefits from the Centre is the latter's ability to act as a think tank. For example, the Centre can provide deep analyses of specific energy-related issues that NATO Headquarters simply cannot produce in-house. Whether the issue is measuring the energy consumption in the military or examining the cultural changes necessary for a more conscious use of energy, the Centre can be at the cutting edge of research. Moreover, the Centre can also outsource certain research projects to other think tanks, thereby further advancing our collective understanding of energy and its security dimensions. Finally, the Centre is a major tool for explaining NATO's role in energy security to the broader public. With its own two journals as well as numerous briefings delivered by members of its staff at international conferences and other events, the ENSEC COE has quickly established itself as a public diplomacy tool that complements NATO's own efforts.

For all these reasons, NATO Secretary General Rasmussen called the ENSEC COE "the right institution, at the right time, and at the right place". It will provide NATO with analyses on energy developments, and Allies and partners with new opportunities for training and education. And it will help to improve the energy efficiency in our armed forces, making NATO both "greener" and smarter.

The Way Ahead

The progress made over the past years is considerable, yet energy security still remains at the periphery of NATO's crowded agenda. For energy security to move closer towards the centre of NATO's attention will require both more time and more work. Three steps appear particularly important:

First, Allies need to have a more systematic discussion about the security implications of energy developments. For example, the US shale gas "revolution" may have implications for US internationalism that might also affect America's role in NATO, notably as a potential gas supplier to Central and Eastern European Allies. By the same token, the growing elasticity of the gas market, thanks to the potential of the shale gas production in Europe and advanced Liquefied Natural Gas transportation technologies, could lead to reverberations in Russia that would have further significant effects. The North Atlantic Council has recently addressed many relevant energy developments in its seminar on 14 January 2014. Holding such brainstormings on a more regular basis would constitute a major step towards a much broader security dialogue, in which the relationship between economic developments, resources and geo-strategic issues can be thoroughly analysed and discussed.

Second, as we complete our ISAF mission at the end of 2014, and are moving from a "deployed" to a "prepared" NATO, the Alliance must make an ever greater effort to integrate energy considerations in its activities. For example, the Connected Forces Initiative, which seeks to maintain the interoperability of NATO's armed forces through enhanced training and exercises, offers numerous opportunities for introducing energy efficiency measures. In the same vein, the need to sustain NATO's partnerships in the absence of a major military operation makes enhanced cooperation on energy security a logical venue for partner countries, many of which are either energy producers or transit states. And the stronger focus on the maritime dimension will also lead to a closer look at the energy angle. All this should result in a sustained effort to consider energy scenarios in NATO exercises – the ultimate expression of an Alliance that is prepared, organisationally and mentally, to cope with any challenge.

Third, NATO's dialogue with other stakeholders – other organisations, think tanks and indus-

try – must gradually expand. Such a dialogue should contribute to a consistent evaluation of risks and threats among the key energy players. At present, such an evaluation does not exist – and this constitutes a risk in itself. Building such a stakeholder community is a crucial aspect of enhancing NATO's "connectivity" (Secretary General Rasmussen). Such a dialogue will help Allies to broaden their understanding of what constitutes essential "capabilities" in the 21st century: in a globalised world, a network of civilian energy and cyber experts, an effective intelligence-sharing process, strong ties with other organisations and trustful relations with partner countries may well become as essential as fighter planes and armoured vehicles.

Conclusion

With energy developments being discussed at the highest political level, deepening relations with partner countries and other institutions, and the standing up of the NATO Energy Security Centre of Excellence, NATO is now in a better position than ever before to make energy security a more natural, and prominent part of its agenda. Close and trustful relations between the Emerging Security Challenges Division and the NATO Energy Security Centre of Excellence are essential for this valuable process to continue.

Security and energy efficiency, a smart energy for a smart defence: examples taken from France

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On 6th September 2013, NATO Energy Security Centre of Excellence (NATO ENSEC COE) was inaugurated in Vilnius, Lithuania, with a ceremony conducted by President of the Republic of Lithuania, HE Dalia Grybauskaitė, and NATO Secretary General, Anders Fogh Rasmussen. Soon afterwards, the newly inaugurated NATO Energy Security Centre of Excellence organized a "Training Landscape Development conference" in the area of energy security, held on 10-11th September 2013 in Trakai (Lithuania), with the aim to provide a high level discussion forum in the area of energy security and energy efficiency. I personally attended the conference and made a few comments about a possible NATO energy security and efficiency agenda, combined with the challenges and opportunities we were all now facing in a world where energy had a growing impact on defence issues.
However, these topics of energy security and energy efficiency in the fields of defence have been on the shelf for quite a while and are now impacting the European political agenda, as shown recently again in Vilnius on 20th November 2013 when France, the United Kingdom, Lithuania, and Hungary established a trust fund to financially support participation of the Eastern Partnership countries in joint Common Security and Defence Policy activities. Lithuanian Minister of National Defence Juozas Olekas welcomed the inclusion of energy security dimension into the draft conclusions, among other emerging security challenges. The minister also welcomed the agreement to initiate consultations on the development of the European Union energy efficiency strategy in the field of defence. In such a moving context a number of innovative energy efficiency measures undertaken by French ministry of Defence can contribute to an adequate response to emerging security challenges.

An Energy Security Centre of Excellence facing world energy uncertainties

In fact, as shown in Vilnius last September, one must keep in mind that the world of energy is changing faster and faster. This phenomenon will keep on growing and it will have a strong impact on defence issues in the next 30 years. Though the supply side should keep us optimistic, with an increasing ability to access large quantities of shale gas and tight oil, together with continuing discovery of new fields around the world, a phenomenon which should ensure that we have enough natural gas for many decades to come, one must acknowledge that the world energy consumption, despite the current economic wild fluctuations, will stay on the rise and will have a deep impact on global political balances throughout the world.

The world energy demand will grow of 80% till 2050 from now, due to stronger energy needs in emerging countries. Faced with an ever-changing world, which has become increasingly unpredictable under the pressure of globalisation, we need to adjust ourselves, considering our current massive use of fossil sources of energy coming from non-European and often unstable world producing areas. Conversely, energy choices increasingly made, with the expansion of China and India, by countries on the Asian continent, may end up determining NATO's energy strategy in terms of security. These countries already have a great influence on the international market for energy products and the geopolitics of energy.

"By making armed forces more energy efficient it may help reduce costs and operational risks and boost military effectiveness. Further, it boosts technological innovations and creates new jobs. Experience and knowledge of Lithuania based NATO Energy Security Centre of Excellence could be used to strengthen European Union and NATO cooperation in energy security area" said Lithuanian Minister of National Defence Juozas Olekas.

1. The views expressed here are solely those of the author. They do not necessarily reflect the views of the Strategic Affairs Directorate or any other organization.

Various key questions arise: how is it possible to guarantee our security of supplies and to minimise risks? Could energy market strategies be enough to solve energy problems or are there more political energy strategies to develop? What could do NATO in the case of a deep strategic crisis somewhere in the world of energy? What could NATO's member states do to diversify their energy supplies and to limit their demand? Are the currently approved energy investments in Europe and North America sufficient and relevant?

Yet, because there is currently no clear alternative to fossil energies and geopolitical uncertainties combined with climatic disruptions, one has to limit the scale of unpredictability of such phenomenon and the number of questions unanswered. Ministries of defence and NATO member states clearly need to integrate energy efficiency, environmental protection measures and sustainable development considerations into their assignments. A less-intensive drain on energy will reduce both energy dependencies and budgetary constraints linked to energy spending.

In such a moving context, a decision to streamline NATO's command structure, in part through the creation of NATO's Allied Command Transformation (ACT), was taken during the 2002 Prague Summit. This command seeks to ensure that the military alliance faces its future challenges by enhancing the interoperability of capacities among NATO's member countries, training opportunities and by organizing exercises for testing new doctrines, concepts and operational strategies. A decision was made to strengthen the coordination of NATO's activities and to meet high quality standards in the areas of scientific, training and specific expertise and to benefit from national resources of this type, including energy.

In pursuit of this vision, the NATO Military Committee approved the concept of the Alliance's Centres of Excellence at the end of 2003. The Centres of Excellence were to offer expertise and experience in specific areas, which could be of benefit to the Alliance, while avoiding the duplication of activities among its member states. For these purposes centre is a nationally or multi-nationally sponsored entity, which offers recognised expertise and experience in support of transformation. NATO has now a total of 19, including the recently created NATO Energy Security Centre of Excellence located in Vilnius.

At the NATO Summit held in November 2010, NATO's final declaration provided for a commitment to integrate energy security into NATO's activities. The six establishing nations of NATO ENSEC COE, including Estonia, France, Italy, Latvia, Lithuania, and Turkey, founded this centre of excellence by validating relevant documents at the Headquarters Supreme Allied Commander Transformation at Norfolk in July 2012, soon after it got key accreditation tasks by the NATO Summit held in May 2012 in Chicago. Then, the North Atlantic Council accredited the ENSEC COE as an international military organization in October 2012.

Though energy-security related topics were on the agenda of the Alliance for a long time, such as the protection of critical energy sea-routes, tasks of the NATO ENSEC COE were to analyse aspects of military energy efficiency and security as well as protection of critical energy infrastructure, to render consultations and advice in the field of operational energy security, employment of alternative energy resources for military purposes and development of environmentally friendly and efficient military capabilities, and to engage in training events and exercise. This ENSEC COE's agenda, when established, was thus to deal with broad energy topics. For practical needs coming from NATO's member states, its agenda was however redirected towards more operational energy security topics.

Training Landscape Development conference, 2013, Lithuania

Considering these tasks, the conference held in September 2013 made a few recommendations[2]: to proceed on projects related to energy efficiency in the military, to continue raising awareness in the area of energy security, to organize and plan training in the area of energy security, to cooperate with NATO Cooperative Cyber Defence Centre of Excellence (CCD COE), NATO Centre Against Weapons of Mass Destruction (WMD) and NATO Centre of Excellence Defence Against Terrorism (COE-DAT).

The conference showed that NATO forces, wherever they were, required large volumes of fuel to operate, in Afghanistan as well as in Mali for French forces. It showed that energy was consumed in generators powering forward operating bases (providing electricity for communications as well as heating, cooling, and lighting of shelters), as well as tactical vehicles transporting troops across Afghanistan, aircraft and helicopters delivering materiel into and around theatre. Alternative energy sources - like the solar-powered communication systems employed by the U.S. Marine Corps in Helmand Province - also increased capability of forces operating in austere environments by reducing the need for fuel resupply and improving operational flexibility. Fuel convoys in Afghanistan have often come under attack and suffered casualties. Considering these key questions of energy supplies in Afghanistan, Susanne Michaelis, Smart Energy Action Officer at NATO Headquarters, explained that "we are trying to make soldiers and commanders understand that saving energy has a direct effect on soldiers' lives and security. It frees up capabilities for NATO's core mission that are currently diverted for protecting fuel convoys" in "Smart Energy camp opens eyes to promising energy-saving solutions" published in June 2013[3].

The September 2013 conference thus focused on a problem everyone was now facing all over the world: to improve energy efficiency in the defence sectors and to limit the level of energy needs for transports and infrastructures for future capabilities. It explains why, for the next NATO Summit to be held in South Wales on 4-5th September 2014, one could expect discussions on green agendas, energy efficiency and security, connected with enhanced military capabilities.

2. http://www.enseccoe.org/events/76-conference-in-the-area-of-energy-security
3. http://www.nato.int/cps/en/natolive/news_101896.htm
4. http://www.defense.gouv.fr/actualites/la-vie-du-ministere/3eme-rapport-developpement-durable-de-la-defense

To reduce energy consumption: a strategic requirement for European MODs and NATO

De facto, expectations in terms of sustainable development deeply increased in recent years among NATO's member states. In France, the Ministry of Defence presented its first report on sustainable development in September 2009 (two other reports were later published[4]), which included energy efficiency as a priority for environmental reasons and security strategies. The French defence ministry set out five priorities through its sustainable development strategy called S3D: to improve energy efficiency and consumption management; promote youth employability as a defining element of social cohesion; give small and medium companies greater access to the ministry of defence's public procurement contracts; increase awareness among the personnel of the ministry in sustainable development; and preserve environment and biodiversity on land and in the sea. Through this, it achieved a 13% cut in energetic consumption since 2009, excluding operational fuel, and 80% of French defence bases introduced energy efficiency certificates.

There are thus now actions to implement sustainable development and energy efficiency all over Europe. Indeed, European ministries of Defence need to adapt themselves by integrating sustainable development as a strategic factor into their assignments. This entails meeting four challenges: territorial preservation, environment-friendly infrastructures, equipment with environmental dimensions, and environmentally responsible players.
To improve energy efficiency in defence sectors leads us to the development of new technologies able to produce the same level of goods and services with less energy. For example, a ton of recycled plastic allows us to save about 1 to 1.2 ton of oil. To decrease the level of energy consumption also implies to develop new industrial process to create low energy building standards or more performing engines and gasoline for armaments and military equipment. Then, each procedure or industrial process has to be analysed and assessed globally to define new technological and industrial choices to be made.

In its environmental action plan of December 2007, the French ministry of Defence reasserted its commitment to the approach of eco-conception, aiming to systematize a green approach in the field of military equipment. The French PP30 (a 30 year prospective plan for military equipment) started integrating these dimensions in 2008: It showed that improvements could come from motorization and low carbon emission transport vehicles. It explains why European defence companies such as Safran insist on developing more performing engines for fighters. Their most recent engines improved the propelling efficiency and the efficiency of heat exchangers in engines; they reduced the global weight of engines. Programs developed by Safran such as Silvercrest were made to increase the environmental bonus of planes with high technical performances.

Military equipment: an efficient defence policy linked to a low energy demand

Transports are still heavily depending on oil for their consumption (95%). In all NATO's member states, the armed forces are among the biggest consumers of fuel and other resources, and so have the greatest opportunity to readily reduce consumption by a significant amount, while at the same time setting an example to industry and the public. Militaries worldwide are now facing the unprecedented challenge of providing more and more energy to support advanced systems while at the same time striving to adhere to ever-tighter budgets and stringent environmental goals. Yet, a definition of what constitutes green defence needs is still to be set out and it is clear that it reaches far beyond simple reduction in fuel consumption and emissions. For example, ministries of defence have to take into

account too buildings, land and property, when considering energy efficiency. Thus, the new French ministry of defence being currently built is announced to be an energy-saving complex. Located in front of the most westerly building, a new green road will link the Paris 15th arrondissement and the close city of Issy-les-Moulineaux. An aeraulic system will be installed on the roof allowing for natural ventilation within the building.

Back to transports and leaving apart these questions on buildings and properties, to be more energy efficient for a ministry of defence, armed forces need first indeed to reduce the consumption of all types of fuel oils for oil substitutes or new engines. Unfortunately, there is not any miracle formula to get rid of fuel oils for fighters or warships. Bio fuels, hybrid fuels or natural gas are possible alternatives to more conventional fuels, but there is a compromise to find between environmental, industrial and technological performances. On the mid-term, a system could be implemented with much more diversified options for armed forces, depending on different needs and different market segments, but its military efficiency is still to be proved.

In air-forces, there is clearly a need to find ways towards cleaner planes. On the short term, there are only three possibilities to reduce the fuel consumption: to improve plane efficiencies, to improve air-traffic regulation, and to replace conventional gasoline with other fuels. A mixture of bio fuel and kerosene was tried, but these new fuels have to answer to defence constraints such as security, velocity, and reactivity. New fuels also have to endure large changes of temperature from a minus 60°C (-140°F) in high altitude to 50°C (+122°F) when parking on a tarmac. Armed forces also need to use similar kinds of fuels with similar design features and they must be available everywhere and at all time. It explains why no fighter was properly developed with environmental considerations till now. However, considering the US Navy's project to fly a F18 Green Hornet, there are questions to be answered when considering the idea of using bio fuels as a way for fighters. The first generation of bio fuels was a mixture of conventional gasoline and ethanol or biodiesel used for cars, quite unsuited for fighters. A second generation of bio fuels should indeed come to life in 2020 and could be used in defence equipment on a larger scale.

New technologies combined with new materials will also have to be taken into account, considering the need to improve the storage of energy in batteries for more energy efficiency in defence equipment. As a last example, in future nuclear engines of submarines or aircraft carriers, fourth generation nuclear reactors will improve the potential of natural uranium. In current water pressurised reactors (WPR), a limited part of the energy potential of uranium is used for energy production. The uranium 238 (99.3% of natural uranium) is thus marginally valued on a proper level. By comparison, the fourth generation fast breeder reactor (FBR) should increase the efficiency of future reactors by a factor of 50 to 100. It is key to defence industries, economies, and energy efficiency.

Energy efficiency in present and future French weapon systems

While it is relatively simple to set a green agenda in the environment of procurement, manufacture, training, accommodation and decommissioning, it is harder to sell the importance of the environment in an operational environment. First, a good example of what is currently done inside the French ministry of Defence, linking both energy and defence technologies, was the DisaSolar R&D contract announced on 12th July 2012. This contract involves the development of bio-mimetic flexible solar panels capable of taking on the shape and colour of their environment for camouflage purposes. Such solar devices are designed to increase autonomy of electronic and communications equipment for units in operations. French public research centres such as the CEA/INES (Atomic Energy Commission) and the CNRS/

XLIM (National Centre for Scientific Research) are also involved and linked to this program. The project is funded by the DGA's (French Defence Procurement Agency) support regime for dual innovation program called RAPID, in conjunction with other French Public administrations. RAPID is designed to finance projects that have major technological and commercial potential, are supported by businesses with less than 2,000 employees, and have both military and civilian applications. 50 million euros will be spent in 2014 for this innovation program.

DisaSolar is a flexible photovoltaic French specialist located in Limoges (Limousin). The company commercializes and installs 2nd generation flexible photovoltaic panels or "thin films" and conjointly works on the development of 3rd generation solar cells, or organic photovoltaic

DisaSolar's CEO Stéphane Poughon then commented: "we are proud to have been chosen by the DGA and to take part in such challenging disruptive technology. Designing bio-mimetic organic photovoltaic is a highly ambitious research project with opportunities in both military and civilian sectors. DisaSolar will contribute its know-how in terms of inkjet printing technology and its R&D ecosystem in order to support the DGA in the development of French technology".

DisaSolar aims to become one of the world's leading manufacturers of organic solar cells using printing technologies developed with the support of numerous French and international research centres, as well as with Ceradrop, a manufacturer of inkjet printers used in the depositing of components. Furthermore, DisaSolar relies on the Disa/Megamark group, which specializes in visual communication using graphic printing solutions, for its technical, logistic and human resources.

Another example is the soldier on the ground himself. Sagem Defence and Security, a Safran company, is behind the French military's FELIN (Fantassin à Equipements et Liaisons INtégrés), one of the most successful dismounted soldier modernization program, currently equipped with 12 regiments. Industrial co-operations and offsets director Renaud d'Hautefeuille said that one of the aims of the program was to make the individual soldier autonomous for fuel requirements. To this end, all the powered systems he carries, including radio, communications, goggles and imaging equipment, are integrated, not just in terms of operations, but using a single Li-ion battery with advanced energy management. This means overall reduced energy use, and energy can be directed to the equipment that particular user is using at that time. The overall weight of systems carried is also greatly reduced. Once discharged, the central battery can be recharged at base, including using renewable sources, or from a vehicle battery. New, lighter battery technology, such as fuel cells, may be considered in future once established as safe and reliable for soldier-worn systems.

On naval capacities, the French naval company DCNS[5] is developing a ship concept called "Advansea concept ship" for ADVanced All-electric Networked ship for SEA dominance. It integrates three technologi-

5. In France, DCNS has contributed to the construction of the following vessels for the French Navy: nuclear-powered ballistic-missile submarines (SSBN) Le Triomphant, the multi-mission European frigate (FREMM) or the Barracuda nuclear-powered attack submarines. DCNS is also applying existing know-how to new areas with strong prospects, including civil nuclear energy and marine renewable energy.

cal breakthroughs: electric motors based on superconductivity; batteries capable of instantaneously delivering high power; and a real-time energy management system able to offer real energy convergence between the combat and platform systems. Beyond the technological challenge, there is a real combat ship, displacing 4,500 tons and with a length of 120m (390ft), which would be equipped with an electric cannon, vertical missile launch systems and capable of operating helicopters as well as drones. With an innovative design (in particular a double helicopter/UAV platform and a wave piercing hull), it will also use composite materials and benefit from measures to reduce its radar, acoustic and IR signatures. The concept ship was presented at the Paris Euronaval show in 2010. It gives a first glimpse of what a next-generation all-electric surface combatant might look like.

The disruptive technologies of the Advansea concept ship are superconducting electric propulsion motors combining energy savings, reduced weight and size and optimal power ratings (10 MW/motor). Superconductivity is the property of certain materials whereby resistance to electric current falls to a value very close to zero at very low temperatures. The ship should impulse energy storage devices that promise the instantaneous availability of large pulses of power. It could give real-time power flow management to users thanks to the convergence of combat system and platform management system technologies.

In terms of naval missions, the aim is to design a warship for use in regional conflicts with a risk of intense combat. This means designing a ship combining improved means of threat detection, the capacity to respond quickly to such threats using gradual and decisive-response weapons, and greater safety and comfort for the ship's crew. The first demonstrators may be available towards 2018. The project is also emblematic of DCNS's determination to position itself as a world leader in all-electric surface combatants.

DCNS is also implementing a new concept called SEPIA for "standing for Submarine with Environmental Performance Improvement Along-life". SEPIA was unveiled in November 2012 during the SIA (Submarine Institute of Australia) international congress. It constitutes a world's first in terms of environmental analysis and ecodesign applied to a submarine. This new R&D project, self-funded by DCNS, started by an analysis of the life cycle of an existing DCNS submarine, such as the Scorpène submarine. The goal is to evaluate the environmental impacts of each step of the submarine's life cycle: construction, active duty, maintenance, dismantling, etc. Ultimately, the aim is to identify new architectures and innovative technol-

ogies allowing the minimization of these impacts while meeting the operational standards of such a vessel. According to Eric Fusil, SEPIA Project Manager and Naval Architect at DCNS Naval Submarine Division, the focus is on three main areas: energy efficiency improvement; waste minimization; use of environmentally friendly materials. The effort is focused first and foremost on energy optimization of the propulsion system, by introducing two major innovations: the choice of a pump-jet, 20% more efficient than classic propulsion, and its implementation by two complementary electric motors to cover the vessel's speed and range envelopes with the best performance. SEPIA also makes extensive use of lighter and less polluting materials: silicone based hull coating (with the advantage of a less resistance in the water), composite pipes and aluminum based electrical wiring.

A last example is the cooperation between the French state-owned armaments group Nexter, the French DGA and the Swedish Defence Procurement Agency FMV. This cooperation included work on environmental management systems, the handling of chemical products and ways in which the environmental impact of the material procurement process could be reduced. Among the results of this cooperation is the jointly run project "Green GALIX". The purpose of this last project was to develop a method of reducing the environmental impact of large calibre munitions. The GALIX 46 is a smoke ammunition for the self-screening of armoured vehicles such as Leclerc and is already in use in France and Sweden. It was chosen as a subject for a specific study on the environmental impact of munitions. The project used life-cycle analysis to show which components of GALIX had the greatest through-life impact on the environment. The problematic components were replaced with "greener" alternatives. This three-year project was completed in 2009. Its methodology was used as an example for other "green" projects.

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As a conclusion, we must remember that energy efficiency friendly solutions cannot lead to a decrease in performances of defence equipment. As an example, energy efficiency measures must not lead to a lower efficiency of explosives or to propellants for missiles using less energy but being less effective. Raw materials used in high-explosive shells have to keep their penetrating power; environmental regulations could put at risk their military might.

The balance to keep between defence considerations and the need to implement energy efficiency measures is thus difficult to find. It explains why more cooperation is needed on energy efficiency.

What energy security implications for air transport operations?

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The end of the year 2013 was marked by the organisation of several international events focusing on defence logistics, Smart defence and operational energy security initiatives. As for instance, the "Defence Logistics Conference 2013"[1] was held from 3 to 5 December 2013 in Washington D.C., United-States and the annual "Military airlift rapid reaction and tanker operations Conference" was held from 3 to 4 December 2013 in Seville, Spain[2]. These conferences followed the "Military Airlift Conference[3]" held in Melsbroek, Belgium from 18 to 20 September 2013. All of them mostly aimed at developing innovative solutions for various key logistics and airlift challenges such as fuel management, commercial networks, energy and sustainability. They also offered a good opportunity to shed light on one particular aspect of military operations: the energy dimensions affecting defence logistical airlifting operations.

I.Strategic airlift: capabilities, energy and cost requirements

NATO operational context: from territorial defence to increased projections

Since the end of the Cold War, NATO has initiated a strategic evolution, partly shifting its operational focus from conventional territorial defence (Article 5 of the North Atlantic Treaty) to worldwide crisis management or humanitarian operations (so-called "non-Article 5" operations). This move has driven the Alliance to increasingly operate outside the traditional European boundaries through projection capabilities. By extending its scope of operations to projection missions, NATO intends to better response to the Alliance's current and future security challenges, as defined in the NATO 2010 Strategic Concept[4].

As NATO adjusted its mission requirements to meet the new strategic environment, the Alliance consequently had to determine the new strategic airlift requirements to meet its desired needs for reinforced projection capabilities.[5] The increased need for strategic airlifting capability in support of NATO's new operational requirements is reflected in NATO's new deployment and force generation schemes. In order to meet the new global mission requirements, NATO initiated force transformation efforts by creating in 2006 the first fully operational NATO Response Force (NRF). Although the NRF's sealift component provides significant lift capacity and potentially mitigates airlift limitations, the speed and flexibility required by the NRF's five-day deployment requirement necessitates a robust strategic airlift capability. Furthermore, NATO would most likely favour more aircraft rather than fewer to rapidly generate the NRF required level of daily combat sorties and deployment support.[6] Assuming that extended strategic airlifting capabilities are required to support potential NRF's deployment, the level of NRF operational requirement and pressure will definitely impact on the level of required airlifting capabilities in support of NRF major deployment and duties. With other words, more intense NRF operational pace will most likely require much more airlifting capabilities.

1. Website of the "Defence Logistics conference 2013" http://www.wbresearch.com/defenselogisticsusa/home.aspx
2. Website of the annual "Military airlift rapid reaction and tanker operations Conference 2013" http://www.smi-online.co.uk/defence/europe/conference/military-airlift-rapid-reaction-operations
3. Website of the "Military Airlift Conference 2013" http://www.militaryairliftevent.com/
4. NATO Official website about the 2010 Strategic Concept http://www.nato.int/cps/en/natolive/topics_56626.htm
5. U.S. Air Force Major James D. Hood – "NATO Strategic Airlift: Capability or Continued US Reliance?" – Air Command and Staff College Air University – April 2009
6. U.S. Air Force Major James D. Hood – Ibid.

Although it remains hard to predict NATO's operational future after the end of the operations in Afghanistan[7], experts agree that no major shift in NATO's overall concept, requirements and use of strategic airlifting capabilities is expected. Most likely, there will be an enduring NATO's requirement to transport personnel and materiel, together with the likelihood of an increase in concurrent operational activity. Expecting to remain engaged in worldwide issues, NATO's current Level of Ambition requires rapid and long-range logistic supports among which strategic airlifting provides the most rapid capability[8]. Therefore, NATO increased focus and involvement in projection operations might potentially increase the requirements for additional strategic airlifting capabilities.

Figure I. U.S airlifter C5 Galaxy loaded at Ramstein Air Base deployed in support of NATO operations
Source: U.S Army Europe, "U.S. Army Europe forces support NATO missile defense", 08 January 2013[9]

Strategic airlifter: fuel-hungry and costly capability

Transporting military equipment by air from NATO home units to areas of operation might be the fastest, most flexible and safest option for meeting NATO's projection strategic goals. However, this option is among the most expensive and the least energy efficient[10]. Indeed, one can assume that fuel supply and management might add substantial financial burden to large and simultaneous military operation's associated costs, as heavy airlifters generally consume huge amount of fuel. Starting from the assumption that NATO's increased interest in projection might bolster the demand in strategic airlift capabilities, the associated fuel (energy) needs might proportionally skyrocket while adding additional financial burden on NATO budget for operations. Although this question has rarely been addressed by experts[11], the case of NATO's involvement in Afghanistan can provide some limited insights.

7. Nevertheless, NATO and U.S. forces will keep operating in the country after 2014 although this point is still under discussion with the Afghan authorities.
8. JAPCC- Ibid.
9. Staff Sgt J. Salgado, "U.S. Army Europe forces support NATO missile defense", U.S Army Europe,, 08 January 2013, http://www.eur.army.mil/news/2013/20130108_10thAAMDC.html
10. General Duncan McNabb, former commander of US Transportation Command (US TRANSCOM), House of Representatives One Hundred Eleventh Congress Second Session Subcommittee on Defense –"Hearings before a subcommittee of the committee on appropriations" - 11 March 2010 "DH-ell: The Logistical Nightmare of Withdrawing From Afghanistan" – Defence IQ – 30 October 2012 - http://www.defenceiq.com/air-land-and-sea-defence-services/articles/withdrawing-from-afghanistan-a-logistical-nightmar/
11. As confirmed by experts contacted for the need of this study (and working at NATO Allied Command Operations (ACO) and Allied Command Transformation (ACT) in the field of heavy airlifter contracting and logistics.)
12. NATO Smart Energy Libguide Webpage - http://natolibguides.info/smartenergy
13. As pinpoint several NATO and military leaders:

As the total energy consumption of the ISAF operation remains unknown, transportation and energy related costs most likely have inflated the financial burden of the operation[12] . NATO assesses that ISAF needed more than four million litres of fuel per day for supporting its operations in Afghanistan (transportation included) in 2009. In addition, an average of four litres of fuel was consumed for supplying and transporting a single litre of fuel to Afghanistan. Furthermore, up to thousand fuel convoys per year have been sent to ISAF bases in Afghanistan. Regarding the costs, the assessments conducted at this early stage have led to a certain financial underestimation of the operation. According to experts, the expected high level of associated costs affecting ISAF is partly caused by the overreliance on costly and energy-hungry airlift capacities. [13]

Looking into details at specific national contributions[14] , an estimated 75 per cent of the U.S. Department of Defence's (DoD) energy use is "operational energy" burned to train, move and sustain military forces[15] where oil accounts for virtually all of DoD operational energy consumption.[16] In addition, the U.S. DoD purchases more than 20 billion of litre of fossil fuel each year out of which more than the half (53 per cent) is used by the U.S. Air Force, the largest fuel consumer out of all U.S. military branches.[17] By comparison, the Navy makes up 28 per cent of total DoD fuel consumption, the Army 18 per cent, and the Marines and Coast Guard less than 1 per cent.[18] This shows the heavy energy burden generated by air operations (including strategic airlift capabilities), as depicted by Figure II.

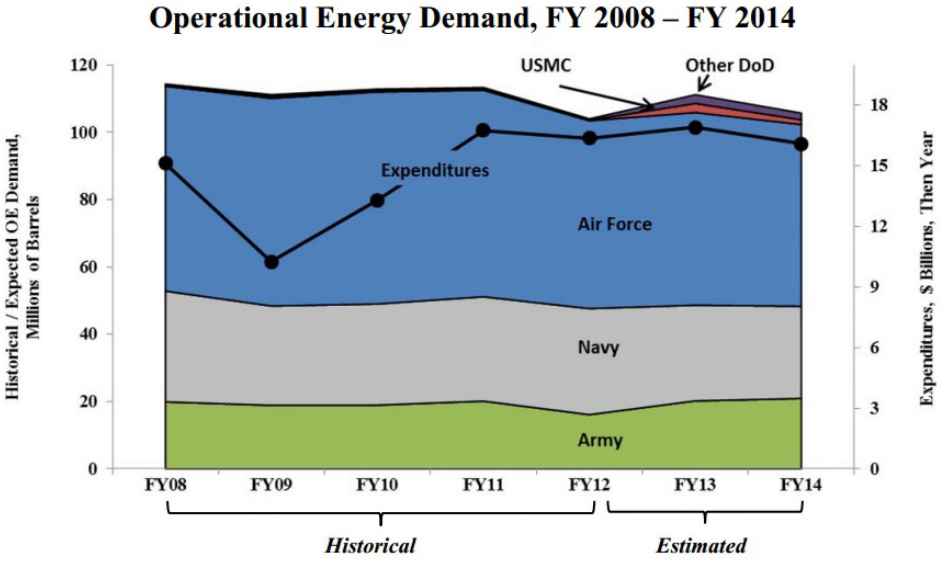

Figure II. U.S. DoD Operational Energy Demand by Service and Oil Prices
Source: U.S. Department of Defense, Fiscal Year 2012 Operational Energy Annual Report [19]

General Duncan McNabb, Ibid. ; Francis Tusa, Securing the Future of Afghanistan, British House of Commons Defence Committee, March 2013; Joshua Kucera - "NATO: Russia's Afghan Transit Center Too Expensive" – EurasiaNet (The Bug Pitt) – 01 April 2013 http://www.eurasianet.org/node/66766?

14. The numbers are not always publicly available for each NATO country. It must also bear in mind that US, UK and Canada are the only NATO Members which own large strategic airlifters. US remain the largest of airlift contributors in support of NATO operations.
15. A. Holland and N. Cunningham, "DoD's Biofuels Program", American Security Project, January 2013, http://americansecurityproject.org/ASP%20Reports/Ref%200109%20-%20Factsheet-%20DoD%E2%80%99s%20Biofuels%20Program.pdf
16. S. Karbuz, "How much Energy Does the U.S. Military Consume – An Update", The Daily Energy Report, 05 August 2013, http://www.dailyenergyreport.com/how-much-energy-does-the-u-s-military-consume-an-update/
17. K. Geiss – "Biofuel takes off with U.S. Air Force" – The Washington Times – 12 April 2011 - http://www.washingtontimes.com/news/2011/apr/12/power-not-prisoners-is-gitmo-legacy/
18. A. Holland and N. Cunningham, Ibid.
19. US Department of Defense, Fiscal Year 2012 Operational Energy Annual Report http://energy.defense.gov/Portals/25/Documents/Reports/20131015_FY12_OE_Annual_Report.pdf
20. A. Holland and N. Cunningham, Ibid.
21. D. Alexander – « U.S. Air Force tests biofuel at $59 per gallon" – Reuters – 15 July 2012 - http://www.reuters.com/article/2012/07/15/us-usa-military-biofuels-idUSBRE86E01N20120715
22. M. Harwood, "A more fuel-efficient Air Force", Air Force Times, 22 September 2013 - http://www.airforcetimes.com/article/20130922/NEWS04/309220006/

Regarding the costs, the U.S. DoD estimates that every USD 25 cent increase in the price of a gallon (approx. 4 litres) of fossil fuel costs[20] the military USD 1 billion in additional fuel costs. Besides, U.S. DoD's fuel costs increased by 381 per cent from 2005 to 2011, grow¬ing from USD 4.5 billion to USD 17.3 billion. Since fuel consumption actually declined by four per cent over this period, the cost surge reflects rising oil prices. According to Kevin Geiss, U.S. Air Force deputy assistant secretary for energy, the U.S. Air Force spends about USD 10 billion a year on energy, with nearly USD 9 billion of that being for plane fuel.[21]

In addition, the Air Force allocates 60 per cent (of this USD 9 billion) to its daily 900 mobility and cargo flights.[22] The graphic provided here below (and using different sources) confirms the aforementioned financial trends provided by the U.S. DoD over the last fifteen years, the U.S. DoD has been coping with increasing price rate to meet its fuel demand out of which the Air Force accounts for more than the half (see Figure III). From 2001 to 2013, the U.S. Air Force spent hundreds of millions of U.S. dollars to private contractors charged with supplying the main U.S. / ISAF logistical air base located in Manas, Kyrgystan with fuel.[23]

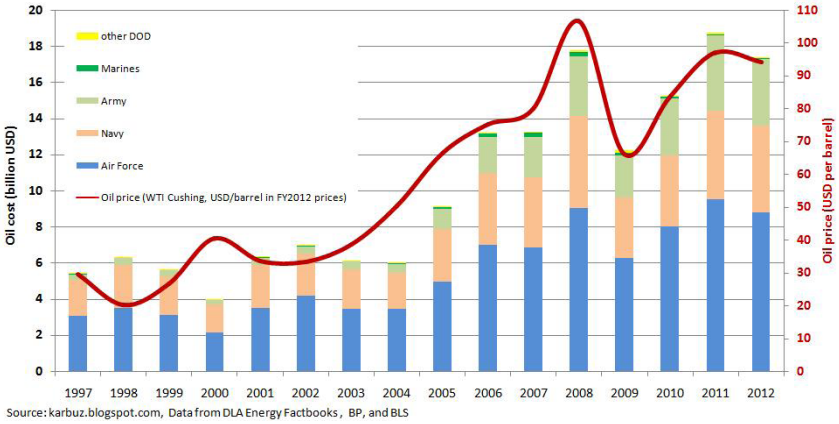

Figure III. The U.S. Department of Defense Oil Cost by Service, and Oil Prices
Source: The Daily Energy Report, "How much Energy Does the U.S. Military Consume – An Update", 05 August 2013

Regarding other NATO Allies as such as France[24], the trends look similar. The French Defence Ministry states that it allocated roughly 70 per cent of its fuel capacity to "operational energy" and transport needs in 2010.[25] Moreover, the Ministry adds that aviation fuels represent the major part of the total fuel demand, which contributes to severely deepen the energy needs of the entire organisation. The French "Defence Fuel Service" (SEA)" disclosed that the French Air Force (Armée de l'air) had consumed approx. 44 per cent (436, 280, 000 litres) out of the total amount of fuel used by the French MoD in 2012.[26] By comparison, the French Navy (Marine Nationale) consumed approx. 21 per cent while the Army (Armée de terre) made up 8 per cent out of the total fuel consumption (see Figure IV). Regarding the recent French operational involvement in Mali[27] – which required extended projection and heavy airlifting capabilities – the French forces carried twice more troops and materiel by air than by sea (18, 000 tons in 480 rotations).[28] From January to March 2013, the French military consumed in Mali 90 million litres of aviation fuel[29] (96 per cent out of the total operation's fuel demand) and three million of regular fuel.[30]

23. G.Lubold, Y. Dreazen, "Cashing Out: U.S. Military Quits Critical Air Base After $100 Million in Payoffs", "Foreign Policy", 18 October 2013 http://complex.foreignpolicy.com/posts/2013/10/18/cashing_out_us_military_quits_critical_air_base_after_100_million_in_payoffs
24. Although France is not a major strategic airlifter operator, the country remains a major player within NATO. Moreover, the country is regularly involved in projection operations (not always within NATO frameworks), which offers interesting insights for studying the issue of fuel consumption in projection and airlifting operations.
25. Ministère de la Défense et des Anciens Combattants, « Stratégie Ministérielle de la Performance Energétique », Feb. 2012
26. - "Service des Essences des Armees (SEA) - "Annual Report 2012of the French Fuels Defence Service" http://www.defense.gouv.fr/content/download/210086/2331777/file/rapport%20activite%202012_SEA.pdf
27. Although the French operation « Serval » in Mali is not a NATO-led mission, it remains one of the best examples of a recent projection operation led by a major NATO Ally.
28. Opex360.com, "Mali : L'opération Serval en chiffres", 22 September 2013, " http://www.opex360.com/2013/09/22/mali-loperation-serval-en-chiffres/
29. Including strategic and intra-theaters, French

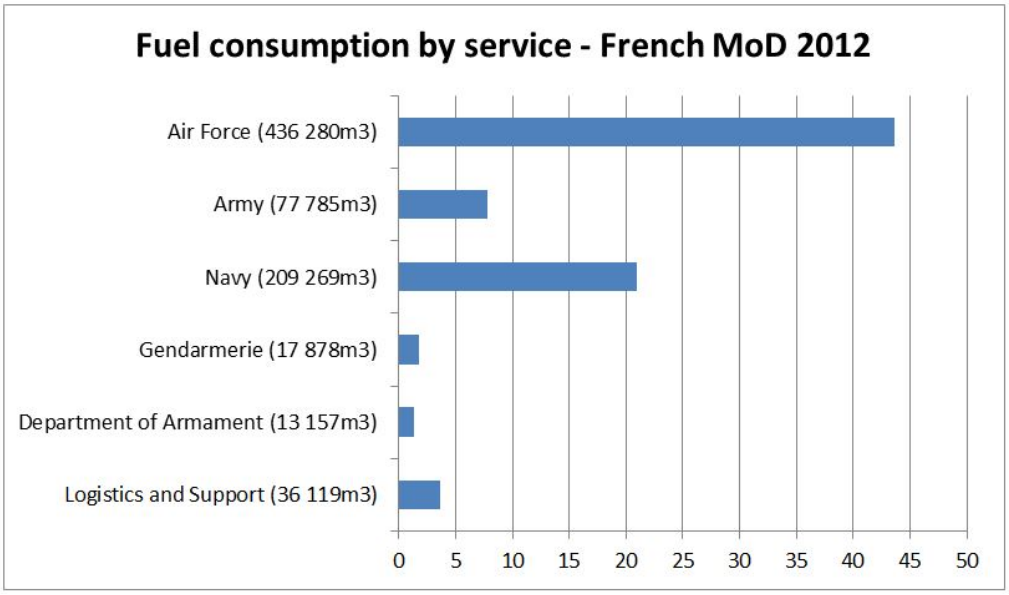

Figure IV. Level of fuel consumption for each service and components of the French Ministry of Defence
Source: Service des Essences des Armees (SEA) – "Annual Report 2012"

Strategic airlifters: fossil fuel dependency and lack of diversification

The previous points highlight a recurrent weakness affecting military forces in general and the air force branches in particular: an overreliance and dependency on fossil fuel and the lack of diversification in the fuel production. This dependence on a single, expensive, difficult-to-transport and finite source of energy consequently causes operational, strategic and financial risks[31]. Apart from cost, the energy and fossil fuel dependence of the armed forces has an impact on operational effectiveness, say NATO officials.[32]

For instance, transporting large quantities of fuel creates risks to the safety of the soldiers and demands an increasingly complex and costly logistical organization, including more air fuel support with heavy airlifters. At the strategic level, military forces might increasingly depend on fossil fuel international producers, the oil market and prices volatility. This issue might reduce the forces' readiness and room of manoeuvre[33] and directly affect the most fuel-hungry military branches such as the air components.

The French MoD confirms this point by acknowledging that its fossil fuel dependency is resulted mainly by its high demand for and use of aviation fuels for which alternatives are rare and/or not existing. [34]

II.Smart Defence and operational energy security initiatives in support of logistical air transport operations

NATO's high interest for projection mission and its subsequent operational Level of Ambi-

and international airlifting operations

30. Service des Essences des Armees (SEA) – "Les Nouvelles du SEA – Deploiement Éclair au Mali" – Numero 2 – 2013 - http://www.defense.gouv.fr/base-de-medias/documents-telechargeables/essences/nouvelles-du-sea/les-nouvelles-du-sea-2-2013
31. A. Holland and N. Cunningham, Ibid.
32. "NATO Armed Forces Embrace Renewable Energy" - Environment News Service (ENS) – 11 July 2013 - http://ens-newswire.com/2013/07/11/nato-armed-forces-embrace-renewable-energy/
33. A. Holland and N. Cunningham, Ibid.
34. Ministère de la Défense et des Anciens Combattants, « Stratégie Ministérielle de la Performance Energétique », Fév. 2012
35. Companies as such Boeing (http://www.boeing.com/news/frontiers/archive/2009/august/qt_ab.pdf) have been working on the improvement of the fuel efficiency of its heavy airlifters (e.g. C-5 Galaxy - http://www.bga-aeroweb.com/Defense/C-5-Galaxy.html) mainly benefiting to the needs of the U.S. Air Force (http://www.dover.af.mil/news/story.asp?id=123296571). Such measures are also implemented by the Australian Air Force (http://www.airforce.gov.au/News/Air-Force-fuel-management-trial-for-Hercules/?RAAF-CbBOXTZQLolSgr47NWBYqhjTXT7ONB+h) or the Russian MoD (http://www.ainonline.com/aviation-news/ain-defense-perspective/2012-10-12/russians-confirm-il-476-airlifter-production)
36. V. Insinna & Y. Tadjdeh , "Air Force Making Headway on Fuel Efficiency Goals", National Defence Magazine, June 2013, http://www.nationaldefensemagazine.org/archive/2013/June/Pages/AirForceMakingHeadwayonFuelEfficiencyGoals.aspx
37. NATO information page on SALIS http://www.

tion (NRF) could fuel higher demands for airlift capabilities among the Alliance. Therefore, the energy demand, the fuel consumption / dependency and the operational associated costs are thus expected to rise especially if NATO undertakes more frequent crisis management missions. In order to address similar issues in current of future operations, leading heavy airlifter's industrial producers and military actors have increasingly realised that they need to take measures for improving their energy independency and the fuel efficiency of their airlifter fleet. Those measures should enable essential cost-limitations while improving the operational efficiency. [35]

Likewise, the U.S. Air Force pledged in 2010 to reduce aviation fuel usage by ten per cent before 2015.[36] In order to meet that goal, the U.S. DoD and the U.S. Air Force have launched several initiatives in the last years to develop alternative fuel production option and fuel efficiency standards, hence setting benchmarks in that field. More precisely, the U.S. strategy centres on reducing demand, diversifying its energy sources and investing in new technologies that save fuel. The following subchapters explore the existing and future options developed by NATO and some of its Member-States (at the national level) in order to tackle the issue of energy and fossil fuel consumption for logistical operations.

Strategic Airlift Interim Solution (SALIS) program

With the support of NATO Support Agency (NSPA), NATO is currently involved in two interim capabilities programmes in order to create a genuine airlift capability at the service of the Alliance and its partners. The Strategic Airlift Interim Solution (SALIS)[37] gathers six leased Antonov An-124-100 transport aircrafts which can be chartered by twelve NATO nations and two partner nations (Finland and Sweden). Those An-124-100 are leased from the heavy cargo charter company "Ruslan International" [38]. The other program is the Strategic Airlift Capability (SAC)[39], under which ten NATO countries plus two partner countries have purchased three Boeing C-17 Globemaster III transport aircraft.[40] So far, most missions have been in support of ISAF operations in Afghanistan, which highlights the impact of the ISAF retrograding on NATO's need for increased heavy airlifter capabilities. [41]

Experts agree that joint ownership and/or leasing provide efficiencies by giving participants a greater airlift capability at a lower cost than if purchased individually. This "Smart Defence" option allows nations to satisfy their individual requirement á la carte and, in collaboration with other nations, to realise potential efficiencies in procurement, operational, maintenance, support, management and through-life costs, including fuel supply.[42] Regarding fuel consumption, experts present those programs as an efficient way to reach economy of scale although they fail providing accurate assessment on the advantages pertaining to fuel efficiency. Looking at the main "spirit" of pooling & sharing initiatives, one can assume that the main advantage lies in the burden and cost sharing among the participants. NATO SALIS / SAC partners benefit here from a collective capability where all the stakeholders share the financial and energy burden of the transportation operation.

nato.int/cps/en/natolive/topics_50106.htm

38. Ruslan International Webpage http://www.ruslanint.com/
39. NATO information page about SAC http://www.nspa.nato.int/en/organization/NAMP/sac.htm
40. However, it must be stressed that the SAC program is not a NATO body: SAC is a multinational program gathering some NATO Members and aiming at purchasing shared heavy airlifters.
41. B. McNally– "Outsourcing Strategic Airlift: NATO's Two Very Different Solutions" – Defense media network – 25 July 2013 - http://www.defensemedianetwork.com/stories/outsourcing-strategic-airlift-natos-two-very-different-solutions/
42. JAPCC – Ibid.
43. C. Molling, "Pooling and Sharing in the EU and NATO", SWP-Berlin, 18 June 2012, http://www.swp-berlin.org/en/publications/swp-comments-en/swp-aktuelle-details/article/europes_defence_pooling_sharing.html
44. NATO Review Magazine, Smart Defence in Action, "The Fuel Soldiers", 21 October 2013, http://www.nato.int/docu/review/2013/Smart-Defence-Action/fuel-soldiers/EN/index.htm
45. B. McNally, Ibid.
46. E. Quintana, "NATO Cannot Sustain its Cur-

In other words, one or more countries can provide their partners with fuel supply for the other partners. If this occurs on a permanent basis, the partners can cut this capability and share / save on costs.[43] With regards to pooling, operational experience has shown that the ability to adapt logistics to changing requirements and to coordinate properly among participating nations is the key to success. Moreover, multinational capabilities are more cost-effective, which is a priority in times of financial austerity. Such initiatives are currently developed within NATO under the name of "smart fuel support".[44] Hence, experts believe that pooling the resources decreased the burden that one nation would have to bear if it had sole responsibility for fuel support. Furthermore, it can enable the Alliance to reduce its logistical footprint, be more effective and cut the costs of coalition fuel support while operating a common fleet of heavy strategic airlifters. The current SALIS /SAC models are likely to be replicated in the future as those programs provide benchmarks and positive lessons-learned derived from the ISAF ongoing retrograding.[45]

Use of alternative fuels

NATO and NATO partners are also developing solutions in order to diversify fuel production options while improving at the same time the energy efficiency during air operations. Energy security concerns are driving the development of alternative fuels principally for the U.S. Air Force and the U.S. Navy. [46] The U.S. Air Force has been working in that field for a couple of years in order to produce biofuel and other alternatives for its jet fighters and planes. The main researches focus on the production of alcohol-made or algae-made biofuel. So far, the U.S. Air Force has approved 99 per cent of its aircraft fleet, ground equipment and vehicles to operate on a blend of synthetic (including biofuel) and traditional jet fuels. [47]

Regarding the cost assessment, Gevo Inc., a private U.S. company involved in biofuel and alcohol-made fuel sold the U.S. Air Force 11 000 gallons of synthetic fuel (almost 42 000 litres) at USD 59 per gallon (3,8 litres) in 2012 to complete certification testing to ensure it can be used in military jets.[48] Due to the existing huge price gap between biofuel / alcohol fuel and fossil fuels, experts remain sceptical about the efficiency and the associated costs of such projects. Experts underline that the prices are not competitive as the purchase of a single gallon of fossil fuel still averages USD 3,60 for the U.S. Air Force.[49] However, experts assess that recent technology breakthroughs could help stabilise the price around USD 2/ gallon by 2017.[50] Retired high ranking U.S. Air Force officers recognise as well that biofuels are currently too expensive for covering large-scale operational needs. [51]

Nevertheless, Air Force officers underline that it is relevant to test those alternative fuels, as the reduction of the Air Force's dependency upon fossil fuel remains a key strategic goal to achieve. Furthermore, Jeff Scheib, Gevo Inc. vice president for fuels acknowledges that alcohol-to-jet fuel made for the Air Force is expensive.[52] However, Gevo Inc. explains that the prices are high because the produced and available quantities of alcohol fuel remain limited. Echoing this concern, the U.S. DoD announced that it would be able to secure 50 per cent of its fuel from alternative sources by 2016 by supporting the creation of large refineries and the annual production of 50 million barrels in a near future.[53]

rent Fuel Addiction", RUSI, 08 October 2010, http://www.rusi.org/analysis/commentary/ref:C4CAED999A3AD8/#.Urcpk_RdXwY

47. K. Geiss – "Biofuel takes off with U.S. Air Force" – The Washington Times – 12 April 2011 - http://www.washingtontimes.com/news/2011/apr/12/power-not-prisoners-is-gitmo-legacy/
48. D. Alexander – « U.S. Air Force tests biofuel at $59 per gallon" – Reuters – 15 July 2012 - http://www.reuters.com/article/2012/07/15/us-usa-military-biofuels-idUSBRE86E01N20120715
49. T. Worstall – "Air Force Biofuel At $59 A Gallon: Cheap At Twice The Price" – Forbes – 16 July 2013 - http://www.forbes.com/sites/timworstall/2012/07/16/air-force-biofuel-at-59-a-gallon-cheap-at-twice-the-price/
50. A. Holland and N. Cunningham, Ibid.
51. D. Alexander – Ibid.
52. Idem
53. E. Quintana, Ibid.
54. V. Insinna & Y. Tadjdeh , Ibid.
55. Air-Attack-com, " Aircrafts Factsheets – C-17

Technological, procedural and management improvements

Beside pooling & sharing measures or alternative fuel production, NATO Air components and the U.S. Air Force have started implementing additional measures aiming at increasing the fuel efficiency of heavy airlifters. Those additional measures are combined with the solutions presented hereinabove in order to achieve high standards in operational energy security for airlift operations. Regarding technologies, new heavy airlifters' generations and platforms are equipped with new equipment, such as fuel efficient engines or improved designs, which lead to greater fuel efficiency.[54] For instance, the U.S. Boeing C-5 Galaxy airlifter has now more energy efficient engines that enable a 3 per cent improvement in the burn rate of fuel per hour while enabling larger range cover.
Other airlifters such as the Boeing C-17 use special wings equipped with advanced air foil designs that enhance the range, cruising speed and fuel efficiency of jet aircraft. In Europe, the new strategic airlift[55] A-400M is also equipped with more energy efficient engines, boosting its operational abilities.[56]

Human behaviour and standard procedures can also improve fuel efficiency and operational energy security standards. Hence, some regular maintenance tasks and engine cleaning techniques also help reduce fuel consumption[57]. Since the airlifters' tankers are cleaned once every two years, the U.S Air Force Air Mobility Command (AMC) averages the fuel savings to 1 per cent per year, which saves USD 2 million in fuel annually. The U.S. Air Force has as well introduced new flying habits and procedures, aiming at improving the fuel efficiency during operations. For instance, the U.S. AMC is reducing the weight of aircraft by removing non-mission essential cargo. Furthermore, the U.S. Air Force and the AMC have started implementing fuel saving procedures used in the civilian and commercial aviation such as routes optimization, new fuel-efficient landing procedures or Cost Index Flying policy implementation (Mission Index Flying (MIF))[58]. At last, the Air Force has also set analysis task force (composed of Reservists and civilian experts) while investing in studies to improve fuel efficiency.

Thanks to the combined effect of all those measures, the U.S. Air Force has reduced its total aviation fuel consumption by 12.4 per cent since 2006, exceeding its previous goal to reduce consumption across the entire fleet by 10 per cent by 2015 based on a 2006 baseline.[59] Since 2006, mobility air forces (including heavy airlifter operations) have cut the cost to move one ton of cargo one mile (1,8 km) by 24 per cent, from USD 1, 56 to USD 1, 18. In other words, the U.S. Air Force has netted millions in savings over the last several years from better fuel efficiency.[60]

Conclusion

Defence logistics and air transport operations are areas where associated energy needs and costs remain high. Therefore, this field offers military actors an opportunity to develop new solutions and alternatives in order to better manage the fossil fuels' needs for air transport operations while limiting their fuel dependency. From that perspective, the current ongoing projects implemented within NATO and by the U.S. Air Force are worth being followed up. However, there is still at this stage room for continuing such initiatives. From that perspective, the current ISAF logistical withdrawal out of Afghanistan or any future NRF deployment could offer valuable lessons-learned for addressing the energy and fuel management concerns of future large-scale logistical air transport operations.

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