NATO OTAN

RESEARCH PAPER

Research Division – NATO Defense College, Rome – No. 106 – November 2014

Operational Green

Enhancing NATO's Energy Supply Security

by Jonathan Bitoun[1]

Research Paper
ISSN 2076 – 0949
(Res. Div. NATO Def. Coll., Print)
ISSN 2076 – 0957
(Res. Div. NATO Def. Coll., Online)

Research Division
NATO Defense College
Via Giorgio Pelosi, 1
00143 Rome – Italy
Dr. Jeffrey A. Larsen, PhD, Division Head
website: www.ndc.nato.int
Follow us on Twitter
at *https://twitter.com/NDC_Research*

Printed and bound by
DEd'A srl
V.le Scalo San Lorenzo 55, 00185 Rome, Italy
www.dedaedizioni.it

Energy security has increasingly become a major theme in the international security debate. This comes as little surprise, in view of the many developments which are shaking global energy markets in unprecedented ways. Such developments include, but are not limited to: intensifying debates on climate change that advocate a decrease in fossil fuel usage; the growing energy needs of rising powers, such as China and India, which will account for a 40 percent increase in future global energy demand;[2] the depletion of global fossil fuel reserves; the general increase in the price of raw materials, such as crude oil; and Europe's ever-growing dependence on oil and gas.

How does this relate to the NATO Alliance? There are growing imbalances between supply and demand in today's energy markets – especially for oil and gas – which can only lead to instability in the supply chains of NATO's Allies and Partners. An increase in the price of fossil fuels can directly affect the operational capacity of military forces, and therefore has an important security dimension. To put this in perspective, in the US "every $1 increase in a barrel of oil adds approximately $130 million to the military's energy bills."[3] Since NATO nations account for about 39 percent of global oil consumption, the highly volatile nature of this commodity and the geopolitical considerations associated with it mean that it is in the Alliance's best interests to reduce its fuel dependency and overall consumption so as to enhance its energy security.[4]

In an age of austerity, it is as former Assistant Secretary General for the Emerging Security Challenges Division Gabor Iklody stated: "All in all, in financial as well as security terms, our fuel dependency creates a lose-lose

[1] Jonathan Bitoun is a Master of Global Affairs candidate at the Munk School of Global Affairs (University of Toronto). The views expressed in this paper are the responsibility of the author and do not necessarily reflect those of the NATO Defense College or the North Atlantic Treaty Organization.

[2] Michael Rühle, "NATO and Energy Security," *NATO Review*, 2011, p. 5, http://www.nato.int/docu/review/2011/Climate-Action/Energy_Security/EN/index.htm (accessed 06 May 2014)

[3] Kevin Kosner, "Smart Energy is Smart Defense," *Journal of Energy Security*, 19 Apr 2012, http://ensec.org/index.php?option=com_content&view=article&id=347:smart-energy-is-smart-defense&catid=123:content&Itemid=389 (accessed 23 June 2014).

[4] Michael Rühle, "Energy Security and NATO: Emerging challenges to critical energy infrastructure," Session 4, Reliability of critical energy infrastructures, Expert meeting on assessing the OSCE's future contribution to international energy security co-operation, OSCE Secretariat - Office of the Co-ordinator of Economic and Environmental Activities, Vilnius, 14 Sept. 2010, speech, p. 2.

situation."[5] NATO has already recognized that energy consumption for its forces has reached "unprecedented levels" that need to be reduced, and that diversifying energy supplies is a strategic imperative.[6] Making defence greener is vital, and the opportunity for progress has never been better.

According to NATO, energy security has three main dimensions: supply security, economic competitiveness and environmental issues.[7] Economic competitiveness is most relevant to the energy industry as a whole, a subject that lies outside the scope of this paper. Naturally, environmental issues are high on the international agenda. NATO has already stated that "demonstrating environmental awareness is in the interest of both Allies and partners alike."[8] Since many have already formulated ambitious environmental policies, it serves little purpose to reiterate the ecological reasons why NATO should pursue greater renewable energy integration. However, the glaring security risks of military fossil fuel dependency have yet to be fully addressed. With that in mind, this paper seeks to further discuss the role of renewable energy in enhancing the supply security of NATO militaries and operations; and stimulate debate to further its integration.

The analysis will focus on solar energy because it is arguably one of the most versatile and fastest growing segments of renewable energies, and one of the most abundant in NATO operational theatres. It will examine how solar power can contribute to both reducing energy demand and diversifying energy supplies, thus translating into greater supply security. Fears over a loss in operational capabilities have often troubled the integration of renewables for military applications. However, this analysis will illustrate how solar energy can actually help increase operational capabilities, as well as help reduce costs. Before doing so, it is important to understand what NATO supply (in)security means, and what NATO has done to address this issue. Therefore, a breakdown of NATO's main energy vulnerabilities will be presented first, followed by an overview of remedial actions which the Alliance has taken thus far. Finally, how solar energy can improve military supply security will be discussed.

NATO energy vulnerabilities: issues with 'business as usual'

Most NATO military forces are dependent on fossil fuels to operate. These are used to provide electricity for communications, heating, cooling or lighting on bases, in addition to powering tactical vehicles and those used for transporting materials, among many other services. In short, fuel is fundamental to the success of NATO forces, but providing it can quickly become a "logistical nightmare."

Energy costs are a colossal drain on nations' defence budgets. For instance, the US Department of Defense (DoD) spends about $20 billion per year on energy, $15 billion on fuels and $5 billion on facilities, both inside and outside of its territory.[9] However, the topic of military fuel costs goes well beyond the financial aspect. The transport of large quantities of fuel into operational theatres requires force protection assets to ensure that the fuel arrives at its designated location. This creates risks for the safety of soldiers and contractors and requires a complex and increasingly costly logistical organization. So when addressing the cost of energy, one should take into account the fully burdened cost of energy (FBCE). This considers all operational factors in the energy supply chain, including transport, infrastructure, manpower, maintenance, security protection and storage of energy, allowing for a more thorough evaluation of costs when assessing energy alternatives for military operations.

NATO's energy demand has two dimensions: energy for fixed installations and operational energy.[10] The ability to

[5] Gábor Iklódy, "NATO Armed Forces Embrace Renewable Energy | Environment News Service," *Environment News Service,* 11 Jul 2013, http://ens-newswire.com/2013/07/11/nato-armed-forces-embrace-renewable-energy/ (accessed 06 May 2014).

[6] NATO Parliamentary Assembly, "Resolution 407 on new energy ideas for NATO militaries: building accountability, reducing demand, securing supply." NATO PA 59th Session, 200 STC 13 E rev, 1 bis, Oct 2013.

[7] "Fuel for thought," *NATO Review*, 2012, http://www.nato.int/docu/review/2012/Food-Water-Energy/Fuel-thought/EN/index.htm (accessed 06 May 2014).

[8] Julijus Grubliauskas, "NATO's energy security agenda," *NATO Review,* 2014, http://www.nato.int/docu/review/2014/NATO-Energy-security-running-on-empty/NATO-energy-security-agenda/EN/index.htm (accessed 06 May 2014).

[9] Col. Romualdas Petkevicius, "Critical Energy Infrastructure Protection," *NATO Advanced Research Workshop*, Defence Against Terrorism Centre of Excellence, Ankara, 13 November 2012, speech, p. 4.

[10] Operational energy refers to the energy required for training, moving and sustaining military forces and weapons platforms for military operations in operational theatres. Osman Bak, "New Energy Ideas for NATO Militaries: Building accountability, reducing demand, securing supply," Report 159 STCEES 13 E bis. Sub-Committee on Energy and Environmental Security, 13 October 2013, p. 8.

access reliable sources of energy and deliver that power to meet needs in both dimensions is of critical importance for the Alliance.

Fixed installations

With regard to fixed military installations, reducing overall demand for fossil fuel energy will ease national energy security vulnerabilities. In the US, 20 percent of military energy consumption occurs at fixed installations, costing about $4 billion per year.[11] Military installations in NATO member states host critical systems that must be operational 24/7 and 365 days a year. This has become increasingly necessary, as these domestic military bases have expanded their role from troop training to also supporting forward operations, emergency response and humanitarian relief.

However, greater responsibilities also mean that more resources are required for these installations to operate, making them even more vulnerable to power outages. Most militaries are dependent on the commercial power grid to provide electricity to their fixed installations, meaning they are susceptible to natural disasters, attacks, or adverse weather conditions. About 500 US domestic bases are 99 percent reliant on the commercial power grid for electricity. Extended outages not only render critical military services powerless, but also represent a significant economic cost. In 2012, 87 percent of US power outages lasting over 8 hours were caused by weather conditions, and had a financial impact estimated at $7 million.[12]

Traditionally, aging backup infrastructure, such as diesel generators, has been used to maintain basic operations if an outage occurs, but there are numerous limitations to the capabilities of such systems. Many of them suffer from low efficiency, and can only provide energy power for periods of a few hours or a few days.[13] Even if located on home territory, these generators don't allow for energy storage and are dependent on continuous fuel supplies. It is important for NATO militaries to be prepared for oil supply disruptions, as this could have crippling effects on both the nation's economy and the ability of military installations to maintain basic operations.

In an age of emerging threats and cyber warfare, "there is too much risk of extended power loss in the events of an attack on the fragile electric grid."[14] To effectively ensure national security, NATO militaries must be able to deploy resilient energy systems that could sustain critical operations during a blackout.

Operational theatres

The energy provided to forward operating bases (FOBs) constitutes a significantly larger share of the military's overall energy consumption.[15] FOBs are vital in supporting the expeditionary and campaign capabilities of NATO militaries in operational theatres. They must be able to provide basic services, including cooking facilities, heating and cooling systems, power supply for running battery chargers, light, sensors and communications. A shortage of fuel and power could result in halting operations and disrupting critical support functions.

FOBs represent a safe haven for soldiers, providing respite from the constant danger, fatigue and psychological toll of warfare; to logisticians, they are the hub of immense logistical efforts and costs.

Fuel Logistics

Approximately half of the fuel consumed by international forces in Afghanistan was provided by NATO in support of International Security Assistance Force in Afghanistan (ISAF), and rose from 23 million litres per year in 2004 to 1 billion litres per year in 2010.[16] These large amounts of fossil fuel required to sustain FOBs can only be met

---

[11] American Council on Renewable Energy, "Renewable Energy for Military Installations: 2014 Industry Review," Industry Review, February 2014, p. 5.

[12] The PEW Charitable Trusts, op. cit., pp. 2-7.

[13] Zuzana Mjartanova, "Real-life options for military energy self-sufficiency," *Energy Security Forum* No 1(7), June 2013, pp. 9-11, NATO Energy Security Centre of Excellence, http://www.conflictstudies.org.uk/files/esforum-2013-m.pdf (Accessed 07 May 2014), p. 9.

[14] Texas Fort Bliss spokesman Maj. Joe Buccino. Hildebrandt, Peter, "US Military Soldiering Up with Energy Efficiency and Renewables Implementation." *Business Energy,* 10 Mar 2014. http://www.distributedenergy.com/DE/Editorial/US_Military_Soldiering_Up_With_Energy_Efficiency_a_24943.aspx (accessed 04 June 2014).

[15] FOBs are rapidly established bases on the front lines and are capable of independently supporting and launching sustained combat operations much like fixed theatre installations. Examples of FOBs include contingency operation bases, main operating bases, camps, combat outposts, patrol bases, tactical bases, logistic bases, intermediate staging bases, fire bases, and enduring bases. David S. Eady, Steven B. Siegel, Steven R. Bell, Scott H. Dicke, "Sustain the Mission Project: Casualty Factors for Fuel and Water Resupply Convoys," Final Technical Report, Army Environmental Policy Institute, September 2009, "Sustain the Mission Project: Casualty Factors for Fuel and Water Resupply Convoys," Final Technical Report, Army Environmental Policy Institute, September 2009, p. 1.

[16] NATO-Wide Executive Development Programme (NEDP), "A GREEN IT Concept for the Alliance: Sustainability, Security, and Savings," NEDP, 2013, p. 20.

by sending frequent fuel convoys, which translates into substantial costs, both in dollars spent and lives lost. At the peak of operations in Afghanistan there were approximately 5,396 trucks supplying US forces daily, in addition to some 1,306 NATO and Defence Logistics Agency energy fuel trucks.[17]

In terms of budgetary costs, conveying these fuel trucks to remote FOBs in underdeveloped countries can increase the cost tenfold. In 2009, the Pentagon disclosed that delivering petroleum fuel to remote combat locations in Afghanistan could cost "a whopping $400 per gallon."[18] Furthermore, according to a 2009 field study from the US Marine Corps (USMC) Afghanistan, for every gallon of generator fuel used, it took seven gallons to transport it there.[19]

More troublesome still is that military units must guard these large logistic resupply convoys, thus putting soldiers' and contractors' lives at considerable risk. As depicted in Figure 1, the force protection required for fuel convoys accounts for the majority of the fully burdened cost of fuel (FBCF) for FOBs. Fuel convoys are susceptible to theft, damage from improvised explosive devices (IEDs) and insurgent attacks. In 2012 alone, there were around 1,100 attacks on ISAF fuel convoys in Afghanistan. According to official records, between 2003 and 2007, the protection of fuel convoys resulted in more than 3,000 military and contractor casualties. It is difficult not to see the value in reducing fossil fuel consumption, when estimates indicate that there is one casualty for every 46 convoys deployed in Afghanistan.[20] In 2007, one American soldier or contractor was wounded or killed for every 24 fuel supply convoys.[21] To put this into greater perspective, up to 1000 fuel convoys per year have been sent to bases in Afghanistan alone, to satisfy ISAF's fuel consumption of up to 4 million litres per day.[22] Clearly, NATO forces rely too heavily on fossil fuels, resulting in high monetary costs, security risks, and human casualties. Any reduction in the amount of fuel requiring transport will have a direct impact on logistical costs and potential casualties.

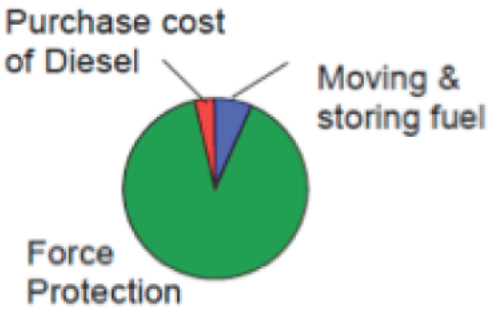

Figure 1: FOB fuel costs[23]

Energy inefficiencies

The transportation of fuel alone represents the lion's share of FOBs' energy costs. However, there is an unnecessarily high energy demand in NATO missions, due mainly to energy inefficiencies in FOB structures. Recent measurements taken in selected camps in Afghanistan reveal that the heating or cooling of tents and shower water accounts for 70 percent of the FOB fuel consumption. Moreover, the power generated largely exceeds demand at most FOBs. At Camp Leatherneck, located in Afghanistan's Helmand province, the 5 megawatts (MW) demand is met by 19 MW of capacity.[24] If we combine this supply-demand mismatch with the fact that there are 196 generators running at 30 percent capacity and

[17] Ibidem.

[18] Evans-Pritchard, Ambrose, "Solar power to trump shale, helped by US military," *The Telegraph*, Telegraph Media Group, 14 August 2013. http://www.telegraph.co.uk/finance/comment/ambroseevans_pritchard/10242882/Solar-power-to-trump-shale-helped-by-US-military.html (accessed 14 May 2014).

[19] Col John Vavrin, "Power and Energy Considerations at Forward Operating Bases (FOBs)," "Environment, Energy Security and Sustainability Symposium and exhibition: Adapting for a Secure Tomorrow", National Defense Industrial Association, Colorado Convention Center, Denver, 16 June 2010, Presentation, slide n. 7.

[20] Osman Bak, op. cit. p. 4.

[21] "Smart Energy: Homepage," *NATO*, 2014, http://www.natolibguides.info/smartenergy/home (accessed 8 Jul 2014).

[22] David S. Eady, et al., "Sustain the Mission Project", op. cit., p. 9.

[23] UK Ministry of Defence, "Reducing Operational dependency on Fossil Fuels Capability Vision 'The Self Sustaining Forward Operating Base'," 2009.

[24] Units of power: 1 gigawatt (GW) is 1,000 megawatts (MW) or 1 million kilowatts (kW). A typical compact fluorescent or LED light bulb uses only 13 watts; 1kW could power roughly 75 bulbs. On average, 1MW of solar can meet all the electricity needs of 160 typical American homes.

Solar Energy Industries Association, "Enlisting the Sun: Powering the U.S Military with Solar Energy," Washington, SEIA, 17 May 2013, p. 3.

consuming 15,431 gallons of fuel per day, there is ample space to cut current levels of consumption.[25] According to Paul Skalny, a 1 percent increase in fuel efficiency leads to 6,444 fewer soldiers being involved in convoy missions.[26] Thus, reducing FOB fuel demand by both diversifying energy supply and improving structural efficiency undeniably becomes a strategic imperative.

At the individual level, the modern wired battlefield requires about 20 gallons of fuel per soldier per day. The high-tech equipment that soldiers use requires increasing amounts of power. This can translate into combat gear weighing up to 40 kilograms (90 pounds), with batteries taking up to 20 percent of the total weight.[27] Be it for communication, battery recharging, or supporting portable power devices, the need for fuel negatively impacts soldiers' mobility and tactical edge.

NATO actions thus far

Until recently, the Alliance paid little attention to reducing energy consumption or establishing new energy sources. Although NATO's role in securing energy supplies was discussed in the 2008 Bucharest and 2010 Lisbon Summits, it was during the 2012 Chicago Summit that NATO Allies officially declared they would work towards making their military forces more energy-efficient and diversify energy supplies.[28]

The goal of reducing militaries' fossil fuel dependency is shared by many countries and organizations. In Europe, the European Defence Agency (EDA) seeks to be a leader in energy transformation. Under the umbrella of the 2012 "Military Green" initiative, it fosters cooperation between European defence forces to become more energy-efficient and cost-effective. The Military Green concept aims to meet environmental protection requirements during EU-led military operations. Much like NATO, the EDA seeks to increase awareness among European stakeholders, and establish steadfast green policies and strategies. This has opened multiple opportunities for NATO and the EU to cooperate, where efforts centre on adding value to each other's ambitions and to avoiding duplication of efforts.

NATO's unique added value lies in its transatlantic nature. Unlike the EU, it unites North America, Europe and other countries within one forum, and offers a continuum of political views, military planning and military action.[29] This allows the Alliance to address supply security issues at various levels. Additionally, with the US pioneering the development and integration of innovative energy technologies for military applications (especially regarding renewable energies), the NATO platform provides considerable advantages for the promotion and advancement of these technologies.

Institutionalizing behavioural change

Understanding that energy is a key consideration in all military activities is critical to changing the culture and behaviour surrounding energy generation and usage. This attitude shift will encourage public and private investments in new energy technologies that could help address the challenges identified above. One can safely say that, in recent years, NATO has begun paying more attention to the voices calling for a behavioural change vis-à-vis the role of energy within the Alliance. For example, when the Danish and Lithuanian Ministries of Defence promoted a green agenda in 2013,[30] the NATO Secretary General requested a Green Defence Framework, which would reinforce NATO efforts towards energy efficiency and sustainability.

One can argue that the establishment of several groups dealing with energy security indicates a behavioural change within NATO. The Energy Security Section within the Emerging Security Challenges Division (ESCD), launched in 2010, deals largely with energy issues. They

[25] David S. Eady et al., "Sustain the Mission Project," op. cit., p. 34.

[26] Paul Skalny is the Director of the National Automotive Center, TARDEC. Chris Williams, "TARDEC's Skalny Addresses Importance of Improved Fuel Efficiency," *Tardec S&T News Update* May 2009, http://www.tardec.info/GVSETNews/article.cfm?iID=0605&aid=08, (accessed 15 July 2014).

[27] Osman Bak, op. cit., p. 4.

[28] Ibidem, p. 15.

[29] Petkeviciu, "Critical Energy Infrastructure Protection," op. cit., p. 6.

[30] Danish and Lithuanian Ministries of Defence, "Towards a Smarter and Greener Defence: NATO and The Green Defence Dimension – Opportunities to Be Investigated," Green Defence Initiative, Brussels, Defence Ministerial, June 2013, http://danato.um.dk/da/-/media/danato/Documents/News/Pressemeddelelse%20-%20Green%20Defence%20NATO_june%202013.pdf (accessed on 16 June 2014). The Green Defence initiative seeks to spur on greater efforts in coordinating the reduction of energy consumption levels, setting energy efficiency standards, and offering specific training to address the Alliances energy challenges.

are the energy focal point for NATO's international staff, and have raised awareness about the intersections between military energy efficiency and effectiveness, as well as about security, environmental sustainability and financial austerity.

Allied Command Transformation (ACT) has also been involved in raising awareness at the military strategic command level. ACT has hosted several training courses, seminars and workshops to highlight the importance of energy security. Together with the NATO Energy Security Centre of Excellence (ENSEC COE), ACT plays a major role in NATO training, education and exercises. Furthermore, the ENSEC COE's role goes beyond educating and training, and into increasing NATO's capabilities, mission effectiveness, and interoperability. It does so by providing comprehensive expertise on energy security.[31] That said, the major strength of ENSEC COE is in concept development, education and training,

The NATO Maintenance and Supply Agency (NAMSA), today called the NATO Support Agency (NSPA), is also relevant to the "green defence" ambition. As NATO's principal logistics support management agency, it provides cooperative logistics services. The NSPA procures equipment which complies with EU and NATO environmental standards. Amongst its many goals is the identification of civilian renewable energy sources and energy-efficient technologies that can be applied to military equipment.

The most recent addition to NATO's energy initiatives is the Smart Energy Team (SENT), established after the 2012 Chicago Summit. Made up of experts from eight nations (Canada, Germany, Lithuania, the Netherlands, Australia, Sweden, the UK and the US), its role is to facilitate the sharing of information concerning interoperability advances. SENT's main task is to identify the most efficient national energy solutions and provide a platform for sharing them with stakeholders. Its greatest value lies in its team of scientific experts, who can validate energy-efficient technologies and provide recommendations for creating and improving NATO standards.

All in all, these bodies raise awareness on energy issues and developments within the Alliance, and play a vital role in efforts to bring about behavioural change. Their presence reflects NATO's decision to increase its efforts on energy security matters. However, getting all stakeholders to change their behaviour remains a big challenge. As one member of the Energy Security Division at NATO ESCD stated, "just getting all the stakeholders together, sharing the information and raising the visibility of the energy issue and possible solutions has been a major step forward in NATO."[32]

Technological change

Understanding that energy is vital to all military activities and operations is only one part of the solution to getting nations to look into alternatives. The other part involves a technological transformation, including the introduction of new energy generation technologies to reduce NATO's fossil fuel dependency and increase resilience. The aforementioned NATO bodies raise awareness and demonstrate possible solutions, but have these efforts translated into implementation? The following analysis will firstly examine events that successfully united stakeholders, and demonstrated available and emerging energy technologies to address energy needs for either fixed installations or FOBs. This will be followed by an overview of the Alliance's most prominent cases of new technology integration, to assess whether the demonstrations of technological potential have translated into implementation.

Technology demonstrations:

IESMA 2011

In November 2011, the ENSEC COE organized the Innovative Energy Solutions for Military Applications (IESMA 2011) conference. More than 200 energy experts from NATO, Partner countries and the private sector gathered to discuss measures that could reduce the militaries' fossil fuel dependence. This discussion revealed ecologically sound technical solutions for waste incineration, power supplies, power storage and energy efficiency. With regard to renewable energy, the conference report states that a whole range of solar

[31] This includes, but is not limited to, the conduct of strategic analysis and research projects on lessons learned by NATO, Nations, Partners and third states with regard to energy efficiency; and civil sector energy innovations for military needs. Osman BAK, op. cit., p. 17.

[32] Dr Susanne Michaelis, personal communication, 18/7/2014.

energy solutions were on display, "some with acceptable efficiency and warranty of 20 years."[33] Another IESMA conference will take place in November 2014, again with a strong focus on energy efficiency technologies.

Capable Logistician 2013

SENT's military logistics exercise, "Capable Logistician 2013" in Slovakia, was an important event that presented a smart energy camp. With over 1,700 participants from 38 nations, the exercise offered a unique opportunity to promote awareness and demonstrate concrete implementation measures towards energy efficiency. It showcased specific advanced energy generation and saving technologies, and tested the interoperability of systems and equipment. It allowed NATO members to share best practices, and incentivize Allies to employ similar technologies. While the focus was predominantly on energy efficiency measures, the Dutch showcased photovoltaic (PV) solar panels that could reduce fuel consumption in operational theatres. Moreover, this solar technology was already field-tested in 2012, showing a return on investment in 9 months.[34] The goal was to incentivize the drafting of new standardization agreements (STANAGs) on Smart Energy that would encourage nations to integrate these new technologies in the early planning stages of camp deployment, the advantage being to enable nations to advance their own national projects on new capabilities while still focusing on interoperability. However, progress on the drafting of a new STANAG and the technology implementation has been slow and limited.

While these events have successfully brought together stakeholders and displayed available emerging technologies, they have not translated into widespread implementation across the Alliance. Only a handful of Allies have seriously employed new energy efficient and renewable technologies. The following are a few examples, excluding the US (which will be examined in the subsequent section).

Technology integration:

The United Kingdom

The UK has been amongst the most proactive Allies when it comes to implementing strategies to secure its energy supply. The British developed a Defence Sustainable Development (SD) strategy that seeks to increase military sustainability from 2011 to 2030. It attempts to streamline the Defence SD goals, which include the reduction of fossil fuel consumption and the diversification of energy supplies, within general defence practices.

The Ministry of Defence (MoD) set a 50 percent fuel reduction target at its Afghanistan military bases in 2009. This would be accomplished by managing fuel more efficiently, improving insulation and capturing waste energy to reduce fossil fuel consumption at Camp. Moreover, energy-efficient navigational aids and fuel-efficient aircraft are expected to save the Royal Air Force more than £5 million by 2015. Similar efforts by the Royal Navy can be seen, as they have replaced their diesel and gas turbine engines with electric transmission gearboxes.[35] Most notably, the UK used intelligent energy management systems – such as microgrids[36] – and incorporated energy storage, combining conventional and alternative energies to significantly reduce FOB energy consumption.[37]

With regard to renewables, the MoD has pursued their integration in both fixed installations and FOBs. In fixed

[33] NATO Political and Partnership Committee, Conference on "Innovative Energy Solutions for Military Applications," NATO/EAPC, Conference report PPC(EAPC) N(2011)0061, 20 December 2011.

[34] 480 m² of solar cells were placed on the roofs of tents in Mazar-e-Sharif, Afghanistan, where they produced 200 kW per day, Dr Susanne Michaelis, "Smart Energy at 'Capable Logistician 2013'," *Energy Security: Operational Highlights* No3 (2013), pp.4-9. NATO Energy Security Centre of Excellence, http://www.enseccoe.org/en/publications/publications_10/energy-security-operational-highlights.html, p. 7 (accessed 08 May 2014).

[35] Osman Bak, op. cit., pp. 9-10.

[36] In short, microgrids are integrated energy systems consisting of distributed energy resources (can generate power from multiple sources –oil, diesel, solar, wing, etc.), a storage system, intelligent control of distribution systems (able to switch between energy resources to generate power), and the ability to disconnect from the commercial grid and run independently.

Michael Hallet, "Microgrids: A Smart Defense Based NATO Contribution to Energy Security," *Journal of Energy Security*. 20 November 2012, http://www.ensec.org/index.php?option=com_content&id=390:microgrids-a-smart-defense-based-nato-contribution-to-energy-security&catid=130:issue-content&Itemid=405 (accessed 22 May 2014).

[37] Desider-magazine, MOD Defence Equipment and Support magazine, "Saving energy in front line military bases," *Sustainable Development in Government*, Dept. of Environment, Food and Rural Affairs, 07 October 2011, http://sd.defra.gov.uk/2011/10/saving-energy-in-front-line-military-bases/ (accessed 08 Jul 2014). Their findings demonstrated that energy storage alone could produce 22 percent fuel savings. When combined with energy demand management and renewables, this could rise to 40 -50 percent fuel savings, depending on the renewables mix.

installations, solar water heating has been introduced, which produces 75 percent of the hot water and helps insulate buildings at the Catterick Garrison. In operational theatres, army soldiers in Afghanistan have been equipped with solar panels instead of heavy combat gear batteries since 2011.[38]

Denmark

The Danes have also been amongst the more proactive Allies in their efforts to reduce military energy consumption. Their MoD implemented a Climate and Energy Strategy for 2012-2015, specifying quotas that are in line with their long-term goal to be independent of fossil fuels by 2050. By 2015, the Danish MoD claims they will have reduced energy consumption by at least 15 percent compared to 2006 levels. Their electricity consumption from renewable energy will purportedly increase by at least 25 percent by 2015, and up to 60 percent by 2020. Because the Danish MoD owns large amounts of land, they plan to install 5,000m^2 of solar cells with a capacity of 500,000 kWh a year by the end of 2013; and 20,000 m^2 by 2015.[39] The Danish MoD has also claimed that, before the end of 2014, they will have analysed and described all options for utilizing renewable energy on missions abroad.

Although ambitious, having specific policies and targets in place is essential to developing and integrating efficient technologies within national militaries. This is indicative of a strong behavioural change within Denmark's MoD, unlike in many other NATO members. Most notably, together with the Lithuanian MoD, the Danish MoD drafted the "Towards a Smarter and Greener [Defence]" report, which sought to push the Alliance towards being more efficient and introducing new technologies, including renewables.

From the cases mentioned above, it is clear that although certain nations are integrating new technologies, these are individual strategies that are not part of a more cohesive, NATO-wide approach. Few of the integrated technologies stem from the demonstration events presented above. There is still a general lack of awareness on energy issues and possible solutions amongst NATO countries. The behavioural change that NATO as an organization is slowly undergoing has not trickled down to all members, and has not materialized into the desired level of efficient and renewable technological change. The Alliance as a whole would benefit from a joint strategic approach. With this in mind, NATO is establishing the Green Defence Framework to reinforce the efforts of NATO bodies, facilitate Allies' efforts and improve NATO's green profile. It should, allegedly, "provide the necessary political impetus and add visibility to the on-going efforts of NATO bodies and among Allies."[40] Despite what has been achieved to date in terms of sharing information and raising awareness, "we have not yet succeeded in changing the mind-set or behaviour of our armed forces."[41]

While the integration of renewable energy has been explored to a certain extent, there has been much more emphasis on energy efficiency measures. As important as these are, they need not be the only centres of attention. The on-site generation of renewables can enhance the ability to operate when the commercial grid fails, as well as greatly improving the operational effectiveness of FOBs. The US DoD is pioneering the shift away from fossil fuels by focusing on both measures. They have "saved hundreds of millions of dollars in energy costs by deploying efficient and renewable technologies."[42] Solar energy plays a particularly valuable role in this endeavour.

Solar: providing energy security

Solar energy is one of the fastest-growing segments in renewable energies, and is arguably one of the most versatile. The question then follows: how can solar energy enhance the supply security of NATO militaries without reducing their operational capabilities? The US will be used as the point of reference, because it has pioneered the development and integration of renewable energy for military applications. Experiments in the US have shown that renewable energies, combined with modern technologies, often have more advantages than do the use of fossil fuels. The US has demonstrated that the shift away from conventional fuels is not an optimistic transition, but ultimately a matter of political will.

[38] Osman Bak, op. cit., p. 13.

[39] Danish Ministry of Defence, "Climate and Energy Strategy of the Ministry of Defence 2012-2015," Strategic vision, 2012, pp. 2-10.

[40] NATO Defence Policy and Planning Committee, "Green Defence Framework," North Atlantic Council. AC/281-N(2013)0096-Rev 4, 23 January 2014, p. 4.

[41] Dr Susanne Michaelis, personal communication, 18/7/2014.

[42] Solar Energy Industries Association, op. cit., p. 3.

Like other NATO members, the US DoD pursued initiatives to increase energy efficiency in both fixed installations and operational theatres for an extensive period of time. Between 2003 and 2010, overall energy usage at both fixed installations and FOBs was reduced by 11.4 percent.[43] However, the US did what few other Allies have done: to aggressively pursue the integration of renewable energy. The goal is simple, and one that is shared by all Allies: to respond to rising energy costs, potential energy supply disruptions, and the need for more secure energy generation and distribution. After all, with renewable energy, there are fewer supply chain vulnerabilities, low commodity costs, and lower chances of disruption, since the energy is produced on-site.[44] Furthermore, as the cost of solar power keeps dropping (by 75 percent between 2010 and 2020, according to the US Energy Department), the price of traditional fossil fuels is on the rise.[45] The opportunity to push forward a green agenda within the Alliance has never been better.

US and solar energy

As part of its 2011 Master Energy Performance Plan, the DoD set specific and ambitious targets across the institution and for each service branch.[46] Accordingly, the Air Force, Army, and Navy were mandated to generate 1 GW of renewable energy each, by 2025. This regime has prompted an increase in activity towards new renewable energy projects, the benefits of which are already visible in both fixed installations and FOBs.

Fixed installations

The US DoD is seeking to develop solar technologies – along with other distributed renewable energy sources – to reduce its $4 billion a year energy bill and make its fixed military installations less dependent on commercial electricity grids. Solar plants can increase installation resiliency by providing greater flexibility to generation systems under attack. This is done by providing an additional energy source, thus decentralizing large, unique, traditional installations. In the event of an extended power outage, the installation could disconnect itself from the regional power grid and generate power on-site. Moreover, if the solar plant produces excess energy, that energy could be stored for later use. According to NATO's Assistant Secretary General for Emerging Security Challenges, if distributed generation technology like microgrids could be integrated into the system, military installations could maintain critical operations "off grid" for weeks or months, in the event of major blackouts or attacks on the commercial grid.[47] The US DoD, through the use of third-party financing mechanisms like Power Purchasing Agreements,[48] is seeking to build such solar plants at little to no up-front cost.

Fort Bliss is a case in point, where an intelligent solar microgrid project is being implemented for the US Army. When the commercial grid is down, this system continues to provide power and economic benefit. It uses solar panels to capture solar energy and charge the microgrid's batteries. As the demand for energy increases, the control unit may provide power from a combination of batteries and solar units. If the batteries are depleted, one or more diesel generators begin to provide power to replenish the batteries, shutting off once they are fully charged again.[49] Fort Bliss already has 1.4 MW solar arrays, and has installed a 13.4 MW rooftop solar array on post housing. The army is planning to add an additional 20 MW solar farm that will power all of the division headquarters, along with other sectors of the installation, ultimately reducing

[43] Osman Bak, op. cit., p. 8.

[44] Ehren Goossens, "Exploding Fuel Tankers Driving U.S. Army to Solar Power." *Bloomberg*. 01 October 2013, http://www.bloomberg.com/news/2013-09-30/exploding-fuel-tankers-driving-u-s-army-to-solar-power.html (accessed 04 Jun 2014).

[45] Ambrose Evans-Pritchard, "*Solar power to trump shale*," op. cit.

[46] The Plan outlines the DoD's strategy to save money, achieved established goals, and assure the continuity of essential operations at installations. It has four main parts: 1) reducing energy demand through conservation and efficiency 2) increasing on-site electricity generation with renewable energy 3) enhanced energy management 4) facility energy innovation. The PEW Charitable Trusts, op. cit., p. 2.

[47] Gábor Iklódy, op. cit.

[48] An agreement between the military and a private entity that designs, finances, builds and operates a renewable energy project. In most cases, the project is constructed on military land (but can also be on private land), but is owned by the developer, hence allowing the military to avoid paying any upfront cost. The military agrees to buy the power produced by the project, usually at a fixed price under the local utility rates, over an extended period of time of up to 30 years. The PEW Charitable Trusts, op. cit., p. 15.

[49] Peter Buxbaum, "Microgrids and Power," *KMI media group*, 14 March 2014, http://www.kmimediagroup.com/military-logistics-forum/432-articles-mlf/microgrids-and-power (accessed 16 June 2014).

the amount of fuel that would need to be purchased.[50]

The US Air Force, which is the largest consumer of energy in the DoD, has also been proactive in diversifying its energy generation mix, in spite of substantial budget constraints. The Air Force initiative at the Hickam Air Force Base in Honolulu has installed and interconnected a 3.4 MW solar system for the 2,000-home community, and is expecting to add additional systems that could bring this number to approximately 5.5 MW. This is part of a greater project called "Project SolarStrong", which intends to provide solar electricity for up to 120,000 US military homes across all three branches of the DoD, and "provide the Air Force with millions of dollars in energy savings."[51] Solar-PV energy is planned to account for over 70 percent of new Air Force renewable energy capacity added, from 2012 to 2017.[52]

Overall, the number of renewable energy projects on US domestic bases has risen by 54 percent, from 454 in 2010 to 700 in 2012. According to Navigant Research estimates, there were 384 MW of renewable capacity on DoD installations by 2013. It projects that 322 MW of additional renewable energy capacity – of which 64 percent is solar-PV – is currently being developed, which would bring capacity up to 706 MW by 2016. This is an 84 percent increase over 2013 levels.[53] Many of the figures quoted come from the Solar Energy Industries Association (SEIA), so the numbers may be optimistic. According to SEIA, the US Navy will also derive half of its energy supply from renewables by the end of this decade. Though these numbers may be optimistic, the shift towards renewables is flagrant. The idea of separating military installations from the commercial grid by localizing renewable energy generation will certainly increase base resiliency against power outages. This is why the US has, and continues to invest in, renewable energy projects. Based on Navigant Research's projections, if all projects in the planning stage materialize, the DoD will increase its total renewable capacity to 2.1 GW by the end of 2018, with solar leading the way, as illustrated in Figure 2.

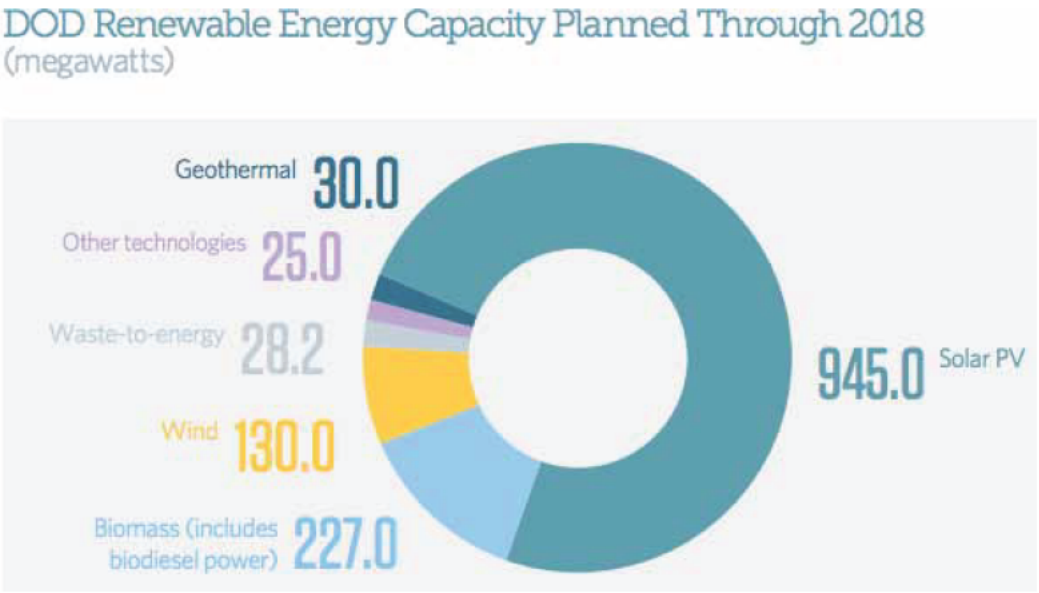

Figure 2: DOD Renewable Energy Capacity Planned Through 2018[54]

[50] Donna Miles, "Fort Bliss to Launch Military's Largest Renewable Energy Project," *DoD News*, U.S Department of Defence, 5 April 2013, http://www.defense.gov/News/NewsArticle.aspx?ID=119715 (accessed 12 June 2014).

[51] Solar Energy Industries Association, op. cit., p. 13.

[52] Ibidem.

[53] The PEW Charitable Trusts, op. cit., p. 26. Navigant Research is a market research and consulting team that provides in-depth analysis of global clean technology markets.

[54] Ibidem, p. 28, Navigant Research, DoD.

Operational Theatres

However, the biggest energy challenge for militaries today is the availability of operational energy. When FOBs are located in austere surroundings, with almost non-existent or extremely dangerous roads, how can commanders ensure an unimpeded source of energy? Where will this energy come from? The unpredictability of combat operations and levels of fuel use, combined with the logistical nightmare of transporting and protecting fuel convoys, make operational energy costs significantly higher than those of fixed military installations.

Many of these front line bases are looking for ways to minimize their logistical burden through greater self-sustainability. It is within this operational dimension that solar energy offers the greatest added value. The inherent advantage that solar energy has over conventional fossil fuels is that it can considerably reduce the need for fuel logistics to remote sites. Although the role of renewable energy will differ according to the FOB location and size, the integration of on-site solar energy would inevitably allow NATO militaries to save manpower, funds, and the lives of those delivering supplies over contested lines of communication.[55]

Improving Fuel Logistics

With the integration of solar energy into operational theatres, Allies' militaries would be able to generate their own energy on-site. This would decrease the demand for fossil fuel at FOBs, and lessen the need for costly and dangerous fuel convoys. Not only can solar-PV technologies be designed for efficient packaging, but they are also significantly lighter and scalable to meet the power generation requirements of varying remote operating bases.[56]

According to a 2010 simulation study aimed at quantifying the impact of installing renewable energy sources in FOBs,[57] there is a linear relationship between saving fuel and solar energy capacity. Figure 3 shows the percentage of fuel saved for both solar-PV arrays and wind turbines. The results of this simulation indicate that, for each megawatt of solar-PV energy acquired, the FOB achieves 6.7 percent of fuel savings.[58] Although these findings are specific to the simulated FOB, it illustrates the valuable impact solar energy can have on fuel savings. The simulation relates the fuel-saving values to the drop in supply-line casualties. As illustrated in Figure 4, installing a 2 MW solar PV array would reduce expected supply casualties by 12 percent, including those incurred by transporting renewable system components. The study claims that, if similar solar systems had been installed on the entire Afghan theatre in 2007, fuel-related supply-line casualties could have been reduced from 38 to approximately 33.[59] These results are not meant to identify a specific solution, but help articulate an important and underappreciated correlation between solar energy, fuel saving and casualty reduction.

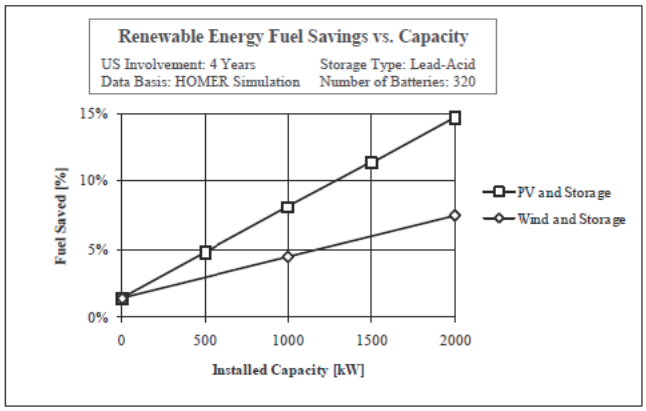

Figure 3: Fuel Savings vs Capacity for PV and Wind Energy[60]

[55] Roy H. Adams, Martin F. Lindsey and Anthony Marro, "Battlefield Renewable Energy: A Key Joint Force Enabler," *Joint Force Quarterly*, April 2010, pp. 43-49.

[56] Ibidem.

[57] The information presented is based on a hypothetical FOB made to represents a typical Air Force deployment in a forward location, consisting of approximately 1,100 airmen. To simulate resource availability, a typical FOB location was chosen, Marjah Afghanistan, an area where U.S DoD is active.

[58] The systems' batteries alone account for a 1.4 percent reduction in fuel consumption, which is why the intercept of each plot is not 0 percent.

[59] Nathan C. McCaskey, "Renewable Energy Systems For Forward Operating Bases: A Simulations-Based Optimization Approach," Master's thesis, Department of Electrical and Computer Engineering, Colorado State University, August 2010, pp. 5-7 and 21-37.

[60] Ibidem, p. 21.

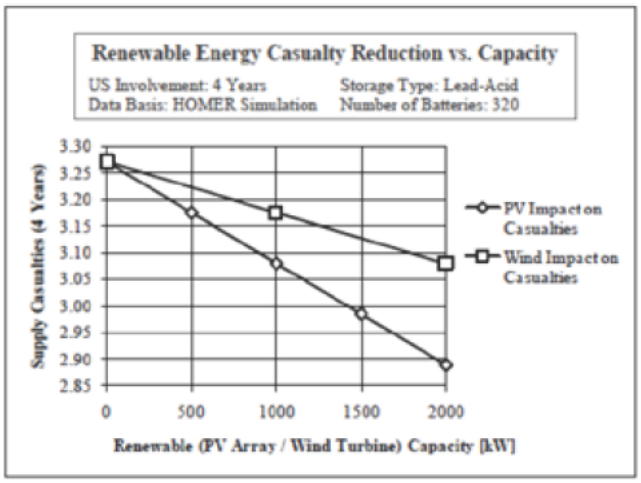

Figure 4: Supply Casualties vs Capacity for PV and Wind Energy[61]

Fighting energy inefficiencies

The majority of FOBs have inefficient infrastructure, as already discussed. Many have argued that, because solar is an intermittent energy source, its effectiveness, and therefore, its deployment is limited. While it is doubtful that renewable energy systems can completely replace the use of fossil fuels for military applications, they can certainly enhance NATO's operational readiness and capabilities by making the Alliance less dependent on traditional energy supplies.

Solar hybrid systems have shown tremendous potential in this regard. For example, the company SunDial Capital Partners developed a portable solar system for the Army, which can be deployed in just a matter of hours. It consists of a 10 ft. container with a solar battery, which can link into a bigger grid of batteries. It will be used in the most austere FOBs, where having a diesel generator becomes logistically unsustainable or burdensome. SunDial claims that "places using this system are seeing a 65 percent reduction in fuel consumption."[62] Like the solar microgrid project in Fort Bliss, the system captures solar energy and stores it in batteries, which power the main electricity needs. If the solar panels cannot keep up with power demands, a tactical generator kicks in to both meet the electricity demand and replenish the battery.

These hybrid systems provide the opportunity to rapidly integrate renewables into FOB power generation systems. In the smaller FOBs, solar could more easily become the main energy source. In larger FOBs, where more generators are needed, solar energy takes on a secondary role. It can be taken offline and back online as needed, to keep the generators running at maximum efficiency. Most importantly, it reduces the need for fuel to power the generators, and thus reduces the number of fuel convoys. In Afghanistan, ten of these portable systems provided about 700 MW/h per year, saving approximately 460,000 gallons of fuel. This is equivalent to 185 fewer tactical fuel trucks in convoys per year. With a return on investment in two and a half months, these systems should become more widely used.[63]

Tactical Edge

From a military standpoint, the tactical edge provided by solar energy in operational theatres is the biggest advantage. Not only would greater energy self-sufficiency improve the effectiveness and mission readiness of NATO troops, but it would also enable FOB operations to reach remote areas previously unsuitable for advanced equipment due to the difficulty of resupplying fuel.[64]

Solar energy is able to reduce NATO troops' logistical footprint by enhancing military manoeuvrability due to its lighter weight and transportability. Illustrating this is the US Marines' Ground Renewable Expeditionary Energy System (GREENS), which has brought solar power to the frontlines. This system took just over a year to transition from concept to implementation, and is meant to replace fossil-fuelled generators. It consists of stackable 1,600-watt solar arrays and rechargeable batteries which provide 300 W of continuous electricity for troops in remote locations.[65] The Marines claim that it has reduced the logistics burden of providing power to remote locations, and will provide power to charge typical communication, targeting and computing devices.

[61] Ibidem, p. 25.

[62] Hildebrandt, "US Military Soldiering Up," op. cit., p. 6.

[63] David Vergun, "Soldiers using sunlight to improve combat capability," *US Army*, 14 November 2012, http://www.army.mil/article/91018/ (accessed 25 June 2014).

[64] Petkevicius, "Critical Energy Infrastructure Protection," op. cit., p. 5.

[65] Office of Naval Research, "Ground Renewable Expeditionary Energy System," Factsheet, *US Navy,* http://www.onr.navy.mil/Media-Center/Fact-Sheets/Greens-Solar-Energy-Battery.aspx (accessed 08 July 2014).

Like SunDial's portable solar system, it will reduce the fuel needed for typical generators. GREENS provides tactical advantages in terms of mobility, as it is rapidly deployable and can easily be transported with Humvees (or HMMWV). One Marine's comment on mobile solar units was that "our generators typically use more than 20 gallons of fuel a day. We are down to 2.5 gallons a day."[66]

Through the development of innovative solar-powered equipment, mitigating soldiers' fuel consumption and heavy combat gear, there has also been an improvement at the individual tactical level. The Rucksack Enhanced Portable Power System (REPPS) is a case in point. It consists of a 4.5 kg (10 lb.) portable battery recharging kit that features a 62W solar panel "blanket" tucked into a backpack.[67] The solar blanket can recharge many common military batteries in just a few hours, run electronic devices and link together to provide even more energy. The system was first deployed in Afghanistan in the summer of 2010, enabling soldiers to harvest energy on-site. As mentioned, up to 20 percent of a modern soldier's 30-40 kg combat gear consists of batteries, which must be charged 2-3 times during a 12-18 hour mission.[68] REPPS eliminates the need to return to vehicles or tactical operation centres to replace or recharge batteries, thus enhancing operational capabilities.

Additional tactical advantages that solar-PV technology can offer include relatively simple operational and maintenance training, a higher power-to-weight ratio, a lower thermal signature and the ability to target specific energy needs, such as heating water and cooling buildings, as seen in the UK example.[69] Additionally, they are significantly quieter than diesel generators.

Solar potential in the NATO Alliance

Not all renewable energy technologies are appropriate for every geographic region. Availability of the resource in question is essential for determining the feasibility and viability of renewable power projects. Moreover, there are other considerations that must be taken into account, such as state regulations or utility laws, which have not been examined here. That said, when it comes to the availability of solar within NATO members' territories, there is considerable potential.

To name just a few examples, according to the International Renewable Energy Agency (IRENA), European NATO members Belgium, Bulgaria, France, Greece, Italy, Latvia, Portugal, Romania and Spain have high solar energy resources.[70] Even though the European solar-PV industry went through a challenging period in 2013, the top five sources of newly installed electricity that year were renewables, with solar-PV leading the way. Although changing political support created a climate of uncertainty, the huge potential and benefits of solar have already been proven. "Solar-PV is becoming a mainstream player within the power system" and will continue to increase its share of the energy mix in Europe and around the world.[71] There is an opportunity for NATO Allies to capitalize on the decreasing cost of solar and other renewables vis-à-vis conventional fuels.

When combined with the fact that European NATO members' militaries are amongst some of the largest owners of land and infrastructure in all public sector institutions (EU militaries possess about 1 percent of the EU's total land surface), the development of energy-generating solar-PV plants for military installations should be given more attention.[72]

NATO has a vested interest in reducing energy-related vulnerabilities for its members and Partners, due to its obligation to ensure the capability of its forces. Yet, little has been done when it comes to employing renewable energies, whose use improves resiliency and minimizes strategic, operational and tactical vulnerabilities. The challenge is closing the gap between research and actual implementation.

---

[66] Solar Energy Industries Association, op. cit., p. 8.

[67] Tina Casey, "U.S. Army Deploys Solar Power Backpacks in Afghanistan," *CleanTechnica,* 14 September 2010, http://cleantechnica.com/2010/09/14/u-s-army-deploys-solar-power-backpacks-in-afghanistan/ (accessed 16 June 2014).

[68] David S. Eady et al., "Sustain the Mission Project," op. cit., p. 35.

[69] Adams, "Battlefield Renewable Energy," op. cit., p. 46.

[70] International Renewable Energy Agency, "Renewable Energy Country Profiles European Union," Country Profile Series, 2013, IRENA specifies that this information should be taken as indicative only and does not refer to any technological choice or feasibility of individual projects.

[71] European Photovoltaic Industry Association, "Global Market Outlook for Photovoltaics 2014-2018," Brussels, EPIA, 2014. pp. 50-55.

[72] Osman Bak, op. cit., p. 14.

Possible ways forward

The Alliance is aware that its militaries' energy consumption is unsustainable, and that its dependence on fossil fuels is too costly both in terms of money spent, and lives lost. This is why NATO Parliamentary Assembly resolution 407 "URGES member governments" to reduce energy demands in fixed installations and operations by improving military energy efficiency, in addition to diversifying energy supplies by "putting a premium on pursuing renewable energy sources."[73]

Yet, while significant effort is being placed on improving energy efficiency technologies, the development and integration of renewable technologies seems to be on the backburner. This is demonstrated by the fact that renewables are low on the agenda in the upcoming IESMA 2014 conference, which will focus on standard, advanced and cutting-edge energy saving technologies.[74] Current efforts are still "very much focused on securing the supply of energies traditionally used in military operations, specifically fossil fuels."[75] It seems that the Alliance has yet to fully recognize the overall value of renewables. Energy efficiency measures may provide quick short-term results, but they need not be the sole priority. Protecting the energy security of NATO members is a long-term strategic task. After all, as seen through the use of solar energy, renewables are playing an increasingly important role in making the US military's energy supply more secure, more affordable and less reliant on foreign sources.[76]

There are ways forward for NATO that could lead towards a greater institutionalization of renewables. Because the concept of green defence has already been placed on the agenda, these recommendations will echo some of the suggestions already brought forth by the Danish-Lithuanian initiative, and the proposed Green Defence Framework.

Public-Private Partnership: finance mechanisms

Energy costs have skyrocketed and national budgetary expenditure on energy is staggering. One of the biggest barriers to pursuing renewable energy projects has been the significant investment they require. Indeed, the US DoD has substantially more funds to invest in new technologies than other NATO members. However, it has been the government's ability to harness private sector resources that has been fundamental to its success with renewable energy projects. About 80 percent of future renewable projects in the US will be financed via PPAs, mainly because this avoids any upfront cost for the military.[77]

Naturally, every nation has its own constraints, and its particular set of utility laws, rate structures, incentives, or land reforms that may dictate what can and cannot be done by the private sector. There is also a cultural difference that should not be neglected. Whereas the line between the private and public sector in the US is easily crossed, it is much harder to negotiate in other countries, such as France. This might explain why, in France, most large-scale alternative energy projects are given to large public companies like the Direction des Constructions Navales, as opposed to private firms.[78]

Nonetheless, third-party agreements provide the necessary investments for the development, installation and management of both renewable and energy efficiency projects alike. This is why greater efforts need to be placed on fostering public-private partnerships. Using third party financing mechanisms would not only reduce, but eliminate high initial costs for military renewable projects; it would also provide opportunities for the private sector to further test new technologies. Through NATO's Industrial Advisory Group, the Alliance has made efforts towards improving cooperation with the private sector. NATO should strengthen these efforts and seek more avenues for cooperation.

---

[73] NATO Parliamentary Assembly, "Resolution 407," op. cit.

[74] NATO Energy Security Center of Excellence, "About the Event," *IESMA 2014,* http://events.enseccoe.org/homepage (accessed 16 July 2014).

[75] Osman Bak, op. cit., p. 18.

[76] Solar Energy Industries Association, op. cit., p. 17.

[77] The PEW Charitable Trusts, op. cit., p. 4.

[78] This is not to say that there are no public-private partnerships at all. DisaSolar, for example, is a flexible solar photovoltaic French specialist that has been chosen by the government to design bio-mimetic flexible solar panels capable of taking on the shape and color of their environment for camouflage. Paillard, Christophe-Alexandre. "Security and energy efficiency, a smart energy for a smart defence: examples taken from France." *Energy Security: Operational Highlights* No 5 (2014), pp. 9-16. NATO Energy Security Centre of Excellence, p. 14 http://www.enseccoe.org/en/publications/publications_10/energy-security-operational-highlights.html (Accessed 08 May 2014).

Defining requirements and policies: guidelines for planning

In the US, what holds all projects and efforts together in the capability development context are policies, specific targets and requirements, as stipulated in a Master Energy Performance Plan.

As was shown in the Danish-Lithuanian initiative, the development of technologies to replace fossil fuels requires strong political support. With this goal in mind, NATO's Defence Policy and Planning Committee brought forward a draft of the Green Defence Framework early this year. Although this is a great and necessary step forward, the framework does not specify any standards, requirements or targets stipulating what NATO would like to achieve in fossil fuel reductions. Defining these will not only provide guidance for energy planners and managers, but also help steer technology towards both renewable and energy efficiency goals. Solar-PV power, along with other renewable technologies, remains a policy-driven business where political decisions strongly influence their success or demise. Stable policy frameworks help increase market confidence. [79]

Therefore, if NATO were able to define clear short-, medium- and long-term targets, this would go a long way towards the creation of lasting public and private sector incentives. Reiterating what the Green Defence Framework paper suggested, the application of "green standards" and principles across the Alliance, along with "green" accounting and benchmarks to measure progress, would help focus project proposals and minimize undesirable consequences. Doing this would strongly contribute to a successful joint, coherent strategic approach to energy security.

EU-NATO cooperation

The EU and NATO share many values and goals, as well as 22 members. They work together to fill each other's military and defence gaps, making the best of limited resources. As previously mentioned, through the EDA's green initiatives, the EU's key strategy for enhanced energy security focuses on the diversification of energy sources and suppliers, as well as increasing energy efficiency. Thus, there is significant overlap of energy concerns and desired objectives between the EU and NATO. Dialogue between the two already exists to avoid duplication of efforts. This can be seen by the fact that both NATO ACT and ENSEC COE are in contact with the EDA, to discuss developments in its Military Green and "Go Green" initiatives. However, according to an Atlantic Treaty Association policy brief, European cooperation is weak due to a lack of coordinated European energy policies, primarily caused by the pre-eminent role of the US.[80] In short, it seems that political will is a limiting factor for a EU-wide energy strategy.

Echoing what was suggested in the Danish-Lithuanian initiative, a strengthening of EU-NATO cooperation could take the form of mutually promoting concepts and doctrines. This could be achieved through existing structures, like the Euro-Atlantic Partnership Council (EAPC), or by strengthening cooperation between the EDA and energy-related NATO agencies. Mutually promoting concepts and doctrines could perhaps provide the political impetus needed in both organizations.

NATO's transatlantic nature can facilitate the sharing of information, best practices and intelligence between the EU, the US, Canada and other non-EU or EAPC actors, like Australia, which have already performed extensive field-testing of renewable and energy efficient technologies. Conversely, with the EU being more in touch with energy market forces, and the EDA's knowledge of different incentive-creation mechanisms foreseen in several EU Directives,[81] better economic tools could be brought to the table, which NATO could use to incentivize its members to proactively pursue the integration of renewables. It seems that, as long as NATO does not have reliable facts and figures, such as the return on investment for different renewable energy technologies, convincing its forces to invest in them will be difficult.

[79] European Photovoltaic Industry Association, op. cit., p. 39.

[80] Alessandro Niglia, "Critical Energy Infrastructure Protection (CEIP), The role of EU and NATO," Policy Brief, Brussels, Atlantic Treaty Association, September 2013, p. 6.

[81] European Defence Agency, "Military Green 2013: Climate, Enivronmental and Energy Security- From Strategy to Action," Report from Workshop Series, 13 June 2013, p. 16.

Conclusion

In an age of austerity, renewables can contribute to increasing budgetary savings in a sustainable manner, whilst making overall capabilities more effective through enhanced resiliency, mobility and autonomy. This paper has examined how solar power could contribute to both reducing energy demand and diversifying energy supplies, thus translating into greater supply security. With the need to stimulate greater debate and discussion over the integration of renewable energy in military operations and installations, however, NATO needs to be more proactive in giving renewables greater visibility within the Alliance. The political commitment of Allies is critical for the successful implementation of new technologies, yet it remains the biggest obstacle.