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‘‘Αειφορία και βιωσιμότητα στις Ένοπλες Δυνάμεις: Επίτευξη και διατήρηση ενσωμάτωσης’’

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‘‘Sustainable Development practices in the Armed Forces: Achieving and maintaining an inclusive behavior’’

By

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Faye, this is exclusively dedicated to you...

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This world of academia I shall forever cherish and endorse.

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Σημαντικοί Όροι: Αειφορία, Βιώσιμη Ανάπτυξη, Ένοπλες Δυνάμεις, Επιχειρησιακή Ικανότητα, Στόχοι Βιώσιμης Ανάπτυξης, Κυκλική Οικονομία

Περίληψη

Με βάση την σύσταση του European Green Deal είναι δεδομένη η απαίτηση μετασχηματισμού των λειτουργιών του δημόσιου και του ιδιωτικού τομέα σε πρακτικές οι οποίες θα μειώσουν το περιβαλλοντικό τους αποτύπωμα. Μέσα από αυτή την εργασία θα εξετάσουμε την προοπτική αυτού του μετασχηματισμού των Ενόπλων Δυνάμεων που ιδιαίτερα στην περίπτωση της Ελλάδας λόγω της πολυχρησίας των μέσων τους, τα οποία βασίζονται κυρίως σε μη φιλικές προς το περιβάλλον τεχνολογίες αναφορικά με την λειτουργία τους, το επιβαρύνουν. Ως εκ τούτου λαμβάνοντας υπόψιν δοκιμασμένες σε παγκόσμιο επίπεδο πρακτικές, που έχουν εκτελεστεί με επιτυχία και με μεθοδικότητα απέφεραν δραματική μείωση του περιβαλλοντικού αποτυπώματος για τις Ένοπλες Δυνάμεις αρκετών χωρών, θα εξετάσουμε την εφαρμογή αυτών στην περίπτωση της χωράς που σαν μέλος της Ευρωπαϊκής Ένωσης, θα πρέπει να συνδράμει στην μείωση κατά 55% των εκπομπών ρύπων του άνθρακα ως το 2030 με συνδρομή όλων των φορέων.

Σκοπός αυτής της διπλωματικής εργασίας είναι να αναγνωρίσει πόσο αειφόρες μπορούν να καταστούν οι ΕΔ, με το να εφαρμόσουν τις πιο κάτω ανεπτυγμένες πρακτικές οι οποίες θα τους επιτρέψουν να μετουσιωθούν σε σύγχρονο, αποδοτικό και ανεπτυγμένο οργανισμό σε σχέση τόσο με τον δημόσιο, όσο και με τον ιδιωτικό τομέα. Αυτή η εξέλιξη θα έχει ως συνέπεια τον μετασχηματισμό των ΕΔ σε έναν ανανεωμένο οργανισμό με βιώσιμη προοπτική, η οποία θα προσδώσει δυνατότητα εξοικονόμησης σημαντικών πόρων με σκοπό την αξιοποίησή τους για εξοπλισμούς προκειμένου να διατηρηθεί η επιχειρησιακή δυναμική τους. Εξοπλισμούς οι οποίοι με τη σειρά τους θα διέπονται από βιώσιμη προοπτική με ‘‘πράσινη’’ τεχνολογία στις εφαρμογές τους.

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Reference terminology: Sustainability, Armed Forces, Operational Capability, War-fighting Capability, Sustainable Development Goals, Circular Economy

Abstract

In accordance to the European Green Deal, actions must be taken regarding the transformation of the public and private sector that will reduce their environmental footprint. The purpose of this dissertation is to provide a perspective of such a transformation within the Armed Forces which due to the multi-use of their equipment, as far as Greece is concerned, the effect to the environment is considered severe. This is because this equipment is based in non-friendly to the environment technologies. Still and taking under account worldwide practices that have been identified as successful after their implementation phase, these managed to project substantial decrease of the environmental footprint for the Armed Forces of several countries. Now is the time that best practices get to be implemented in the occasion of our country, which as a member of the European Union must achieve its goals to an overall continental decrease of 55% CO_2 emissions reduction by 2030.

The scope of this dissertation is to identify how sustainable can the Armed Forces be, by implementing practices that will allow them to become a modern, efficient and developed organization within both the public and private sectors. This practice will result in transforming them to a renewed institute with a sustainable perspective which will provide resources and fund saving for the purpose of modern arms procurement which will also be sustainable by adopting ‘‘green’’ technologies. The overall outcome will see the Armed Forces maintaining a thoroughly organized and operationally capable structure.

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Chapter 1 – Introduction

Every Nation in the world regardless of its political, economic, social or any other background must maintain sovereignty over its territory in order to ensure security, economic prosperity and consequently lead to development that will allow it to sustain further generations.

Hence, it is imperative to organize, equip, train and sustain both a reliable and operationally capable military structure. Sustaining because it must be coupled with the fact that in order to maintain such a fighting force, there is the requirement of availability of financial resources which will equate to an overall substantial investment. A country's GDP is significantly affected by the expenditure in military expenses which amounts to 2.58% for Greece for FY 2020 and an overall fiscal expenditure of 1.9t$ worldwide.

Apparently, the fact that Greece is surrounded by sea and has to confront both migrant flows[1] as well as a provocative neighbor[2], leads to the conclusion that almost every island inhabited by people is safeguarded by a military force. Also, smaller islands that do not sustain life still have an ongoing requirement to be guarded by an expeditionary small force, which is periodically changed.

One can only imagine that there are many challenges for a country, whose economy is in recession, and at the same time must be consistent in its foreign policy strategy and its obligations to participating alliances. The guideline promoting the adoption of ''green'' practices as a safe haven for such an economy with regards to attaining resources, can be put in effect especially through:

- Implementing energy efficiency programs financed by the EU[3].
- Reforming the public service electric company into a ''green'' and sustainable electric production hub, by transforming lignite production compounds to RES and PV facilities.[4]
- Setting the bases in reforming traditional agriculture to ''smart'' agriculture.

[1] https://migration.iom.int/europe?type=arrivals
[2] https://www.europarl.europa.eu/doceo/document/E-8-2018-001894_EN.html
[3] https://exoikonomo2020.gov.gr/
[4] https://www.iefimerida.gr/oikonomia/dei-shedio-apolignitopoiisi-treis-basikoi-axones

- Moving in line with the EU expectations for achieving reduction to CO_2 emissions down to 55% by 2030.[5]

An operationally capable defense needs to have renewed and upgraded equipment. For Greece, this means that in order to maintain a sufficient deterrence doctrine, a substantial amount of the country's expenditure consists of military expenses. These expenses relate to armaments that require further the purchase of a very expensive follow on support[6] to preserve their operational reliability. As such in the following chapters we will determine methods that will allow us to finance our defense expenditure in a consistent manner.

[5] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_el

[6] The term Follow On Support is relevant to the overall costs needed to maintain and successfully operate delicate equipment inside its Life Cycle from the day of commissioning up to the day of decommissioning.

Chapter 2 – Current status

In this chapter the current facility structure will be defined so that the magnitude of the installations owned by the armed forces is comprehended and in addition realizing how much potential regarding it, there is in turning it to ‘‘green’’ infrastructure. This transformation will considerably contribute to cost revenue through savings from utility costs.

a. Bases and facilities

Bases and facilities regard a wide complex consisting of a variety for utilization by the Armed Forces. In Greece those contain:

1. Ground facilities related to the army, consist of six major commands divided to twenty mixed formations which are further divided to two hundred and five minor formations and finally six army hospitals.
2. Ground facilities related to the navy consist of two major and one intermediate naval arsenal, thirteen naval bases, eleven naval commands and three naval hospitals.
3. Ground facilities related to the air force (other than airports) consist of eleven RA.D.A.R. stations, three anti-aircraft artillery camps, two meteorological stations one main organization and one peripheral station, seven smaller bases and one hospital.
4. Furthermore, a complex in Athens is housing the DoD, the National Defense General Staff and the General Staff for each branch of the Armed Forces.

b. Airports

Moving on to Airport facilities we count eleven large, three intermediate size airports and several small heli-pads around the islands. The airports that cover air force’s operations within the National area are mainly stated near urban areas, but care has been taken in most occasions and they do not interfere directly with local communities. This means that the majority of the existing active ones are located at a safe distance from habitable estates and consideration has been taken so that their operation does not hamper the local community’s activities in a way that may impose an unwanted impact (such as accident, noise disturbance, etc.). However, because it is of vital importance balancing between sustainability and military operations, an assessment to meet adequate standards need to take place for every aviation

installation that incorporates flight ops. An airport can sustainably-speaking be undermined when:

- Climate change affects its infrastructure with a subsequent effect in its day to day operations
- Aviation operations such as (flights, testing, exercising etc.) that produce noise disturbance, emissions etc. related to:
    - Regulation limitations (risks, closeness to a populated area), planning limitations or limitations imposed due to change of regulations
    - Toleration limits that have to do with affecting the inhabitant population (danger of an accident, noise, air quality etc.)
- Airport's failure in securing resources such as land, energy, water thus being unable to grow on operational perspective.
- Further infrastructure growth being limited by surrounding local infrastructure or local obscurance. (Ferruli, 2016)

Picture 1: A sustainable airport

As such, the results of the aforementioned assessment are made to enable us to define the social, economic and environmental aspects that are subject to degradation by airport operations. Hence there is a need to evaluate the possible footprint of an airport within those three fundamental pillars of Sustainable Development. To that respect, several methods have

been developed to evaluate an airport's infrastructure sustainability. And to that extent several rating systems and certifications are broadly adopted. These systems include:

- Quality assurance
- Environmental stewardship
- Assurance of long-term viability
- Basis of financial incentives
- Increased accountability and public recognition.

Most commonly, we find the LEED system in the aviation industry (Leadership in Energy and Environmental Design), which is a system that evaluates six categories for sustainability achievement and those are:

- Location and Transport
- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality

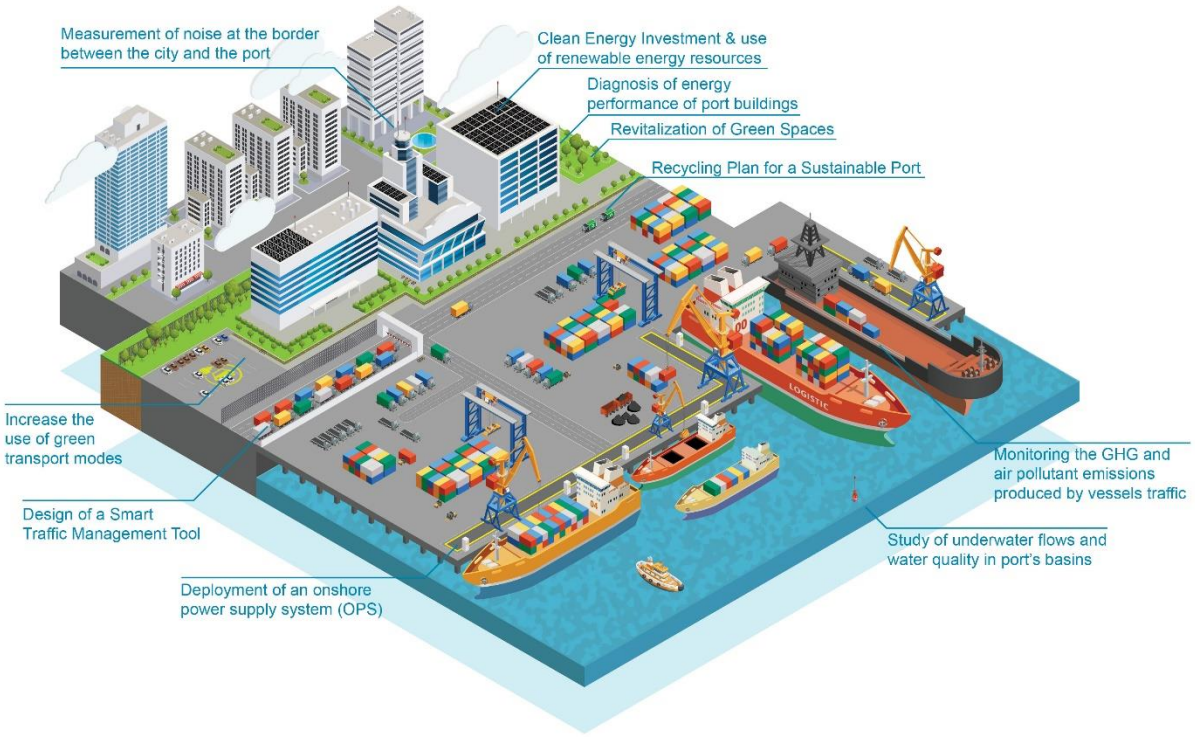
Another is BREEAM (Building Research Establishment Environmental Assessment Method), a well-known method which is actually the most widely used. This one evaluates ten categories, them being:

- Management
- Health & well-being
- Energy
- Transport
- Water
- Materials
- Waste
- Land Use & Ecology
- Pollution
- Innovation

A formal and solid organization such as the Armed Forces can highly benefit in many ways from such procedures that guide the way to an eco-systemic and sustainable approach. (ICAO, 2019)

c. Harbor facilities

There are three major harbor facilities that incorporate the capacity to cover major repairs on naval vessels and submarines, similar to those carried out on shipyards, thus using a massive and expensive in components equipment. Additionally, there are several locations that are being shared with the merchant naval sector for operational purposes and do not contain that large infrastructure to cover major repair for naval vessels.



Picture 2: A sustainable port

Following the footsteps of the above mentioned methods regarding airports, harbors can also benefit by adopting an evaluation doctrine that could provide useful guidelines to sustainability. An adaption of such doctrine could be implemented on the existing facilities of the islandic and maritime nation we live in. especially in the case of Naval Arsenals (just three in Greece). In addition, the fact that the stake holders engaged are the entire local community and it's activities, implementing best practices through a formal evaluation report, would have a major impact in securing the diverse environment of landscape, sea and air to those locations.

Furthermore, the fact that military harbors are actually performing as industrial areas due to the extensive repairs on ships held within them, should be put under thorough study in engaging stakeholders to form a task group that will produce a strategy for every one and stimulate them to achieve eco-friendliness and sustainable actions. There are several significant steps that can promote sustainability for such a facility. Should an attempt be made to define those steps, a harbor can be a big resource for:

- Circular economy in managing general, plastic and metal waste
- Implementing and testing best practices to manage shipping waste
- Implementing practices to promote life under the water
- Controlling gas emissions
- Building heat and power plant to cover ports activities by recycling waste energy.

Needless to mention the benefit for such activities for the local communities which will and must contribute to such an effort, providing waste energy thus covering the plant's needs.

In the instance of ports this assessment is highly relevant and can impose significant changes that could result in a much better life quality for the inhabitants and the bio-diversity of their location. Putting it to a context, an eco-systemic assessment, provides the framework that defines the social and environmental impact whilst a project is developed and materializes to existence. This has the potential to offer the best alternative of a project's development in case the impact on the environment and/or society is negative. In that way the decision making process while developing the project becomes far more efficient for any level within the management chain. Especially for such complex projects like transforming an existing Naval Base form a functional to a sustainable infrastructure paves the way from ‘‘damage avoidance’’ to ‘‘opportunity creation’’. This by its own creates a fruitful co-operation by all stakeholders related to the project and who are now will be delivering support instead offending the effort. (Boerema, 2017)

d. Current energy status

Most of these facilities indeed is older than ten years and a significant number may go back to fifty or sixty years. Occasionally those facilities are subject to upgrading yet not in terms of becoming actually ‘‘green’’. Most of those upgrades regarded maintenance of the

existing structure and some modifications could potentially prove to have a substantial impact in insulation.

In all these facilities one can surely find equipment related to:

- Houseware[7]
- Office support[8]
- Lighting
- Communication equipment[9]
- Other special electrical equipment used for military purposes and support[10]

The aforementioned systems are being supplied by the grid in use from the electric company and as such are subject to its quality and reliability. The consumption of power supply within these establishments is constant and varies little during the day as Armed Forces operate in a constant intensive tempo 24/7.

e. Demand in consideration for infrastructure ‘‘green’’ transformation.

The EU has established through EPBD 2010/31/EU directive, that Member States must comply with it and minimize consumption to all buildings of their jurisdiction, as well as apply certain minimum requirements regarding energy performance. To achieve that certain methodology has to be taken into consideration. The pillars under energy efficiency are building orientation, refrigeration – heating issues, lighting and heat recovery. The priority steps that lead the way to achieving energy consumption saving are:

- Improving the facility’s insulation, thus saving energy
- Building installations that are energy efficient
- Extensive use of RES, Solar Energy and PVs.

At this point we must define the energy performance of buildings which according to (EC, 2018) is classified in the following way:

[7] Laundry equipment, kitchen equipment, electric boilers, elevators etc.
[8] Laptops, desk tops, printers, plotting devices etc.
[9] Radios, routers etc.
[10] RADARs, maintenance and servicing components, factory equipment etc.

- Energy needs (savings): is relevant to indoor environmental control for working or living buildings and it has to do with the heat transfer phenomenon[11] that takes into account climate conditions these account for the indoor temperature, humidity air quality and light, as well as the outdoor ambient temperature humidity solar radiation and wind. By using the appropriate equipment, we can manage transforming the ambient conditions to ideal indoor conditions by using the appropriate equipment.
- Energy efficient systems co-operation: this is very important as it relates achieving more by using less. And it regards the overall co-operation of different stand-alone systems that provide heating, cooling, ventilation, hot-water and electricity.
- Occupancy energy and sustainable consumption: this being related to how the occupant uses the building equipment in covering day by day needs. To provide an example, the use of household appliances produces auxiliary heating as they require electricity to function and generate heat. Taking also into account the way we use windows, doors and other openings which their use can significantly impact indoor environmental control. (EC, 2018)

It is highly important to understand that renewable energy can affect the overall function of a building and it can benefit from the implementation of such use. Solar energy is classified as:

- Passive Solar Energy: is entirely connected to the installations positioning and design in absorbing solar energy that can impact its heating requirements.
- Solar Electrical Energy: that require PV use in order to produce or store for future consumption electric energy
- Solar Thermal Energy: where solar collectors, are used to produce hot water for domestic and/or space heating uses. (EC, 2018)

As already mentioned all of this infrastructure rely on the main grid power supply, which in several occasions can challenge the operators when there is a power failure. Another issue is accounting for the fact that most of these infrastructures are stated in a large real estate size-wise. Finally, the existence of specialized and skillful personnel with regards to operating

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sensitive equipment, all of the above can be seen as a motivator in exercising RES and Solar practices to swiftly reduce footprint by an organization which is the biggest homeland energy consumer to most countries around the globe.

Implementing such practices provides resilience to the fighting force and the operator which is now autonomously, efficiently and consistently delivering their product away from relying to the grid. Certainly for operational redundancy purposes the option to change over to the grid remains viable, yet the use of micro grids can provide energy security and integrity not only for defense purposes but to the commercial grid as well. That stated redundancy can go both ways. Furthermore, a micro grid will not be enough to cover the whole commercial grid demand, but essential services can rely on it.

The next section discusses the advantages of implementing microgrid technology to such complex uses and operations, and how the Armed Forces can benefit a lot by enhancing their Operational Capability along with reducing energy costs and their environmental footprint as well.

Chapter 3 – Transformation of the Armed Forces – Stance towards sustainability of the Armed Forces in Greece

a. Eco systemic approach

As a medium, internet technology allows people to communicate and exchange information very fast around the globe. Social media is a major tool that contributes to that information flow. In the effort of approaching the commercial needs the military can take advantage of this technology and listen to the broad demand of the public to serve it better. The adaption of Military systems and Military conduct of operations as they strive to meet civil approaches has been a goal to achieve by NATO which materialized through the founding of Civil - Military Co-operation Centre of Excellence (CIMIC CoE) in 2001. Since then a number of activities are leading the transformation in several aspects of the military communities worldwide and sustainability was one of them. "*Today a new training approach is being implemented through the Civil – Military Center of Excellence in NATO in which the military learns to integrate specific concepts into their missions, such as environmental issues"* (Janssen & Wit, 2011).

A very specific goal must be achieved when we record a large scale military operation successful. "*That a secure and stable environment in which an affected society can regain their confidence in a sustainable future is evident"* (Janssen & Wit, 2011)

The eco-systemic approach is "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way" Appendix 1; Shepherd, 2008)

b. Energy demand for the future's warfighting capability

The warfighting arsenal whether we refer to it as training or operational, requires a substantial amount of energy. Most of the equipment utilized by a nation's armed forces requires energy resources which correspond to electricity or fuel consumption. Evidently, this practice is extremely costly. Furthermore and since our business now and in the future will rely on electronic equipment and cyber technology the demand for energy consumption is expected to increase. (Robyn & Marqusee, 2019)

Ministry of Defense (MoD) energy needs are changing as well as growing. Most significant, the dramatic increase in electrical systems that are in use on military platforms (vehicles, ships, aircraft etc.) is driving electrification of the battlefield. The aforementioned increase in electrical systems demand and the need to reduce the logistics footprint are creating requirements for distributed and portable power generation, smart energy networks, improved energy storage, and wireless power transmission. (Robyn & Marqusee, 2019)

c. Key findings

The modern operational environment requires from the soldier to operate portable electrical devices, which require energy reserve and the capability once this energy is used to be portably recharged.

Military contingent installations around the world in support of operations on remote places require a constant growth of energy demand to ensure electric power availability and demand to and from multiple sources and loads as well as automated control.

Military bases may rely on a fragile commercial electric grid but cannot afford to lose continuous power to critical equipment.

Manned military equipment in order to be completely functional and operational, relies on energy. The newer the equipment the higher the demand for energy consumption; also there is an undisputed need for the highest quality power supply input to the modern devices that allow them to function consistently.

Autonomous systems not only demand the aforementioned need suitable for manned technology, but also due to the necessity in remaining within the operational theater this requires minimizing power need in terms of recharging allowing them to operate longer in both terms of distance and time.

Wireless power transmission: DOD wants to recharge drones remotely so they can remain aloft longer; and demonstrations using lasers are underway. Wireless recharging will facilitate the electrification of ground vehicles, among other clean energy uses.

Building energy technologies: DOD has funded more than 130 rigorous demonstrations of innovative, building energy technologies on its bases (e.g., electrochromic glass, waste-to-

energy systems, and remote auditing tools) to facilitate their commercialization and deployment.

d. Energy as the essential enabler

There are two main purposes for which the Mod consumes energy. Firstly, so that the Operational needs are met. This mostly relies on petroleum based energy, that is directly related to the mobility capability of operational equipment such as, ships, aircraft, vehicles etc. But we must not forget the power supply's contribution to the warfighter himself as he relies on portable equipment that uses batteries or capacitors in order to properly function and support his mission.

The second use of energy is related to the fixed installation energy consumption. This refers to the power supply demand of bases, buildings, warehouses, factories and industrial installations as well as other facilities of the Armed Forces.

Understandably operability of the Armed Forces is straightly linked with power supply. Even a minor gr id in the continuous current flow can have great cost in operations, in equipment, affect the decision making process and also imply a potential hazard for life. That said and by taking into account the fact that it is quite hard to support the operational means in fuel

e. Innovation and HiTech within the Armed Forces

Justifiably the Armed Forces and their relation to technology is key to operational success both in the battle field as well as within their operations in safeguarding the public needs whenever this is difficult to achieve by the commercial sector itself. What of better example than the Nov-SARS CoViD-19 pandemic, where scientists and medical staff from the military worldwide provided services to the public health in tackling the severity caused by the fracture in hospital care, especially due to their vast knowledge of military treatment and trauma. In our country services from all three branches of our military assist daily by using the capabilities provided by each one's means, in harm's way to achieve small miracles in remote communities un-protected by the safety of our main land.

In general, Armed Forces worldwide invest in a high amount of money and resources to evaluate and early adopt innovation technologies regardless how radical this innovation may

be. The reason being the necessity to tackle a huge variety of challenges within their operational environment, that in this line of work tend to arise swiftly and unexpectedly, making the decision making process very difficult for the operator who must react quickly and successfully based in insufficient info in order to tackle the threat.

As such there is no doubt that the Armed Forces implement an early adopter policy and this is of great importance to industry. That is because the test and evaluation of Modern tech takes place in very difficult and at the edge of their envelope environment, making the feedback resourceful and important for the product improvement.

To the extent concerning the Armed Forces, R&D must be a top priority as far as innovation is involved. The necessity of a product in service of covering a need must be driven by the costumer to the industry. The costumer, facilitates the requirements in accordance to the existing laws and standardization and the industry delivers the product for initial testing and fine tuning that wishfully it will be held by the final user. Therefore, a significant investment is a must for the R&D departments of the military.

Furthermore, lest we forget the investment made by Mod's around the world to the academia in research of improving basically used capabilities. For instance, appropriate power supply equipment in provision of undisturbed and high quality electric current, improving aviation fuel's efficiency etc.

Technological innovation is key to how MOD tackles almost every military challenge it faces, and energy is no exception.

The R&D outcomes and implementation of these practices by the Mod will significantly affect also the commercial trade that will benefit from tested and ready to use equipment and procedures. These benefits, among others include:

- Safe venture investments in further evolving fundamental technology

- Co-operation and partnership with Mod experts in advancing and promoting ready for use technology by adapting it to commercial needs

- Military installations will accommodate building and testing of improved equipment, allowing developers to effectively manage their budget in more R&D rather than building new installations for their own initial production.

Chapter 4 – Energy challenges

a. The necessity to ensure quality in power supply capability

Is driven by the following requirements:

- Abundant and high quality power supply with less fuel in demand. At the moment, operating equipment and infrastructure on contingency military real estate, demands that loads of fuel are transported to support undisrupted power supply functions. The future lies in exchanging this type of fuel based energy with 'green' practices implementation such as solar and wind based RES. Another possible alternative especially for the islandic part of a country, could be the kinetic energy deriving from sea-waves. Furthermore, adopting within the bases (which are quite limited in active area) smart cities practices is another viable and certainly interesting operationally-wise option.

- Another issue that is quite significant particularly for remote operational establishments is the perseverance of undisturbed electricity, free of the limitations imposed by the circuitry of the public service of the adjutant area and cyber-secure in order for inconsistencies not occurring during operational action. As such microgrid technology has become an area for R&D.

- Finally, we as people tend to be more careful in estate engineering and architecture, as we progress to much more energy efficient constructions. A necessity dictated by new law and institutional documentation, along with the agenda for an autonomous energy-wise Europe for 2050 and achieving the 17 SDGs by the UN. This by itself has the potential of ensuring that accomplishing a better environmental control of the interior in terms of temperature and humidity, as sustainable as possible and for longer periods without the need of having our Environmental Control Units (such as coolers, ACU, chilled water units, thermal units etc.) operating constantly, has a significant reduction requirement in terms of electricity. (Robyn & Marqusee, 2019)

Because of its large budget and mission focus, the military is less sensitive to high costs and early failures than commercial customers and private investors. Of course by defining a sustainable energy and practice road map, this will clear the problem of cost ineffectiveness and will promote prosperity and viable solutions.

As a country containing more than 5,000 islands, islets and skerries Greece is challenged by the need to provide its inhabitants with a power supply of high quality. As such and following practices of the past, most of these islands rely on industrial (diesel generator) power. In several occasions one can witness that some private or small scale domestic venture has been put to practice and adoption of small scale microgrids is evident on small or private locations. Just before 2021, a huge VW group investment was announced by the PM himself reflecting on the government's willingness to promote ''green practices'' and have Astypalaia, an island resting in the south eastern Aegean, turned into a sustainability example by minimizing to almost zero its' carbon emissions. (iefimerida, 2020) With this project in hand there is an expectation of adopting best practices derived from it to other remote places too. A breakthrough of innovation regarding sustainable technology is a must have – must do in Greece, since wind and solar power can massively expand in this country turning it to an example for Europe. Greece is blessed with sunshine, depended the area between 100 and 150 days annually. (Τσαβδάρης, 2020). Yet another characteristic of the Greek climate is the annual wind presence to speeds up to 45 kts. when gusting and a median speed of 8 kts. (timeanddate.com, 2021)

Microgrids co-operation with **fixed installations** reflects in three components:

- They include RES and facilities related with waste to energy for power production, as well as other power production constructions including power storage forms.

- They can potentially operate in parallel with the local grid and as such reduce the operating cost of the facility.

- It can operate as an ''island'' Mode which is an autonomous function with the grid cut off and as such along with its' ability to store energy can also provide essential operational services for the base. Maintaining the load and operating safely and with high quality is crucial for the delicate electronic military equipment.

Acquiring the know-how in implementing microgrid practices is another issue that has to be considered. This obstacle can be overcome easily if the Mod establishes a Memorandum of Co-operation (MoC), along with the MoE, that contains all this vital knowledge and also employ assets from the National academia and private sector. Such practice will lead the way

in building a joint doctrine of energy efficiency that may be useful to commercial activities also.

Digging deeper into the research a number of benefits rise by the possible MoE – Mod collaboration.

- Microgrid deployment into the public service would speed enormously, as the early adopter technology demonstrator military, would employ it and test it. Furthermore, the importance of such engagement would be the armed forces understanding the economic remuneration of microgrids and substantial pay back.

- A number of MoE's co-operations with the national industry would allow the Mod to participate and use these installations for testing and design optimization processes of the microgrids

- The aforementioned practice would further engage the MoDG in terms of developing cyber-security techniques and software in order to produce along with the other two departments a secure microgrid operational environment.

b. Microgrid advantages over stand alone generators

Looking into the advantages of microgrid technology in we discover that:

- The use of microgrids utilizes resources that allow distribution over a complex and not just one building, without the harmful emissions which is a product of a generator.

- Depending the equipment (PV or RES) we can make use of the given space of a building without occupying extra space or the least, in case of RES occupy a small portion of real estate.

- In terms of maintenance the microgrids require very little maintenance due to the fact that they operate in a minimum or no whatsoever moving parts. Most of them as far as the grid equipment is concerned being small and cheap electronic commercial of the self (COTS) parts.

- They project great reliability, which is essential for the continuous and undisturbed high quality of power distribution, as within their structure and should the occasion

arise, a failure can adequately be covered by setting on line another power distribution asset along the complex instantly.

- Due to their capability in being networked, microgrids respond immediately to electricity requirements should these differ occasionally with no cost whatsoever as it is natural resource reliant and not fuel-reliant unlike generators.

- Finally, microgrids are being built in order to cover the annual peak load of an installation. With that in mind its ability to connect excess generation is always available either by a stand-alone generator or by the electric's company available power resource.

- The one drawback microgrids are subject to, is actually the wiring they are connected to for power distribution. As such, should this wiring be unreliable, the quality of the electric power will not be the required one. Nevertheless, wiring integration (due to the commonly short distance between the microgrid and the base infrastructure) is always a viable and cost-effective option.

c. RES and Energy Security

One of the main focuses when we discuss for armed conflicts, is targeting certain components of the opposite side, in order to achieve maximum impact with minimum resources. As such the power distribution company's sites is a key component to take out and send a whole nation's infrastructure back to stone age if it is reliant to just that. Needless to say, should that occur the impact it would have in supporting defensive operations, since communications, transportation, detection as well as other vital components will be inoperative. Microgrid technology, which is a low cost and pay back technology comes to solve this major issue. Since every remote area and/or outstation will be self-reliant as far as electricity is concerned and redundancy would still remain by either interconnection between microgrids, other bases near the damaged installation using that technology and/or the main grid itself at worst. The energy security is probably micro grid's technology major advantage.

Adding to the above, we must underline the fact of a possible redundant response of the base power supply to the local communities in case of power failure. Even just to cover the essential needs due to the grid cut out.

Another feature that adds to the resilience of a microgrid regarding security is the load management. When operating delicate equipment that provide essential elements and assets in the battlefield and at the same time you support it with equally delicate power supply equipment that has no tolerance in exceeding its limits, proper management of the supported loads is essential to network integrity.

Another aspect that we have to take under thorough consideration when employing microgrids on our region especially for military purposes are the hybrid threats. With the most common and cost effective for the actor being cyber-attack. This type of threat can have a broad impact on the operation of a microgrid that is delivering power to essential equipment, since the whole monitoring and control of the industrial equipment is software and hardware based.

d. Energy's Security value

We have already discussed the necessity to establish security in our microgrid facility especially since its' primary output is to provide high quality undisturbed power supply. We mentioned the two pillars regarding the integrity of a micro grid's security as we referred to it in terms of nominal power with sufficient (power) margin to compensate for possible overloading that may hamper its' undisturbed operation. And of course the cyber-security required to safeguard it from potential actors that impose a threat for the function of a military installation. Proceeding even further and as issues arise concerning on how someone can determine the value of energy security, it is quite difficult under the existing structure to capture certain aspects that contain vital power supply information and would lead us in setting our security boundaries.

First of all, the buildings do not contain load measurement meters and a value of the critical building load is not available. This value is key to fragmenting and determining the appropriate equipment that will form the installation of a microgrid as well as the power margin need. With this in hand not just the security issue is resolved but also the investment costs are managed much coherently.

Secondly, the total cost of standalone generators, could be a first look at the value of energy security. So by looking on the cost to recover back up power after an outage using different methods, the less costly method that compensates for the power supply security should be adopted. (Jeffrey Marqusee, 2017)

e. Purchasing Energy Security

The armed forces in Greece are on the top (if not the first) social responsible organizations in terms of delivering safety along with security to remote regions. Meaning their continuous effort in providing health services, disaster relief, transportation for medical emergencies etc. (HNDGS, 2018). Building a robust type of trust in the Greek society has been a priority for both the government and the military for this side of the world's turbulent region. Maintaining it has a significant cost in resources but successfully the Mod has managed to compensate for the demand. Especially in the islandic part of the eastern Aegean but also nationally there is a two way supporting link between local communities and the bases. As our armed forces are trying consistently to further develop this relationship, adoption of microgrid technology could be an essential enabler of that practice.

As such and under the co-operation with the MoE, an investigation of the local island need for each one in terms of power demand, could pave the way for an investment for ''green'' power supply technology of the military installation and cover besides the base itself, basic or in some occasions total power demand needs of the region, connecting the microgrid to its grid.

We do not what so ever imply in investing for a microgrid with capacity of covering the power demand of the whole island. Rather certain vital requirements (e.g. hospital care, harbor facilities, possible airports).

f. Technology implementation shortcomings

There is a substantial portion of reluctance within the armed forces, in adopting commercial systems regardless of how innovative these may be. Microgrid technology is certainly one. There are barriers than need to be surpassed and we will identify them in order to make sure we can comply with best practices.

- The wide spread use of standalone generators among the armed forces infrastructure pushes back on our willingness to reform on a new Model under the fear of implementing a new thus lacking know how technology.

- Add to the above our skepticism in safeguarding this technology by the added need (when employing such technology in managing this delicate equipment) of securing and

cyber-securing it. Security's definition has been covered in terms of dimensions defined such as duration, reliability, and flexibility) and setting different requirements for different loads.

- Understandably and because the new requirement will set off a new approach in power supply management, decentralized from the main grid, it will require the employment of a large number of people to manage it nation and/or remote – wide as well setting up a thorough and robust training program to bring up to date the available personnel.

- The revenue of such investment is another huge element that the armed forces are hesitant to comprehend as the stand alone generator scheme has an impact of conventionality due to its' broad use. (Jeffrey Marqusee, 2017)

g. Bio fuels

Another highly contributing factor within the transformation to a sustainable force for the military is the use of bio-fuels. Bio fuel technology has been introduced. For the purpose of this particular chapter the focus will remain in ethanol as a vehicle bio fuel and bio diesel as a potential aircraft and vessel bio fuel.

i. Ethanol

In the instance of ethanol, is a common vehicle bio-fuel. Ethanol can be produced as a product of microbial fermentation of sugar. The E15 ethanol gasoline mixture (15% ethanol – 85% gasoline), is approved for sale for every gasoline vehicle from 2001 and on in the US[12]. Suggesting that the use of this particular mixture is the appropriate one for commercial use of vehicles with regards to economy and emissions. Ethanol bio-fuel though environmental friendly, yet MoEs not provide the same mileage cover as pure gasoline. As such initially the Environment Protection Agency in the USA, suggested that an E15 mixture is a dual-benefit choice for gasoline vehicle owners.

Later on an MIT 2004 study, suggested that hybrid technology in gasoline vehicles could increase the ethanol percentage in a higher mixture on a dual fuel (carried separately),

[12] Fred Meier (13 October 2010). "EPA allows 15% ethanol in gasoline, but only for late-Model cars". USA Today. Retrieved 14 October 2010.

gasoline engine for hybrid technology.[13] This paper suggested the use of E85 ethanol gasoline mixture along with gasoline and the ingestion for the fuel calculated in accordance to vehicle power demand. This paper noted a reduction of 30% in CO_2 emissions.

Certainly though and in line with what is the trend for a sustainable organization the above adoption would refer to an intermediate act, with a much more sufficient planning in changing over the vehicle fleet of the armed forces. Always taking into account that at this point we refer to conventional vehicle and not armored vehicles. Armored vehicles will be addressed in the following paragraphs.

ii. Bio-diesel

Most of the internal combustion engines including thermal turbomachinery, within the armed forces uses diesel fuel or its equivalent distils as their work producing fuel. This means that adoption of bio-diesel as a fuel in the armed forces can certainly be implemented. Bio-diesel is a type of fuel that is produced as an agricultural bio-product (soya or other vegetable oil). The unique feature of this fuel is that it is compatible in any mixture with diesel fuel and given the proper application it can be used as 100% fuel. In the armed forces bio-diesel has been used extensively (especially by the US Navy) (SECNAV, 2009), for experimental to early adoption methods. In fact a US Navy fast jet F/A-18F Super Hornet, conducted a supersonic flight on 50-50 bio-diesel mixture to kerosene[14] with no engine alternations what so ever. According to further reports[15] bio-diesel can easily meet in a calculated mixture the needs of the armed forces, with no or minor adjustment to the application. Additionally this type of fuel contributes extensively in sustainability application change over since it[16]:

- Reduces lifecycle greenhouse gases by 86%
- Lowers particulate matter by 47%, reduces smog and makes our air healthier to breathe

[13] Cohn, D.R.; Bromberg, L.; Heywood, J.B. (20 April 2005), "Direct Injection Ethanol Boosted Gasoline Engines: Biofuel Leveraging for Cost Effective Reduction of Oil Dependence and CO2 Emissions. MIT Report PSFC/JA-06-16" (PDF), MIT Energy Initiative, archived from the original
[14] https://www.nationalgeographic.com/news/2010/4/100420-energy-biofuel-fighter-jet/
[15] https://www.researchandmarkets.com/reports/4770532/biofuel-usage-in-the-armed-forces-2019?utm_source=BW&utm_medium=PressRelease&utm_code=q6vdmq&utm_campaign=1244928+-+Biofuel+Usage+in+the+Armed+Forces%2c+2019+-+Companies%2c+Economic+Impact+%26+Benefits&utm_exec=joca220prd
[16] https://www.biodiesel.org/what-is-biodiesel/biodiesel-basics

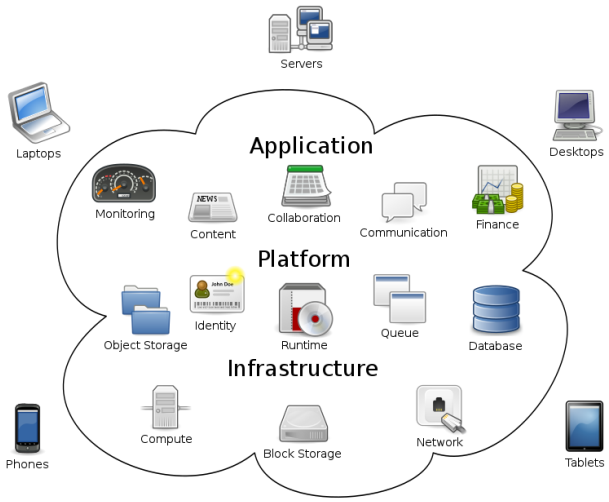
- Reduces hydrocarbon emissions by 67%

- For every unit of fossil energy, it takes to produce biodiesel, 3.5 units of renewable energy are returned.

Use of bio-diesel fuel, should also be incorporated to the equipment re-fit and procurement procedures.

h. Digital Transformation

Digital Transformation has been a major goal achievement especially during the pandemic. Moreover, it institutes one of the main EU goals for the 2050 agenda[17]. Meeting that particular requirement in our everyday routine, would extensively contribute by reducing our environmental footprint significantly. Taking into account that visits in public services, banks, markets etc. will significantly reduce as well as the same organizations themselves shall use smart technology for mails, documentation, reports etc. without using hard copy technology. Transforming to a ‘‘cloud’’ world our businesses, will allow striving to new concepts and new opportunities will grow. From the public to the medical sector and from e-commerce, banking and training to the Armed Forces.



Picture 3: Digital ''Cloud''

In this instance information flow, from and to operators worldwide will be swiftly addressed allowing thorough decision making processes, reporting and mailing will be

[17] https://ec.europa.eu/commission/presscorner/detail/en/fs_20_278

evaluated more consistently as the need to deliver back and forth paperwork will seize to exist. Situational awareness in real time during operations will be linked to the most remote places in image or as a raw projection of a RA.D.A.R screen allowing the chain of command to act quickly and address corrective actions as operation evolves. Information flow will be far more consistent and secure, with the development of adequate cyber-security systems.

Finally, training will become far more coherent as it will be easier for the trainee to access it at any time and the trainer will refine his methods and classes, developing even more innovative techniques.

Digital transformation will allow consistent time management on activities along with the reduction of human intervention in the overall environmental footprint.

Chapter 5 – Expeditionary Military installations

A huge challenge when troops are deploying to forward locations where establishment of the force in infrastructure is limited or non-existing remains the power supply for operational and auxiliary – supporting purposes. The solution to this problem can easily be the development of portable equipment that can be transferred with the force and with limited engineering knowledge can materialize in a tactical microgrid. The footprint logistically speaking of such an accomplishment will be minimal as the need for carrying complex generators along with their fuel demands is no longer an issue. Attention should be paid to designing such equipment, as it would take a lot of effort in optimizing the equipment accordingly in order to meet standards that will allow it to operate safely, in high quality of power supply distribution and easily to put it together and maintain it especially when those works are expected to be carried out from people with minor engineering knowledge.

Picture 4: An Expeditionary Camp

Mod as an early adopter and technology demonstrator, could play a significant role in the tactical microgrid R&D and employment of practice, mobilizing and intriguing interest of this technology to serve public requirements. Where necessary tactical microgrids can offer significant flexibility especially to construction sites in remote places were initial power distribution is not provided. (Jeffrey Marqusee, 2017).

An expeditionary unit deployment, can easily be considered as by far one of the most if not the most challenging operationally-wise mission. The reason being is related to several factors. Most common ones are:

- How far from the metropolitan installations will this mission be mobilized to?
- What are the required assets (aircraft, tanks, probably ships, vehicles, special unit deployment, logistic support, medical, maintenance for aviation and special equipment, troops, command centers, communications, utilities etc.) the list can go on and on.
- How big in numbers is required
- How the rest of the national theater is affected by ‘‘loosing’’ from proximity these assets?
- How much time will this expedition last?
- Last and foremost important… what is the energy required to sustain such operation, what are the local potential assets in delivering that demand and how long can this venture be sustained. Can we make it autonomous?

These answers mostly rely on sustainability as one can realize. And obviously the energy part is the most challenging one. From the very beginning of the expedition energy availability is of the highest priority. In lack of it the unit can only operate in survival Mode and not sustainment, as they will go back to the Trojan War era. This is because features like:

- Setting up a command and control center
- Office requirements
- Laptops, printers
- Communication devices
- Intranet and internet services
- RA.D.A.R services
- Habitability services
- Hospital care services
- Lighting and general use
- Cooking and entertainment
- Devices recharging etc.

Will not be operable and as a result the overall operation will not be adequately supported. As such the whole deployment will be jeopardized.

Furthermore, sustainability does not only have to do with energy. Other vital resources need to be covered to assist in the viable Military Operation. And it also has to do even on the treatment by the Military Force against all stakeholders of their deployment. The fact that an operation is a military one, does not imply that the use of force is justifiable against all causes. A sovereign and responsible Nation still functions under specific rules of engagement and it is widely proven that should respect and conformity to UN standards be payed even against the enemy can significantly affect in favor of the military force the result of the operation even by avoiding the use of force. Still expeditionary operations for this country are by experience peace keeping and as such we will examine this issue. Especially since conformity by the 17 SDGs is a priority for NATO operations. The (Civil Military Center of Excellence) – CIMIC CoE was created to address these goals consistently.

As the operational requirement sets off and at the planning phase, the commanders decision must rely to his team effort of combining their understanding of costs engaged and goals to achieve adding to that the idea of sustainability to make sure that the chain between the Social, Economic, Environmental links remains intact and the operation does not rely on assets that may require unjustifiable costs from the part of the assigning Nation.

Picture 5: Alexander's the Great empire - A sustainable operational force

Technology is now there to allow possible design of portable microgrids that can be easily installed regardless of whether we are talking about RES or PVs. This has a significant operational benefit, due to the fact that it does not require fossil fuels, thus constant replenishment and it is also noise friendly. Furthermore, the maintainability of a microgrid,

tends to be straight forward and it does not require special knowledge by the maintainer or special monitoring by the operator, allowing the force to be more focused in their mission, in contrast with the possibility of using a gen-set which would be far more demanding in the above contest. Even worse the possible necessity to having to operate by the remote areas grid, suggests an unnecessary risk that can compromise the operation, or demand extra operations to take place to ensure energy security.

Moving on to mobility, the use of vehicles that can be operated in a hybrid manner can contribute to a very resilient operational result as well, since the requirement for fuel will be limited and the overall noise as well, which is a demand for military operations, as very often noise is regarded as an enemy within. Additionally, the Mean Time Between Failure (MTBF), as well as the maintenance of such vehicles is very limited and as already stated above, the operational gain is once more mission oriented.

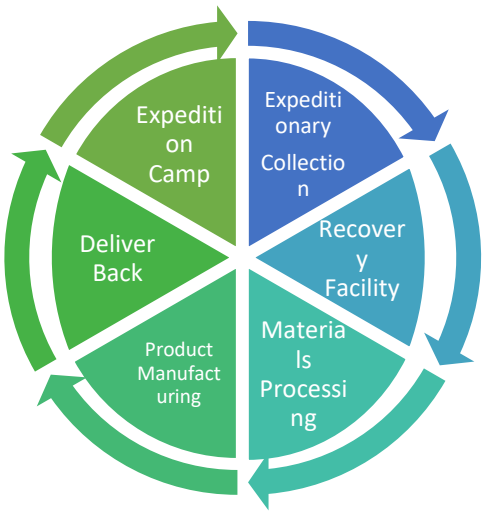
New technologies have broadly emerged and derived from commercial activities. One of those is the widespread use of PVC fabrication. PVC in comparison to cotton is far lighter, and waterproof. PVC dries quicker than cotton and it actually MoEs not absorb whatsoever water, unlike cotton that becomes quite heavy as it is highly water friendly. Another important feature of PVC is that it is very easily cleaned, very light which implies that its transportation is easier and the fact that in case of damage the repair techniques are existing and do not insist a problem in rectification of damage. New technology PVC, is now white inside and as such, lighting can be less demanding in terms of resources, as this feature projects better reflection. Leading to less consumption, thus making the energy management easier to perform. Life cycle costs for PVC is reduced since the new materials are far more resistant to heavy duty and quite stronger. Another very important feature is the fact that insulation methods for PVC have been discovered and as such energy consumption with regards to heating – cooling is expressively reduced. Add to that the decaying resistance as well as the replacement costs are well diminished together with the customization availability to the client in terms of shapes, patterns, camo etc. provide flexibility to the Armed Forces. Finally, this material fulfils the norms for environmental disposal standards. (Defence, 2017 - 2018).

Which leads us to the next step of our study in this chapter regarding expeditionary waste management. Such diverse and unconventional operations demand a thorough waste management for the sustainable army. Waste produced in a remote and unknown environment

are understandably waste producing and as such a great opportunity is evident in recycling, up-cycling and setting up to establish circular economy practices. To achieve maximum performance in delivering a good result with regards to sustainability, educating the military force is essential. This can take place inside the framework of a tier system:

- Tier 1: Sustainability lesson on commissioning
- Tier 2: Sustainability seminars whilst serving
- Tier 3: Sustainability seminars prior to deployment

All those actions must be combined with everyday activities at the working environment as well as combined activities with the local communities. To that end understanding the importance of circular economy, during the Nov – SARS CoViD – 19 pandemic the necessity to produce materials based on tissue, textile, toweling and general packaging for medical supplies as well as every day domestic market requirements was tested to its core especially during the beginning of it. Face masks unavailability to health workers and to people due to social panic, hygiene products etc. were challenged as their production could not meet the demand. This forced a severe social and economic lock down forcing economies to face recession globally. The necessity of proper recycling was deemed a first priority and the benefits of exercising that was later what managed to recover the demand production meeting the requirement. Putting it to the context, proper operational waste management and sustainable transportation of it to the industry in meeting circular methods, results in up keeping momentum in logistic support thus making this type of support sustainable, and the operators reassured for an undisturbed supply chain.



Picture 6: Recycling in a Fort

From the side of Mod there is an emerging concern that could be also an emerging opportunity. This being, identifying potential partners and/or stakeholders within the waste management cycle chain that can deliver their product swiftly from and back to the war-fighter.

The part of the organization of waste management in the expedition camp the expeditionary collection and the delivery back to the camp, certainly relies to the Mod processes. The recovery facility, material processing and product manufacturing, with regards to what has been collected and shorted, can either be managed by Mods industrial facilities and private sector facilities as well in case know how in managing several recyclable items is an issue.

Finally, organic waste management is another feature that can be addressed in both expeditionary or metropolitan units, since a lot of eatable consumable are discharged mainly due to personal dietary preferences. It is well known within the agricultural and circular economy processes that food compost is a major contribution to landfills and that it can be used as a valuable source in providing energy. On the other hand, and whilst expeditionary operations engage local stakeholders, building trust in a civilian – military co-operation path is of key importance, thus making donation a major contributor. As a final point into this process we must add the so called CORe initiative. This is an organic waste management process mainly food, that converts food waste to ‘‘green’’ electric energy. Through this initiative, the sum of collected organic eatable waste, is collected and then processed through slurry. Further on this mixture is injected to treatment digesters in a waste water infrastructure and biogas is produced of such quality that can be used in power generation facilities. (Management, 2019)

Picture 7: Waste management

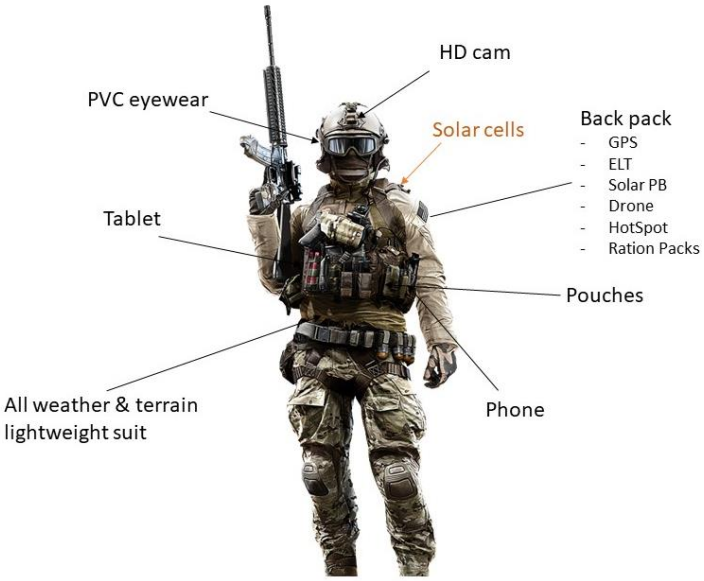
It is in our history that we have examples of sustainable expeditions of a large military force, able to lead countries, recognize opportunities, identify resources and sustain operations keeping autonomy of their expedition in a multi-cultural and diverse environment that accepted their submission. Alexander the Great is probably one of the most visionary leaders the world ever experienced and certainly managed his military on a sustainable and innovative manner.

Chapter 6 – The sustainable Warfighter

One of the things that define sustainability is life cycle and life cycle costs. The life cycle of a product is defined as the time between the products commissioning and end of use ability. To be feasible for a product to meet the life cycle as defined by its producer, two things must not be deviated by the consumer.

a. The product to function within its specified design environment and limits
b. That the product's maintenance schedule should it be specific, to be followed consistently.

All of the above, apply equally regarding every product. Obviously in order to achieve sustainability for every aspect that we examine, we need to address and engage known and well understood procedures with new innovative best practices. Following we will discuss how a soldier can be sustainable in operations.



Picture 8: The Sustainable Soldier

a. Hardware

In this section we will not discuss weapons, as this is not the purpose of this dissertation. However, a number of other features that define the Soldiers equipment and play a significant role in his mission, will be addressed and these can also apply to a broad aspect of other professions thus serving as food for thought.

There have been significant requirements for Modern Armed Forces, in developing a uniform to comply with all terrain and all weather aspects in the most challenging operational environment. The need of a war fighter regarding that uniform, relies on being:

- Light-weight
- Waterproof and water-phobic
- Windproof
- Wearable in every season
- Rugged
- Breathable
- Fast fitted
- Pocket reliant
- Comfortable in aggressive motion

The above first seven features apply to all standard clothing such as:

- including footwear (e.g. tactical boots)
- head gear (tactical hats, operational helmets).
- Hand gear (gloves)
- Eye gear
- Store gear (back packs, munition stores, belts)
- Pouches
- Cold gear (jackets for extreme conditions).

To meet these standards several attempts have been made by the US and HM Armed Forces. Furthermore, a number of companies both National and International, try to meet the aforementioned demands. A number of options are viable with many of them projecting long life cycles and recycle potential.

Moving forward to the rest gear required from a soldier in the Modern era of vast information and sheer distribution of it in real-time to achieve a thorough and updated decision making process by the operational staff, communications stand out. The Modern warfare is strongly linked to portable electronic equipment. As such the lone operator can significantly and successfully update status by transmitting vital information to hers/his HQ and/or receive execution orders in real time. Analyzing a potential equipment this would be:

- Radio
- Sports watch
- iPad / Tablet
- iPhone / Android Phone
- Hot Spot
- GoPro cam / HD Cam (for intelligence)
- Portable drone (flying or sea-going)
- Night vision equipment
- GPS or other navigational equipment
- Emergency Locator Transmitter.

All of these critical equipment, does rely on energy. Also all of it can easily be recharged by a home socket or by a quite huge power bank in sufficient quantity. Which would increase the carrying weight of the soldier. If not, the whole operation could not last more than 24hrs. meaning that the operator may not be able to achieve the expected result. Ration pack carrying can support a soldier for three days with no concern. But energy resilience is the key to keep him operating. To overcome this obstacle, the solution is a portable solar power bank, available in the market. Despite that fact several concerns arise regarding the use of such equipment, as far as internet and location transmitters – receivers are concerned. An obstacle that will be following discussed.

b. Cyber security

As already introduced sustainability for the Modern operational environment crosses through and is closely related to cyber security. To achieve resourcefulness and mission accomplishment whilst conducting enduring operations, the infrastructure and the soldier must be cyber secured in order to avoid compromise. The methodology proposed for that is a six step approach:

- Simulate
- Analyse
- Plan
- Develop
- Build

- Operate

The first two phases help us to define the context and address the challenges that will eventually lead to the planning face of sustainable cyber security operations. The planning phase will define the needs that are demanded to accomplish our goal and define both software and hardware development, as well as introducing technical and economical requirements. The last three components define the implementation phase of putting everything together and setting it up to action which will conclude in confronting cyber-attacks. (Kafol, 2017)

More analytically, simulating our demand is a viable approach and a cost effective one. Lots of simulated and analytic programs stand out and suggest best practices, while putting together a smaller and less complex network to actually practice the simulation, MoEs not impose a significant costly option. Moreover, by practicing on the animated or the micrographic network, customizing the need suggests the approach to the best possible solution.

Analysis follows the simulation part, were all the observations from possible security inconsistencies will be addressed and the whole network will be designed to its final sketched form. Once the demand for parts and stakeholders is addressed, everything will be subject to calculated and pre-meditated security risks that will provide the tools for the best possible confrontation of them.

Moving on to planning, it is imperative to have concluded and decided relying on the outcomes of the analysis phase. The produced plan will provide an accurate path for the coherent implementation of the cyber-secure practice. This phase will include techno economic issues and options for the decision makers to consider and conclude to the most reliant and viable one. Due to the importance of cyber security in the Modern warfare environment, selecting the what seems costlier option, is counter-balanced by mission success, lifesaving, hybrid threat abolishing and intelligence integrity within the technical to strategic decision making processes.

As already mentioned the development phase, will consider everything. Meaning, human resources, all relevant stake holders, hardware and software. After that the implementation of the whole designed architecture will take place and the environment will start shaping its form.

The second step of the implementation phase will be the building of a Cyber Security Warfare Center – CWOC. This will actually be the command and control element of the whole network, that will facilitate, operators which will monitor cyber operations, on-going operations and communications between the HQ to the tactical operators and vice-versa, throughout the chain of command (tactical – operational – strategic).

Operational exploitation will then take place under a first initial testing so that fine tuning procedures can provide a resourceful and reliable environment for the operational stakeholders. As transitioning occurs from trials to full operational employment, feedback should be provided constantly to the developers in order to address, noted inconsistencies.

The above mentioned six steps will conform a loop that will keep updated the whole cyber-security organization.

c. Energy assurance

The Armed Forces operational environment is a diversive multi-threat one. Achieving mission accomplishment relies on many boundaries that form the solid structure guarding everyone from the operator to the procedures all the way to infrastructure. In th instance of energy and autonomy for that, we already mentioned the electronic security required for its stability. As we move forward to identify other possible considerations, we must relate them to the performance standards.

Grid outages imply a high risk should a military facility rely only on the commercial grid and that can hamper a possible operation at its execution. Adding to that the main reason for an outage may be severe weather due to climate change, terrorism and/or cyber warfare one cannot but expect that these threats will increase in the future (Jeffrey Marqusee, 2017). This makes grid autonomy a necessity for the military force of the future. Furthermore the life cycle of a microgrid has the potential to save money on a large base installation from 8 to 20 m.$ (Jeffrey Marqusee, 2017) in comparison to the use of standalone generators.

Another key finding is that microgrid technology is free of any financial barrier. This means that the choice lies with the interested part, in being the owner – operator of the installation or just go for the service from a private company that manages and provides microgrid services. This suggests funding flexibility for the purchaser, allowing him the choice

in entering this technology as an investor whenever he may find fit. The most important benefit of this option is that the purchaser rests the performance, maintenance and operational services to the third party that only fulfills the demands and is subject to any cost.

Energy efficiency is of vital importance when we demand such equipment. A significant amount of energy is lost to the operation of a standalone generator or of non-consistency in power supply management. A thorough energy efficiency plan will provide the needed information for building the proper microgrid in terms of energy security, thus safeguarding the investments funding by reducing costs to the appropriate amount. Additionally, the ability of the installation in storing energy, further supporting the investment as excessive use can be avoided. (Jeffrey Marqusee, 2017).

Whilst transforming to ‘‘green’’ technology is mandatory for the sustainable Armed Forces, yet operational resilience must not be a victim of potential actors that pose threats. With that in mind, we must focus on transforming our businesses following a dependable plan. As such we need to ensure the undisturbed operation of this delicate national security organization and implement those ‘‘green’’ best practices by introducing hybrid power generation to safeguard microgrid operation, institute appropriate procedures to ensure safe isolation and reconnection of power distribution to operational equipment, relying on grid redundancy, employ all available synergies with other public and private sector stakeholders, by releasing findings and discussing new technologies as well as defining areas of common operational interest to succeed in transforming to not just ‘‘green’’ but sustainable fighting force. (Feldman, RENEWABLE ENERGY FOR MILITARY INSTALLATIONS: 2014 INDUSTRY REVIEW, 2014)

The second issue arising by this chapter, is the operator’s energy assurance. To that respect, technology now provides those tools required for him to carry his equipment and relying to weather, being able to operate it as sufficiently as possible. In this occasion we do not refer mostly to the infantry operators which will participate in large numbers at conflicts and deploy from organized camps or forward bases, rather the operator which must rely in conducting a special or even ‘‘black’’ operation.[18] To that instance, where the soldiers will

[18] Special Operations and ‘‘Black Ops’’ are activities conducted by specially trained military operators, in a broad aspect of unconventional warfare that has to do mostly in managing harsh environment in combat and severe weather. Features of such activities include, guerilla warfare, under-water warfare, reconnaissance missions, behind enemy lines operations, demolitions etc.

subject himself in a challenging situation having to operate in small numbers and the use of special equipment is important for the information flow, sustainability in energy means is of vital importance for mission success.

d. The Veteran

Sustainability is a way of life. An everlasting stance to oppose pure survival, that actually combines it with quality of life. The challenging career path of all Armed Forces personnel regardless of the responsibilities undertaken, eventually come to a willing or unwilling still unavoidable end. To that respect the specialized knowledge acquired through intensive inter-organizational training may or may not be useful for the after service career. Yet obtaining skills with regards to sustainability really provide a diverse approach to civilian life, that can fit to any profession. Most organizations, strive to find skillful personnel, that have obtained an unprecedented understanding of sustainability in a demanding environment, can perform without hesitation under pressure and are experienced operators in their line of work. With that in mind the armed forces can meet a position in the professional arena that will attract fine young people to follow a notable path within them, as well their own commissioned personnel will be stimulated in attaining education with regards to sustainability under the scope of self-improvement. This can only be a significant advantage for a transforming organization. The overall trust of the private sector will further develop as to their existing very promising co-operation with the Mod and their veterans and a substantial pool of human resources will be readily and easily absorbed.

The center of gravity for all organizations is its human resources. Meeting the needs and the worries of this diversive personnel and managing to engage them in achieving a sustainable approach to every day work life will turn back to the organization and optimize its function further.

Chapter 7 – Milestone setting in achieving SDGs

a. Goal setting as the guide path to sustainability

The added value of energy as a force multiplier MoEs not require verification. But the way it is produced if managed correctly MoEs create circumstances that multiply the operational efficiency of the fighting force. ‘‘Green’’ energy can increase the range and endurance of the operator and because the installation is stated in a protected place, there is no added requirement of assigning extra forces to protect it just as it would happen for the grid’s energy supply lines. (Institute E. a., 2011).

In 2011 the US Armed Forces, each issued a plan[19] that suggested certain actions needed to be taken for reaching specific goals that would gradually transform them to ‘‘green’’ forces. Those suggestions could potentially be implemented as best practices for our county’s armed forces and they consist of several strategic goals:

- Improve resiliency in order to:
    - Identify vulnerabilities to energy supplies, such as physical and cyber-attacks or natural disasters
    - Mitigate impacts from disruptions in energy supplies to critical assets, installations, and priority missions
    - Develop ability to prioritize resources against risks to the mission
    - Advance physical and cyber security solutions to protect critical energy assets and secure industrial controls systems
- Optimize demand in order to:
    - Increase energy efficiency and operational efficiency for Air Force systems
    - Enhance capabilities by focusing on the energy required to achieve the Air Force mission
    - Build energy considerations into Air Force research, development, test and evaluation (RDT&E) efforts

[19] https://www.afcec.af.mil/Portals/17/documents/Energy/AFEnergyFlightPlan2017.pdf?ver=2019-12-16-105948-090

- Ensure supply in order to:

    - Integrate alternative sources of energy compatible with mission requirements
    - Diversify drop-in sources of energy
    - Increase access to reliable and uninterrupted energy supplies (USAF, 2017)

To achieve the aforementioned goals, the necessity of an all-inclusive approach needs to be satisfied. All inclusive meaning achieving: a comprehensive budget, resilience and ‘‘green’’ resources. All these lie with managing microgrid technology by designing the feature in an holistic approach from cabling Modernization, to energy security and all the way to utilizing efficient resources. (USAF, 2017)

The most important characteristic of this transformation is the adoption of ‘‘green’’ technology. Either RES or PVs regarding power supply and storage are key components in providing energy diversity to the enabler as well as assurance in achieving the goal of converting to sustainable Armed Forces.

Moreover, the overall engagement by interested in the Armed Forces stakeholders needs to be addressed into those goals, as their involvement, can significantly affect their successful achievement. Issues that are important to be taken under consideration are:

- Ship and aircraft manufacturing and repair
- IT, communications, and electronics manufacturers
- Vehicle manufacturers
- Fuel developers and suppliers
- Builders and construction firms
- Energy service contractors
- Equipment manufacturers and vendors (SECNAV, 2009)

It is imperative for such an organization to reach out to industry and negotiate sustainable procurements, not only just in being up to date with the overall trend. As notably we can relate sustainability’s benefits in effective economy and smart practices.

b. Goal tracking and monitoring

A smart approach to achieve the road map to goal setting, would be the introduction of a tri-service Sustainable Development Goal Setting committee. Its main work should focus on attaining the information stated in the UN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT and analyze the 17 Sustainable Development Goals and their 169 sub-disciplines. This will provide the pathway in building up a strategy engaging the internal stakeholders that will eventually build up actions for implementation to meet them within the time frame required for their accomplishment.

Picture 9: The UN's 17 Sustainable Development Goals

Needless to say that the proposed transformation would satisfy most of them in a required level, providing the initial dynamic that would drive stakeholders for subsequent actions. Once those guidelines are produced to cover specific appointments from the general staff to the unit level and from that up to the individual, another process must be carried out in order to ensure monitoring and keeping up the effort. This process could be a 6-month periodical achievement report that would be fed to the evaluation commands of each general staff and from there an annual SDG progress report that would contribute to the Voluntary National Report.

Furthermore, in site monitoring and evaluation of the progress by the aforementioned committee must periodically be conducted in order to ensure that the organization is well on the curve.

c. Stance towards sustainability, innovation and ‘‘green’’ practices

It is indeed a fact that most of the productive functioning of the Armed Forces cannot be considered neither ‘‘green’’ nor sustainable. On the other hand, the equipment and training used for operational purposes is indeed a major breakthrough of innovation of its’ time (e.g. the Airplane, RA.D.A.R etc.). There is no doubt that the broader civilian contemplation of how Military operates and the professional stance its people are adopting through their training and working process is considered inflexible and administrative. Yet Operational Resilience needs to be addressed by open minded, innovative people and equipment and this is a fact. However, as part of a wider community the Armed Forces have to function by a wider society of operators with different backgrounds, under thorough discipline and rules that often result in not being as flexible as required. Standardization within the Military was addressed to re-assure that all those different backgrounds would achieve a certain level of competence, knowledge and operational awareness. Yet as technology progresses and at the same time resources reduction is highly evident, economy within the Military needs to be driven towards sustainability and innovation. This requires Modern and adaptive behavior within the personnel nowadays eager to perform in that manner.

As we progress into a new decade and set our goals to the end of that, one cannot but only notice that the demand for even more (not less) energy for military systems to function will be the case. As stated from the Chairman of the EU Dr. von der Leyen this decade marks ‘Europe’s digital decade’. Hence the breakthrough innovation on this technology will require high electrical energy availability, which will substantially increase demand. Therefor power generation will become a massive challenge to counter plate, which means that implementing ‘green practices’ in order to keep up with the environmental awareness curve, shall be a goal to achieve by all players within the public and private sectors. Currently the US Mod, invested approximately 1.6b USD in RDT&E straight related to energy, reflecting its’ importance to military mission. Robyn, D. – Marqusee, J. (2019).

This thesis will eventually stimulate the reader in realizing that especially as far as the military is concerned, achieving sustainability within their community is of great importance to

the war-fighter and especially one must understand that innovation can become a force multiplier Robyn, D. – Marqusee, J. (2019).

d. Synergy opportunities between Ministry of Defense (MoD) and Ministry of Environment (MoE)

A number of synergies with the MoE can be implemented in order for the MoD to achieve capture of know-how, as well a solid understanding in transformation to sustainable practices and development of innovative techniques to approach gradually the milestones that will effectively allow it to achieve it's goals. The most profound with regards to discussed parameters are:

MoE should factor MoD's needs and strengths as an innovator into the strategies of, and roadmaps for, both its fundamental and its applied research, development and demonstration (RD&D) so as to capture MoE-MoD synergies.

MoE should partner with MoD on its stationary-storage programs.

MoE's battery technology programs should engage with MoD end users to identify their storage needs.

MoE's solar technology program should partner with MoD to speed the path to next-generation PV materials that can compete with silicon.

MoE's manufacturing initiatives should look to MoD to be an early adopter.

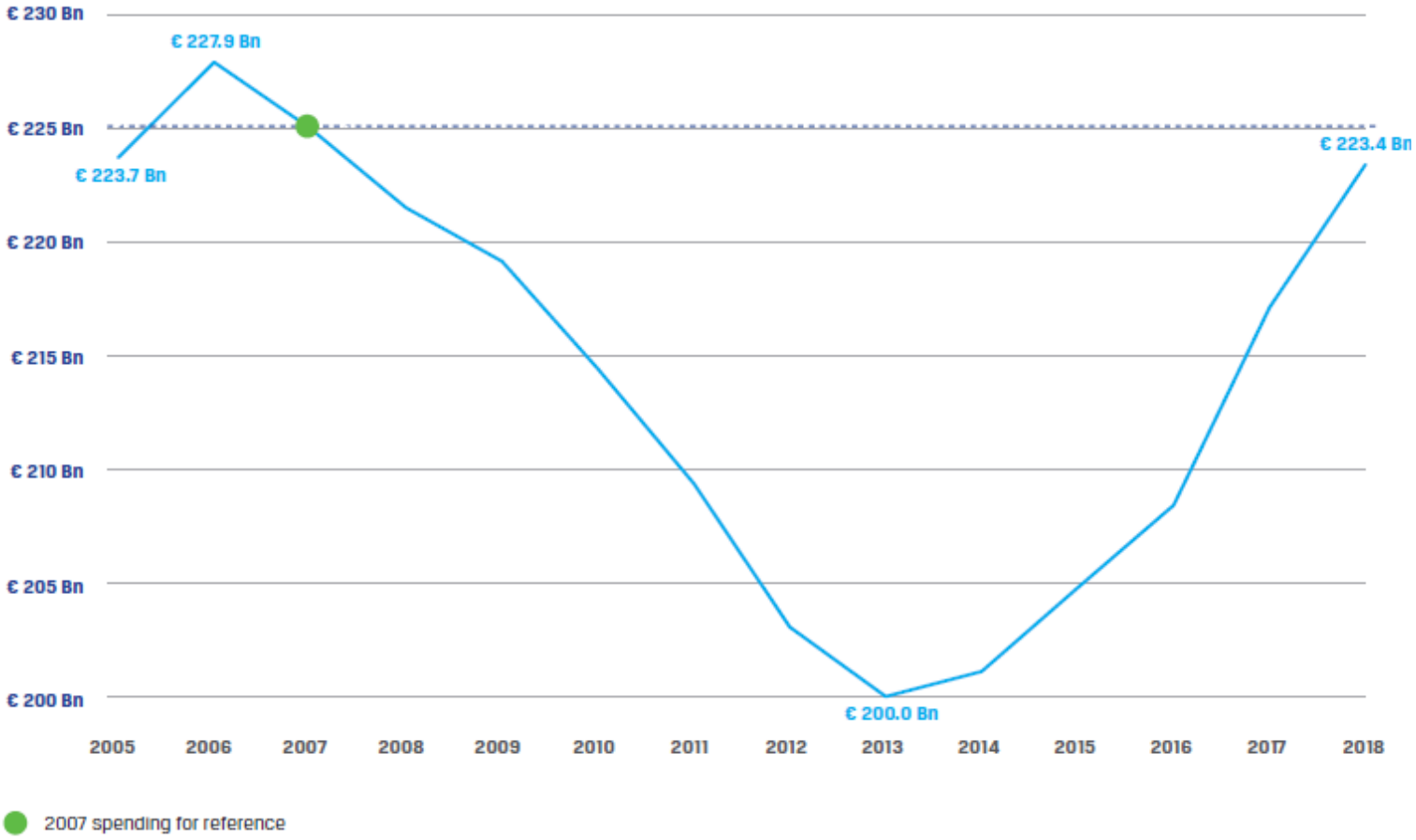
MoE should partner with MoD to advance the deployment of stationary (non-tactical) microgrids.

MoE, through its Building Office, should lead a government-wide effort to demonstrate and validate energy. (Robyn & Marqusee, 2019).

e. Indicative economical graphs

As per 2018, the amount of expenditure on defense by EU's twenty-seven member states accounted for 223.4 b€. This accounts for 1.4% of GDP and 3.1% of Total Government Expenditure. Whereas defense budgets suffered heavily from spending cuts following the 2008 financial crisis, outlays for defense are finally on the rise again since 2014 for most EU countries (EDA, 2019) and since 2020 for Greece[20].

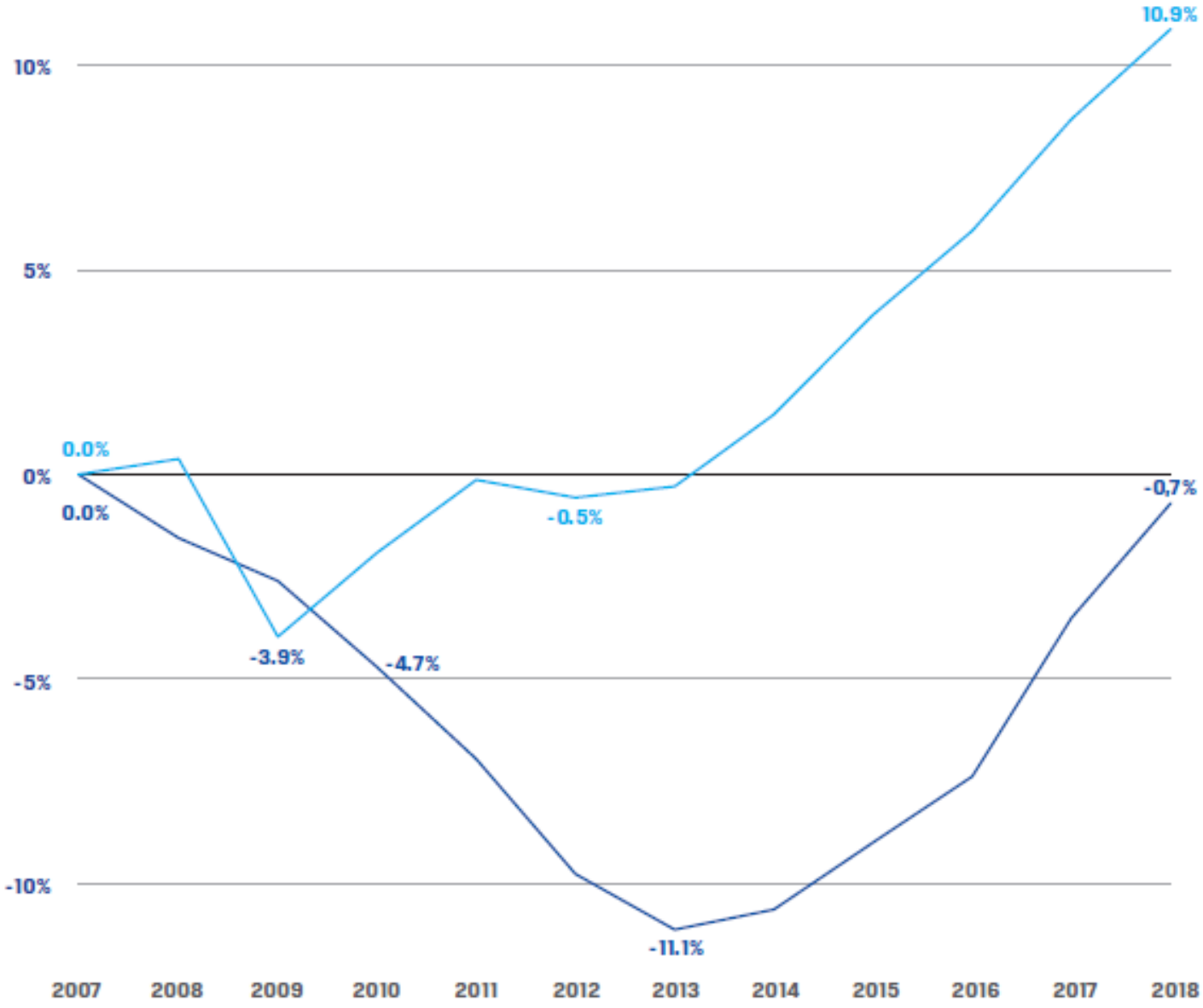
In the graph below we get the trend of the Total Defense expenditure for EU's member states from 2005 to 2018.



Picture 10: Total Defense expenditure for EU Member States trend

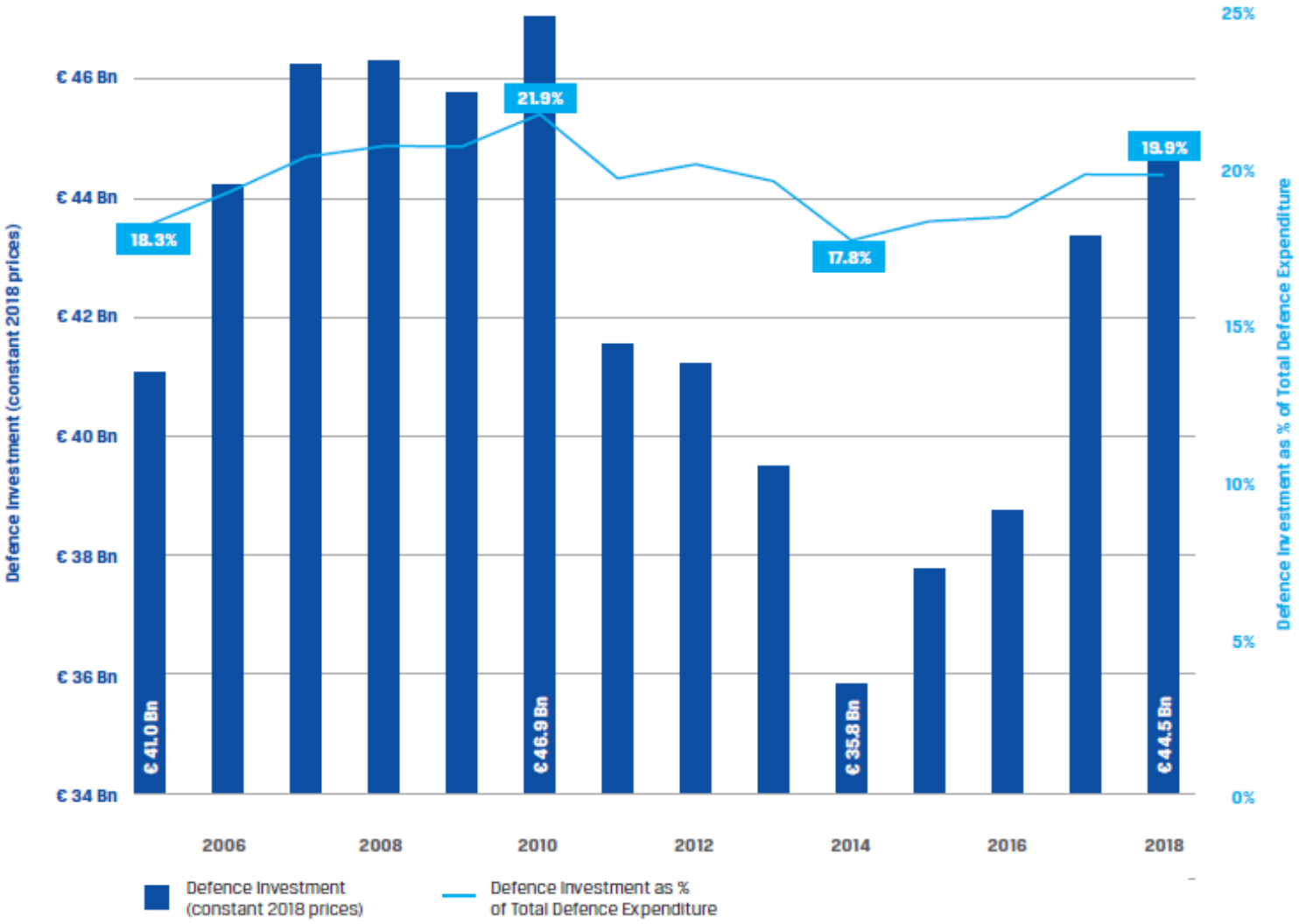
[20] https://www.iefimerida.gr/politiki/exoplistiko-programma-10-dis-ti-syzita-i-elliniki-kybernisi

As we further move on the graph below is comparing the trend of the Total Defense expenditure for EU's member states from 2005 to 2018 and the Total GDP.



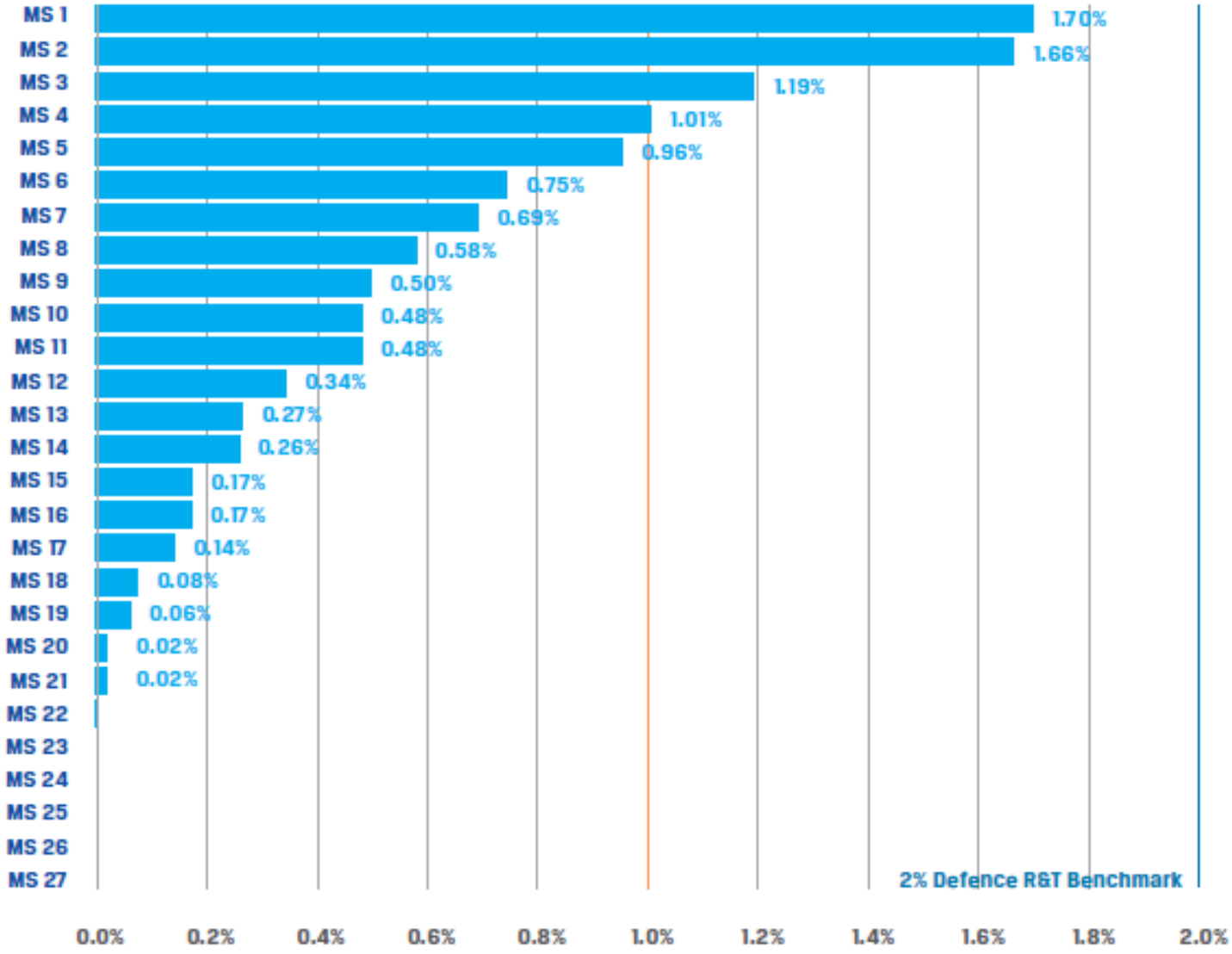
Picture 11: Comparative graph of total GDP and Defense expenditure trend for EU's member states from 2005 to 2018

In order to adopt ''green'' technologies, investments in research and technology are vital. In the graph below we have the trend of these investments that despite the fact that in recent years are experiencing increase once more, they still are eligible to further expand in order to achieve the best possible result dictated by the European ''Green'' Deal.



Picture 12: Defense investment constant (2018 prices) and as a share of total defense expenditure 2005 – 2018

Finally, in the last graph we can clearly see that most EU countries have indeed a long way towards innovation, as their budget for R&T within their Armed Forces is rock bottom.



Picture 13: Defense R&T as share of total Defense expenditure by EDA

f. Armed Forces Social Responsibility

The Armed Forces are probably one of the most social responsible organizations in every county, but especially in our maritime nation.

The overall effort daily undertaken by the military in support of the Greek citizens and the Nation as a whole is noteworthy. A number of examples to support this statement exist and are profound ((HNDGS), 2018). Several examples consist of:

- Transportation of medical emergencies from remote places to the metropolitan country.
- Numerous search & rescue operations in Greece, the Mediterranean and even countries around the globe.
- Medical care from armed forces medical staff to remote places.
- Scholar awards for outstanding achievements for armed forces personnel children.
- Dietary coverage and medical assistance to refugees.
- Seminars and presentations of various subjects to include stakeholders from every aspect of public and private life.
- Mine and artillery removal from beaches around the county.
- Care for the wild life and rescue of individual animals from endangered species.
- Land, beach and sea cleansing.
- Assistance throughout the year in areas subject to natural disasters in Greece and abroad.
- Distress relief to areas subject to natural disasters in Greece and abroad.
- Protection of fishery in the eastern Aegean and other areas.
- Fire fighting and fire rescue operations.
- Hosting of numerous cultural and social events.
- Hosting of numerous sports events.
- Hosting of natural disaster area occupants to military camps.
- Damage repair and early adopting testing for public and private ventures.
- Participation in world fares and other exhibitions.
- Landscaping and forest caring activities.

These are just some of the recurring activities the armed forces are carrying out with great enthusiasm too. Yet understanding the needs of all involved stakeholders and formulate an innovative approach to corporate responsibility is also a great concern for the active leader.

As such it is imperative and a must approach should suggest a field for action to the following activities:

- Repair of old installations in remote societies that can cover activities of interest within their social environment (old harbors for yachting, old airports for general aviation, old military locations turned to parks).
- Involvement of the remote societies in upgrading military installations with a recurring benefit of allowing possible use of microgrids installed.
- Hosting innovative training for all people and especially for lower income groups in yachting, sailing, flying, mountain climbing, scuba diving inside an environmental responsibility framework.
- Actively engage all the stakeholders in their own activities in remote places.
- Participating in sport events under a civil – military approach.
- Funding scholarships for young people that are not economically eligible to higher education under a recurring plan.
- Engage the academia, co-operate and provide funding for innovation with them as early adopters.

The social responsibility activity of this omni-capable organization whilst transforming as an innovative adopter on ‘‘green’’ practices can benefit society and can significantly include the armed forces to the effort of leaving no one behind as the obvious leader.

Chapter 8 – Conclusions

As we complete the circle of this pragmatic visionary paper, suggestions arise prominent of what can help the Nation's Armed Forces prioritize towards achieving sustainability.

Education during the academic indoctrination of military personnel in sustainability issues must occur and it should be combined with voluntary practice within their academic area. Following and during their career path, seminars in a regular bases with updating the knowledge on this subject should be held and a record must be monitored.

Military industry must engage along with co-operations from the private and public sectors in developing sustainable methods of conducting business and training upon those with regards to:

- ''Green'' buildings
- RES Technology
- PV Technology
- Energy security
- Cyber security
- Sustainability in the expedition and the battlefield
- Electric vehicle technology
- Fuel technology

Armed Forces installations regarding remote places and Operational Centers should transform to energy autonomy by using RES and/or PVs still maintain the grid redundancy. This will provide flexibility to the decision making process that will carry out actions undisturbed.

Investment in Space technology with a focus on communications and cyber security that will provide sustainability to the lone war-fighter who will have to operate in a Spec or ''Black'' intel- Operation behind enemy lines, should be a great concern together with swift digitalization.

Energy autonomy in remote places and expeditions, will provide energy security and withdrawal of energy focus on the grid provider. Along that security could potentially be maintained redundant for the remote area as a whole in a recurring social responsibility status.

Transformation of military ports and airports to ‘‘green’’ will pave the way for expanding in the public sector.

Waste management in raw material that due to military equipment de-commissioning is projecting over adequacy, can be an area for a wide spectrum co-operation between the Armed Forces and the private sector.

War-fighter sustainability is an important issue to mission success and the guideline to achieve that could be an interest of a new un-explored co-operation between the academia and the Armed Forces.

Chapter 9 – Epilogue

In conclusion the involvement of the Armed Forces in a transformation to a sustainable world offers a wide variety for research to take place and certain actions to prioritize. Moreover, the potential to achieve peace and prosperity requires the fighting force first of all to realize its role as the main stakeholder in achieving sustainability by setting an example. An example by their innovative stance, their initiative to implementing sustainable practices whilst maintaining their operational capability and agility and by their genuine approach towards social prosperity and National Protection.

Pictures

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