

GERGELY GÖNCZI<sup>1</sup>

## Technologies and Methods for Mitigating the Ecological Footprint of the Forces

### Technológiák és módszerek a haderők ökológiai lábnyomának mérséklésére

#### Abstract

*There is no doubt about the negative impact of military forces on the environment. There have been several publications about the issue both domestic and international. By the 21<sup>st</sup> century countries that have more developed armed forces realized that they need to limit their impact on the environment, their ecological footprint and at the same time they need to emphasize sustainability. Luckily today we have those technological measures and with their help these aims are achievable even that they positively influence the activities of the armed forces.*

*The following article would want to demonstrate these technological measures firstly through the US armed forces than through examples from NATO and Hungary.*

*Keywords: green energy, renewable energy source, armed forces, sustainability, ecology*

#### Absztrakt

*A haderők környezetterhelő tevékenységéhez nem fér kétség, erről már számos kutatás és publikáció született mind nemzetközi mint hazai szinten. A XXI. századra a korszerűbb haderővel rendelkező országok felismerték, hogy valamilyen szinten csökkenteniük kell környezeti terhelésüket, ökológiai lábnyomukat ezzel együtt a fenntarthatóságra is hangsúlyt kell fektetniük. Szerencsére napjainkra rendelkezésre állnak azok a technológiai megoldások melyekkel ezek a célkitűzé-*

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sek megvalósíthatóak, ráadásul úgy, hogy az a haderők működésére is pozitív hatással lehetnek.

*Jelen cikk tehát ezeket a technológiai megoldásokat szeretné bemutatni először az Egyesült Államok Hadseregén keresztül egészen a NATO illetve a Magyar Honvédség példáján át.*

**Kulcsszavak:** zöld energia, megújuló energiaforrás, haderő, fenntarthatóság, ökológia

#### INTRODUCTION OF THE TOPIC

With the start of the Industrial Revolution and with the continuous rise of the population of the Earth the measure of the environmental burden grew extensively. Industries and agricultural production that satisfies the growing consumption needs as well as sustaining of our everyday life means an incredible amount of fossil fuel burning that emit greenhouse gases and other polluting materials. They greatly contribute to the most serious problem of today, the climate change. It is a fact that the climate of the Earth has changed in the previous decade, we experience the growth of heat<sup>2</sup> (1) and extreme weather conditions due to the above-mentioned factors. Between 1970 and 2004, the emission of the greenhouse gases that are produced from energy supply, transportation and industry grew by 70 %.<sup>3</sup> (1)

Furthermore, if we speak about pollution or sources of pollution it is very important to mention the armed forces. We know that the activities of the armed forces pollute the environment which is a real problem. This problem exists not only at wartime but in peacetime, too. In the present case, besides other environment burdening activities it is important to emphasize that the use of fossil fuels, in other words, non-renewable energy sources, as well as the energy needs of the armed forces can be enormous.

By the 21<sup>st</sup> century we arrived, due to the above-mentioned, that the use of the alternative so-called "Green" energy sources that are used in the civilian sphere, are used more and more frequently in the military forces, too. These uses of these renewable energy sources help reduce the emission of pollutants, to limit the dependence on fossil fuel-based energy, which may lead to the decrease of dependency on other countries as well as the further development of similar „Green” technologies and the reduction of costs.

In the following chapters, in the first round, the renewable and non-renewable energies will be introduced, the methods of their use, technical background, both in the civilian and military spheres.

<sup>2</sup> Sárváry Attila: Környezetegészségtan, Debreceni Egyetem, 2011  
[https://www.tankonyvtar.hu/hu/tartalom/tamop425/0019\\_1A\\_Kornyezetegeszsegtan/ch03s03.html](https://www.tankonyvtar.hu/hu/tartalom/tamop425/0019_1A_Kornyezetegeszsegtan/ch03s03.html)

## THE RENEWABLE ENERGIES, METHODS OF THEIR USE

So, in the previous part it was mentioned that we differentiate between renewable and non-renewable energy sources. First it is necessary to clarify what exactly the non-renewable sources are since they will be introduced only briefly.

## NON-RENEWABLE ENERGY SOURCES

These types of energy sources can be found in the crust of the Earth in a certain quantity. Their reformation is a very slow process or it may not even happen.<sup>3</sup> (2)

These types of energy sources can be used by the exploitation of certain types of basic stones. Due to the lessening of reserves their exploitation is more and more expensive. Moreover, their exploitation can negatively influence several element of the environment, such as the soil, the water management, for the landscape or the wildlife.<sup>4</sup> (2) The main types of these energy sources are the following:<sup>4</sup> (2)

- fossil fuels (coal, oil, gas),
- non- metal minerals (pebbles, sand, clay),
- metal (iron, brass, aluminum) materials,
- radioactive (uranium ore) minerals.<sup>4</sup> (2)

Due to the environment burdening nature of the fossil fuels it is important to use alternative renewable sources of energy.

## RENEWABLE SOURCES OF ENERGY

Regenerative sources of energy are called renewable sources of energy.<sup>4</sup> (3) They are in continuous supply or resupply during natural processes<sup>5</sup> (4) although after being used they renew or can be renewed, it does not mean that they are infinite since the intensive use or a serious pollution affect them.<sup>4</sup> (2)

The renewable sources are the following:

- solar energy
- energy of wind
- water energy
- biomasses
- geothermal energy

From the above-mentioned the solar and the wind energy are the ones that can be considered inexhaustible, the water energy, the biomass and the geothermic energy are available.

<sup>3</sup> Tamás János: Agrárium és környezetgazdálkodás Mezőgazda kiadó, 2008, pp.12-15, 176-198 ISBN: 978-963-286-455-6

<sup>4</sup> Dr. Tóth Péter, Dr. Bulla Miklós, Dr. Nagy Géza: Energetika 2011

[https://www.tankonyvtar.hu/hu/tartalom/tamop425/0021\\_Energetika/index.html](https://www.tankonyvtar.hu/hu/tartalom/tamop425/0021_Energetika/index.html)

<sup>5</sup> Barthoy Judit, Breuer Hajnalka, Pieczka Ildikó, Pongrácz Rita, Radics Kornélia: Megújuló energiaforrások, Eötvös Lóránd Tudományegyetem, 2013

<http://elte.prompt.hu/sites/default/files/tananyagok/MegujuloEnergiaforrasok/book.pdf>

le due to their geographic accessibility.<sup>6</sup> (4) There are plenty of renewable energy sources on the Earth<sup>6</sup> (4) so they are an alternative besides the fossil fuels.<sup>6</sup> (5) Furthermore, their use can solve the redemption of fossil fuels<sup>6</sup> (4) that have several positive effects. These are the following:

- their environment polluting impact is much lower,<sup>7</sup> (6)
- reduction in the emission of greenhouse gases,<sup>8</sup> (6)
- consequently, reduction of the air pollution,<sup>8</sup> (6)
- reduction on the dependence on import,<sup>8</sup> (6)
- due to investment into technology new workplace creation.<sup>8</sup> (6)

The renewable energy sources can be used in the production of electric energy, as fuel and in cooling/warming technologies.<sup>8</sup> (6)

### *Solar energy*

There are two ways of solar energy known: passive and active utilization.<sup>6</sup> (4) Passive utilization, for example is the drying of the different types of plants or the pasteurization of water [4] but it is important to mention another way of utilization, that is the shadowing of buildings or the choice of building materials (passive house).<sup>8</sup> (6) The Main characteristics of the passive utilization is that it is not necessary to take care of the conversion or transportation of the produced energy.<sup>6</sup> (4)

During the active utilization we apply active devices to change the solar energy into final energy.<sup>8</sup> (6) There are two known methods of active use: photothermic and photoelectric.

During photothermic (thermic) utilization we collect sun rays<sup>6</sup> (4) and with the help of a so-called solar collector we transform them into heat energy, then they are utilized by building engineering devices<sup>8</sup> (6), for production of warm water and heating, for example.

During photoelectric (photovoltaic) utilization we apply so-called solar panels to convert solar energy into electricity.<sup>6</sup> (4) We utilize them by electro technical devices.<sup>8</sup> (6)

### *Water energy*

„The renewable energy store of a water course can be established on the place of the swelling up of the water echelon with the help of a water plant”.<sup>4</sup> (2) We can distinguish between three types of water power plants:

- power plants installed on rivers that generate electric power byexploiting the natural flow of the water,<sup>6</sup> (4)
- power plants connected to water storages that produceelectric power by pouring down the accumulated water,<sup>6</sup> (4)

<sup>6</sup> Dr. Barótfi István: Környezettechnika, Mezőgazda kiadó, 2000

<https://www.tankonyvtar.hu/hu/tartalom/tkt/kornyezettechnika-eloszo/index.html>

<sup>7</sup> Dr. Horváth József: Megújuló energia, 2011

[https://www.tankonyvtar.hu/hu/tartalom/tamop425/0021\\_Megujulo\\_energia/index.html](https://www.tankonyvtar.hu/hu/tartalom/tamop425/0021_Megujulo_energia/index.html)

- storage water power plants that „pump the water mass lowered into a lower placed storage into a higher placed storage and it is lowered again from there.”<sup>6</sup> (4)

### *Wind energy*

The modern form of the wind energy utilization is the application of wind turbines<sup>8</sup> (7) that utilize the wind movement to convert it to mechanic energy.<sup>4</sup> (2) The positive effects of wind energy utilization, among others, is that there is no pollution during the operation of wind turbines, they do not need fuel, the area can be used for agriculture like before the installation and the turbines can be installed quickly.<sup>5</sup> (3)

### *Geothermic energy*

Geothermic energy is the inner energy of the earth's crust<sup>4</sup> (2) that can be utilized for the purpose of energy<sup>6</sup> (4), which source is in the core. Geothermic energy sources are at least 30 degrees C.<sup>6</sup> (4) They are present in the rock shell and they are liquid or gas physical condition. The method of utilization depends on the temperature of the energy carriers that arrive to the surface.<sup>6</sup> (4) The fluids with the temperature of 100 degrees C are proper for energy production while the ones of lower temperature for heat use.<sup>6</sup> (4)

### *Biomass*

„Biomass is an indirect utilization of the solar energy by means of deliberate application of biological phenomena”.<sup>7</sup> (5) By the notion of biomass we understand the mass of all living and dead fauna, the products of microbiological industries and all biological products and waste that appeared due to some kind of transformation.<sup>7</sup> (5) Biomass that can be utilized for energy production can be grouped the following way:<sup>6</sup> (4) raw timber products, agricultural products, energy plants and other organisms waste.<sup>6</sup> (4) The following are the utilization of the biomass for energy: solid biomass is used for energy production, fluid biomass for fuel production, gas biomass is used for heating and production of fuel.<sup>7</sup> (5)

## PROGRAMS THAT SUPPORT RENEWABLE ENERGY WITHIN THE ARMED FORCES

In the 21<sup>st</sup> century, as it was mentioned earlier, sustainability and the use of renewable energy sources plays a more and more important role and that applies not only to the civilian sphere but to the military as well. Technologies that can be connected to renewable energy have reached a level these of which is being considered by the military as well. One of the reasons is that limitation of the environmental burdening is also an aim of the armed forces, on the other hand, the enormous energy need of the armed forces and

<sup>8</sup> Megújuló energiaforrások fajtái és magyarországi eloszlása  
<https://www.napelemek-napkollektorok.hu/magazin/napenergia/megujulo-energiaforrasok/>

consequently, the energy dependence can be reduced this way taking into consideration ecological points, too. Thirdly, the innovative technological, energetic solutions can support the success of an operation. This will be mentioned in more detail later.

First it is worth to look through some more significant international programs that deal with the utilization of renewable energy and they are definitely applicable to the military.

#### THE NET-ZERO/ TRIPLE NET-ZERO CONCEPT AND THEIR MILITARY RELATION

These programs were first applied in the USA and they still have been used. The implementation in NATO and other countries started from there.

The NET-ZERO energy concepts mean self-sufficiency with energy that is based on renewable energy sources.<sup>9</sup> (8)

According to the first definition the NET-ZERO installation „is a kind of installation that produces as much energy on the installation or on its proximity as it is consumed in its buildings or facilities”.<sup>10</sup> (8) Theoretically the NET-ZERO energy installations should reduce the energy needs by retaining and by energy efficiency than the appearing needs should be provided by the renewable energy on the site. In the definition the „NET-ZERO” means that the energy produced on the site is the same as the energy need of a given installation in a given period of a year.<sup>10</sup> (8)

Later when referring to the military of the USA the term „NET-ZERO energy military installation produces as much energy from the renewable sources or from renewable fuel materials on the spot as is consumed in the buildings, facilities or by fleets of vehicles”.<sup>10</sup> (8) The definition of the NET-ZERO military installation used for military purposes is not easy since it is necessary to take into consideration – besides certain buildings, public utilities and infrastructures – the issue of energy consumption connected with different methods of transportation and the specific energy needs of the mission such as needs for tactical fuel.<sup>10</sup> (8) The program was first worked out in connection with civilian buildings where the challenge was that all necessary energy is provided by the renewable energy on site. During the previous years this concept was extended, for example to different civilian buildings or to military facilities.<sup>10</sup> (8)

The NET-ZERO Energy Assessment and Planning Approach:<sup>10</sup> (8)

- Start of the project:<sup>10</sup> (8)  
To provide the leadership support, to establish a group who represent the sides involved, to establish the borders of the project and a time frame.<sup>10</sup> (8)
- The establishment of the starting values of the energy and the greenhouse gases:<sup>10</sup> (8) It is necessary to identify the procedure necessary for the establishment of the installation, the geographical constraints, important mandates in connection with the energy and any requirements connected to any special energy; it is nec-

<sup>9</sup> Samuel Booth, John Barnett, Kari Burman, Josh Hambrick, Robert Westby: Net Zero Energy Military Installations: A guide to Assessment and Planning, National Renewable Energy Laboratory, 2010 pp.5-9,28-29

essary to summarize the yearly energy consumption together with all energy sources used for mission support, their types and the methods of distribution and to get acquainted with the energy projects that had already been planned in connection with the sight. The starting values of the gases that cause greenhouse effect have to be compared with the planned emissions of the future systems.<sup>10</sup> (8)

- Reduction of the demand due to human activities:<sup>10</sup> (8)

It is necessary to establish approaches that minimize the wanted energy while we sustain or improve the quality of the mission execution with the involvement of the will, energy and creativity of the staff.<sup>10</sup> (8)

- The evaluation of the energy efficiency:<sup>10</sup> (8)

It is necessary to establish the energy efficiency projects on the site and their impact on the energy consumption of the installation.<sup>10</sup> (8)

- The evaluation of the renewable energy and reduction of the burden has to be performed:<sup>10</sup> (8)

Such projects have to be identified that utilize the renewable energy for electric energy or/and heat production or it is necessary to use renewable fuels.<sup>10</sup> (8)

- Evaluation of transportation:<sup>10</sup> (8)

Projects have to be established that can help reduce or substitute the use of fossil fuels in vehicles.<sup>10</sup> (8)

- Evaluation of electric systems:<sup>10</sup> (8)

- The impact of projects that are connected to the renewable energy on the site on the electric system of the installation should be established. The installation needs its characteristics to be outlined to a smart micro grid; its purpose is to support dangerous operations in case of a fallout of a public net.<sup>10</sup> (8)

- Proposals should be made in connection with the project:<sup>10</sup> (8)

It is necessary to summarize the results of the earlier efforts to be able to evaluate the energy projects and to examine their implementation possibilities. Then we can propose other projects with reference to wider installation and mission constraints. (8) We are able to calculate in what measure the installation is able to approach the zero energy state. We can demonstrate that the proposed projects by the installation in connection with the already planned projects how energy saving can be performed taking into consideration the timing of the project, the economic life span and the contract and financial possibilities.<sup>10</sup> (8)

In the next part some figures will be shown that demonstrate technical development within the concept of NET-ZERO. They were carried out in the USA.



Figure 1: Solar pool heating system and solar photovoltaic system at Camp Pendleton, CA.<sup>10</sup> (8)



Figure 2: Wind turbines at a U.S. Navy installation, San Clemente Island, CA. 10 (8)





Figure 3: The large battery storage system at Fort Hunter Liggett. 10 (9)



Figure 4: Fort Carson solar array. 11 (9)

According to one formulation the NET-ZERO energy, water and waste is a long and sustainable holistic strategy that is based on the best practices that manages issues connected

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<sup>10</sup> Colton Heaps: Army Net Zero, Lessons Learned in Net Zero Energy, National Renewable Energy Laboratory, 2015 pp.31,39 <https://www.nrel.gov/docs/fy15osti/62946.pdf>

with energy, water and solid waste in the military establishments.<sup>11</sup> (10) Though this definition extended with the issues of water and waste, this definition applies to the TRIPLE NET-ZERO concept. The definition of the TRIPLE NET-ZERO expression means the combination of NET-ZERO Energy plus the NET-ZERO Water and NET-ZERO Waste.<sup>12</sup> (11)

To express this more precisely:

- The NET-ZERO Installation is able to produce the amount of energy that is needed for the given year.<sup>13</sup> (11)
- The NET-ZERO Water Installation, on the one hand, limits the consumption of the fresh water sources, on the other hand, it can rotate back the water into the same water container, this way it does not empty the underground and the ground water of the region.<sup>13</sup> (11)
- The NET-ZERO Waste Installation reduces the amount of waste and then it recycles them as an energy source.<sup>13</sup> (11)

Following the example of the US military, many NATO member countries consider the possibilities provided by the TRIPLER NET-ZERO. But why this can be important for NATO:

- The rising market price of the fossil fuels, the environmental burden of the fossil fuels, connected challenges and due to the dependence on other countries it is important to look for other alternatives.<sup>13</sup> (11)
- It can be possible to prepare an armed force for sudden unexpected changes due to energy dependence.<sup>12</sup> (10)
- It can support NATO strategies of energy security.<sup>12</sup> (10)
- It provides an example to follow and supports the „European Building Performance Directive” that aimed to establish CO<sub>2</sub> neutral buildings by 2050.<sup>12</sup> (10)

Although it is important to say that the start of such a program has structural and doctrinal challenges, moreover, it is necessary to harmonize it with other NATO environmental programs, so it is a slow process.

#### NET-ZERO AND THE „GREEN BUILDINGS”

In the Advancing Net Zero project, the World Green Building Council participated with the aim to establish the zero CO<sub>2</sub> neutral buildings until 2050. Figure 5 shows the draft of the program where the key strategies and aim to reach are demonstrated.<sup>13</sup> (12)

<sup>11</sup> Advanced Net Zero Energy, Water and Waste Training Course 2016, Germany  
<https://www.training-course.de/invitation/what-is-net-zero-energy-water-and-waste/>

<sup>12</sup> Michael Evan Goodsite, Sirkku Juhola: Green Defense Technology, Triple Net Zero Energy, Water and Waste Models and Applications, Springer, pp.1-24

<sup>13</sup> World Green Building Council, What is Net Zero, Green Building <http://www.worldgbc.org/advancing-net-zero/what-net-zero>  
<http://www.worldgbc.org/what-green-building>  
<http://www.worldgbc.org/how-can-we-make-our-buildings-green>  
<http://www.worldgbc.org/benefits-green-buildings>

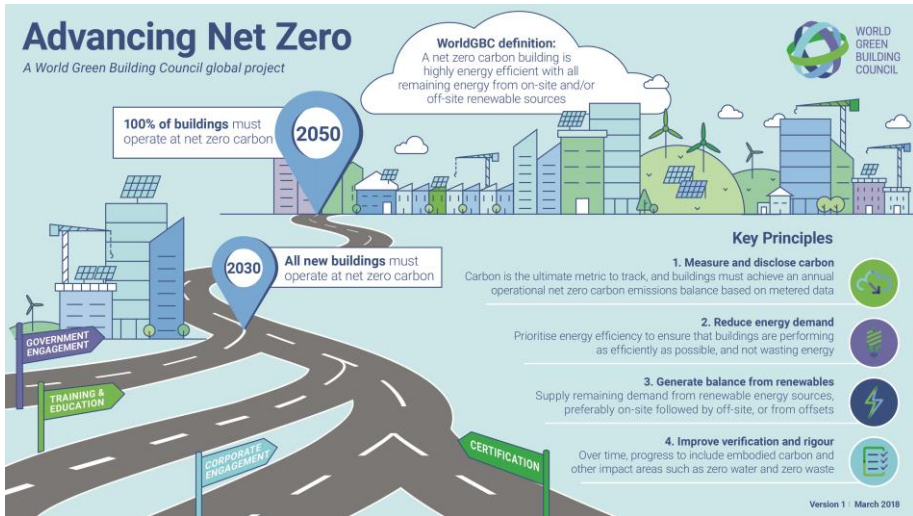


Figure 5: Strategies of the Advancing NET-ZERO. <sup>14</sup> (12)

This type of building is defined as „a building that is highly energy-efficient and fully maintained by on-site and / or off-site renewable energy sources”<sup>14</sup> (12), and whose, as a result of the design, construction or operation can reduce or completely eliminate the negative impacts on climate and natural environment and improve quality of life.<sup>14</sup> (12) In addition, they set out the criteria and elements that needed to make a building „greener” for any purpose, so the criteria set out in the program will be discussed in the program as it is included in the program.

Intelligent approach to the energy:

- Minimizing energy consumption at all stages of the building's life cycle, making new and refurbished buildings more convenient and cost-effective, and helping users to learn the efficiency.<sup>14</sup> (12)
- Integrating renewable and low carbon technologies to meet the energy needs of buildings after design has maximized the natural and (inbuilt) efficiency.<sup>14</sup> (12)

Protection of water resources:

- Exploring ways to improve the efficiency and management of drinking water and waste water, provision of water in innovative ways for safe indoor use and, in general, minimization of water use in buildings.<sup>14</sup> (12)

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- Taking into account of the impact of buildings and their environment on rainwater and drainage infrastructures, it must be ensured that they do not become overused or do not have any interfering factor during their operation. <sup>14</sup> (12)

## Minimizing waste and maximizing reuse:

- The use of less and more durable materials and less waste production and taking into account the last stage of the life cycle of the building in order to exploit and reuse the demolition waste. <sup>14</sup> (12)
- Convince building users to use the recycling and reuse methods of waste. <sup>14</sup> (12)

## Supporting health and well-being:

- Providing fresh air, good indoor air quality through ventilation, avoiding the release of chemicals that can cause harmful or toxic effects. <sup>14</sup> (12)
- Providing natural light and a view to the building user that serves comfort and the enjoyment of their surroundings and reducing the amount of energy usage intended for lighting. <sup>14</sup> (12)
- The ears and eyes are important aspects of the planning. Acoustics and sound-proofing play an important role for the concentration and the peaceful use of the buildings whether it be an educational, health or residential building. <sup>14</sup> (12)
- It is necessary to ensure that people are comfortable in their everyday environment, must create an appropriate indoor temperature condition through passive design and create a monitoring system. <sup>14</sup> (12)

## We need to keep our environment „green“:

- We need to recognize that our urban environment must preserve nature and ensure the protection of the quality of different wildlife and lands by increasing the need to remediate contaminated sites or to create new green spaces. <sup>14</sup> (12)
- We should strive to utilize urban areas more efficiently and bring agriculture into cities. <sup>14</sup> (12)

## Creating Resilient and Flexible Structures:

- In the context of climate change, a certain level of resistance should be provided against events such as flooding, earthquakes or fires, thus the buildings have to stand the test of time to keep the people and their belongings safe. <sup>14</sup> (12)
- Flexible and dynamic spaces need to be created, the timely changes in the life cycle of buildings need to be predicted. <sup>14</sup> (12)

## Connections of people and communities:

- A diverse environment should be created to link and strengthen communities, ask them what kind of positive economic and social impact they may have in the context of the building and thus involve them in the planning process. <sup>14</sup> (12)
- It is necessary to ensure the comfort aspects of transport and distance during design, to reduce the impact of personal transport on the environment, and to encourage more environmentally friendly modes of transport such as walking or cycling. <sup>14</sup> (12)

- It is necessary to explore the potential of „smart” and information communication technologies for the better communication with the world around us, for example through „smart” energy networks that understand when and where to transport energy when needed. <sup>14</sup> (12)

All stages of the building's lifecycle must be taken into account:

- A solution must be sought to reduce environmental impacts and maximize social and economic values throughout the entire life cycle of the building (from design to implementation, operation and maintenance, up to renovation or final dismantling). <sup>14</sup> (12)
- „Ensuring that embodied resources, such as the energy or water used to produce and transport the materials in the building are minimised so that buildings are truly low impact.” <sup>14</sup> (12)

So, in short, making a building „Greener” as required by the program is:

- the efficient use of energy, water and other resources, <sup>14</sup> (12)
- the use of renewable energy such as solar energy, <sup>14</sup> (12)
- pollution and waste reduction measures, as well as the re-use and recycling, <sup>14</sup> (12)
- good indoor air quality, <sup>14</sup> (12)
- use of non-toxic, ethical and sustainable materials, <sup>14</sup> (12)
- consideration of the environment in design, construction and operation, <sup>14</sup> (12)
- taking into account the users' quality of life in design, construction and operation, a design that allows adaptation to a changing environment. <sup>14</sup> (12)

At the global level, there are more and more signs that the green building program has many benefits. Thanks to the program, we are getting closer to reaching global goals such as managing climate change, creating sustainable and prosperous communities and boosting economic growth. The green building potential can be divided into three categories according to the content of the World Green Building Council: environmental, economic and social. <sup>14</sup> (12) Based on the official material:

### *Environmental*

One of the biggest benefits of the green building project is the climate and the natural environment. Green buildings can reduce the negative impacts on the environment, for example by using less water, energy, and natural resources, as well as having a positive impact on the environment at both the city and the city level by producing their own energy or increasing biodiversity. <sup>14</sup> (12)

At global level in the context of UNEP 2009 and UNEP 2016:

- Building sector has one of the greatest potential for reducing greenhouse gas emissions compared to other polluting sectors. <sup>14</sup> (12)

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- The emissions savings potential can reach 84 gigatonnes of carbon dioxide by 2050 through direct measures such as energy efficiency, fuel conversion and renewable energy utilization. <sup>14</sup> (12)
- In the construction sector, there is the potential to save energy by 50% by 2050. <sup>14</sup> (12)

Examples at building level:

- In Australia, the Green Star certification buildings release 62% less greenhouse gas compared to other buildings, and 51% less drinking water is used. <sup>14</sup> (12)
- In India, buildings certified by the Indian Green Building Council (IGBC) have 40-50% energy savings and 20-30% can save on drinking water compared to traditional Indian buildings. <sup>14</sup> (12)
- In South Africa, Green Star certified buildings save on energy and carbon emissions by an average of 30-40% per year, while drinking water output is 20-30% less than other traditional buildings. <sup>14</sup> (12)
- In the United States and other countries, LEED certified buildings consume 25% less energy and 11% less water than other traditional buildings. <sup>14</sup> (12)

## *Economic*

Green buildings have many economic and financial benefits. These include the cost reduction of tenants and households utility bills resulting from a decrease in water and energy use; lower construction costs and higher real estate values for building developers, rising rental rates and declining operating costs, and job creation. <sup>14</sup> (12)

Examples at global level:

- „Global energy efficiency measures could save an estimated €280 to €410 billion in savings on energy spending.” <sup>14</sup> (12)

Examples at country level:

- Canada's green building industry has produced \$23.45 billion and has created nearly 300,000 full-time jobs in 2014. <sup>14</sup> (12)
- Up to now, the industry that specialized in green buildings has created 3.3 million jobs in the United States. <sup>14</sup> (12)

Example at a building level:

- Building Owners have reported that the green buildings they live in - whether new or upgraded - have achieved a 7 percent increase in value. <sup>14</sup> (12)

## *Social*

The potential of green buildings has surpassed the economic and environmental indicators and have proven to have a positive impact on society as well. These positive effects are reflected in the health and wellbeing of people working and living in these buildings, which are reflected in the increase in performance, in capacity and in the number of sleeping hours. <sup>14</sup> [12]

*Green building rating tools*

Green building rating tools are designed to appreciate and recognize a particular building so that it meets the requirements they have to gain green building certification. Furthermore, they recognize and reward companies and organizations involved in the design, construction and operation of such buildings, thus encouraging them to achieve new results in the field of sustainability.

These tools are present in design and modeling, construction, operation and maintenance, refurbishment and any demolition phase. The rating may be different depending on the type of building (office premises, residential buildings).

From the above, we can conclude that such a program contributes significantly to sustainability and energy efficiency. Moreover, this is a well-functioning, global practice that is almost accessible to everyone who needs it. Its use is almost unlimited, so it can be applied to work environments beyond our living environment. This means that it could be used either in government buildings or in NATO buildings. Later on, such technologies can be further developed to provide opportunities to use them in a more complete form, even in battlefield.

## THE „MILITARY GREEN” PROJECT

Building on various laws and European Union directives, the Military Green project utilizes the European Union military concept that focuses on Environment and Energy Efficiency. (13) The project defines the principles and obligations that meet the environmental protection requirements of European Union-led military operations.<sup>14</sup> (13) Its objectives are:

- „Aims at reducing through-life costs and environmental impact while saving lives and increasing operational effectiveness.”<sup>15</sup> (13)
- In addition to optimizing energy management, water management and waste management, the development of more environmentally friendly materials and ammunition.<sup>15</sup> (13)
- Reducing the dependence on fossil fuels<sup>15</sup> (13), and focusing on renewable energy sources.
- Reducing the ecological footprint, managing crises, addressing climate change challenges, maintaining stability, and developing skills.<sup>15</sup> (13)
- Development of defense technologies.<sup>15</sup> (13)

In recent years, a number of projects have started in the context of the military application of environmentally conscious technologies and systems initiated by the European Defense Agency (EDA) and its predecessor at the Western European Armament Group.<sup>15</sup> (13) According to this these are the following:

<sup>14</sup> Military Green 2013: Climate, Environmental and Energy Security - From Strategy to Action pp.4, 19-20, 25 <https://www.eda.europa.eu/docs/default-source/documents/military-green-2013-report.pdf>

## „Energy:

- All Electric Combat Vehicle.
- Diesel Fuel Processor for Fuel Cells.
- Electric Actuators – BE, F.
- Molted Carbonate Fuel Cell System.
- Naval Electric Distribution System Based Upon Innovative Solid State Switches.
- High Speed Generator.
- DC Hybrid Switch.
- Pulsed and Burst Power Supplies for Electric Weapons, Sensors and Armour.
- Survey of the Maturity of Diesel Compatible Fuel Cells.
- Electric Armour.
- Overall Platform Energy.
- Energy Supply for Unmanned Underwater Vehicles.
- Fuel Dependencies.
- UMS – Study of Hybrid fuel cells Energy Interoperable System.
- Go Green – ARM.
- High Energy Efficiency Container.”<sup>15</sup> (13)

## „Munitions:

- Insensitive Munitions and Ageing (IMA).
- Environmentally Responsible Munitions (ERM).
- Munition-Life Management.
- Sensor on Structural Health Monitoring.”<sup>15</sup> (13)

## „Materials:

- Corrosion Control on Navy Ships.
- Antifouling coatings for warships.
- Environmentally compliant coatings.
- Drag reducing antifouling coatings for navy ships.
- New paint systems for the protection of critical areas of a ship.
- Fouling control for sea water.
- Piping systems.
- REACH – harmonisation of defence exemptions.”<sup>15</sup> (13)

## „Climate and Ecology:

- Protection of Marine Mammals Against Sonar Emissions.
- Biological Effects of Radio Frequency Electromagnetic Fields.”<sup>15</sup> (13)

Overall, Figure 6. will illustrate the future vision of the practical implementation of the „Military Green” project, where renewable energy sources are already a fully-fledged practice.



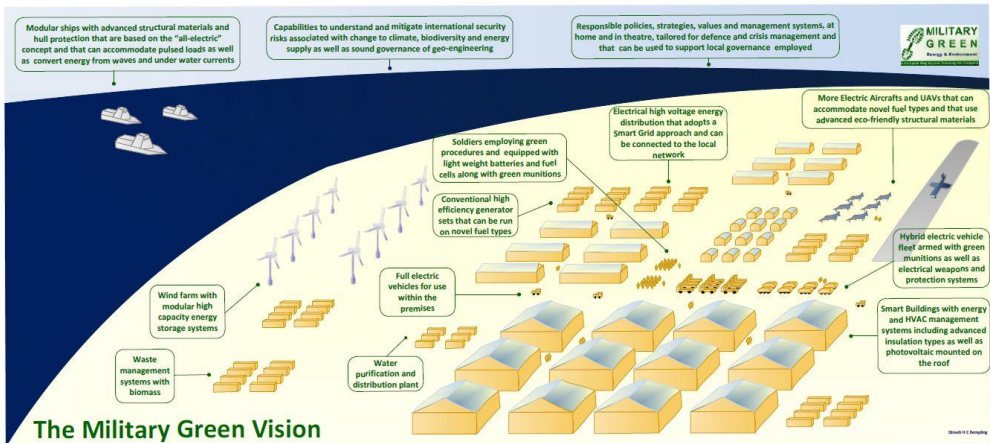


Figure 6: Practical implementation of the „Military Green” project.<sup>15</sup> (13)

## RENEWABLE ENERGY IN U.S. MILITARY

While in the previous sections it was mostly about programs and concepts, now the practical application is being presented. The U.S. Military has already recognized the risks inherent in climate change and fossil fuels, and therefore the use of renewable energies is a key element in their energy strategy.<sup>15</sup> (14) It should be added that the U.S. Military does not plan to eliminate fossil resources, but also supports the utilization of renewable energies and therefore aims to provide 25% of the energy needed to maintain their facility by renewable energy sources by 2025.<sup>16</sup> (14)

It has significance not only in the domestic environment but also in the international environment and in combat zones. Solar panels can partially serve the energy requirements of the camp equipment and the personnel equipment. By using electric or hybrid vehicles, we can reduce the use of fuel consumptions. That means we can reduce the number of resupply convoys, so we can reduce the number of attacks.<sup>16</sup> (15) On the battlefield there may be a problem with the use of wind power because the height of the wind turbine makes it easier to the enemy to measure the position of the camp and could be a target of later attacks.<sup>17</sup> (15)

## The Army

<sup>15</sup> Saltanat Berdikееva: Energy Digital The US military: Winning the renewable war, 2017.sept 13. <https://www.energydigital.com/renewable-energy/us-military-winning-renewable-war>

<sup>16</sup> Alejandra Román Rodríguez, Barbarics Tamás: Foreign Military Bases With Renewable Energy Sources Hadmérnök, VII. Évf 1. szám, 2012 március, pp.287-288. [http://hadmernok.hu/2012\\_1\\_rodriguez\\_barbarics.pdf](http://hadmernok.hu/2012_1_rodriguez_barbarics.pdf)

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The Army consumes less power than the Navy or the Air Force, as air and water transport is carried out through the other two sectors, so its energy consumption is mainly concentrated in its facilities.<sup>17</sup> (16) From the Army's point of view the use of renewable energies are important, as reflected in the Army Energy Security Implementation Strategy, which requires that at least five installations has to meet the „NET-ZERO” program energy target by 2020. <sup>18</sup> (16) Energy initiatives have started in many locations. For example, in Fort Stewart, that one of the largest solar energy producers in Georgia, a solar power plant has been developed that can produce 30 megawatts (MW) of electricity. In addition, Fort Hood implements wind and solar energy projects that provide 230 gigawatt hours (GWh) of renewable energy. <sup>18</sup> (16)

## THE NAVY

In 2013, the Navy and Marine Corps could reduce the use of all energy by 19.3%. The Navy's overall goal is to produce 1GW of renewable energy by 2020. Its further goals include the practical application of the so-called „Great Green Fleet”, which includes energy-efficient water- and aircrafts, which are partly used in alternative, mainly nuclear energy. <sup>18</sup> (16) In 2012, the Navy has successfully accomplished its goal of demonstrating the capabilities of the „Great Green Fleet” on the world's largest naval exercise in the Rim of the Pacific Exercise. <sup>18</sup> (16) Before 2013, the navy has completed one of the largest solar energy projects in our days, a 14 MW photovoltaic power supply system at California's China Lake Naval Air Weapon Station. It is expected to save more than \$ 13 million to the Navy over the next 20 years and will produce clean enough energy to deliver one third of the electricity's annual electricity demand. <sup>18</sup> (16)

## THE AIR FORCE

The Air Force is responsible for the use of 2.4 trillion gallons of kerosene per year, making it the largest fossil energy user. That is why it is important for him, alongside with the Navy and the Army, to move towards energy efficiency. That is why plans are to reach Zero-Net Energy by the year 2030. <sup>18</sup> (16) In 2013, the Air Force had around 261 renewable energy projects including solar energy recovery, waste to energy landfill gas and wind energy recovery. The Cape Cod Air Force Base is the first Net-Zero installation that uses wind turbines in the area. These turbines produce about 8,000MW of electricity, which means savings of 1 million dollar a year. <sup>18</sup> (16)

<sup>17</sup> Armed With Science: The Official US Defense Department Science Blog, Military's Shift Toward Renewable Energy, 2015. Aug 12. <http://science.dodlive.mil/2015/08/12/militarys-shift-toward-renewable-energy/>

## RENEWABLE ENERGY AND THE HUNGARIAN DEFENCE FORCES

In general, the defense sector as an energy market participant plays a very important role.<sup>18</sup> (17) Through the example of the US. Military, we could see how much an army's energy needs could be. Of course during a war period, it is not recommended to reduce energy consumption without alternative sources of energy, as it would jeopardize proper operation and the priority is always the successful execution of tasks.<sup>19</sup> (17) In the peacetime, however, efforts can be made to make energy consumption more efficient.<sup>19</sup> (17)

„In peacetime, increasing energy efficiency is the most important. Efficient use of energy alone will result in a reduction in defense costs as a result of the unchanged military potential, with a direct consequence of a reduction in environmental impacts, which indirectly improves the overall perception of the defense sector.”<sup>19</sup> (17)

In Hungary, electricity and natural gas are used for the operation of defense-related infrastructures<sup>19</sup> (17), while the maintenance and operation of these properties is carried out by the Ministry of Defense, Electronics, Logistics and Property Management Ltd. (17) (Honvédelmi Minisztérium Elektronikai, Logisztikai és Vagyonkezelő Zrt.)

Regarding renewable energies, a total of eight locations of the Hungarian Defense Forces have been installed with solar panels since 2013<sup>19</sup> (17), and this year additional thirteen military related location will be equipped with solar panels.<sup>19</sup> (18) In a view of this, the Hungarian Defense Forces and the Ministry of Defense are also doing everything to reduce the environmental impact.

## SUMMARY

As has been said at the beginning, the use of renewable energies is increasingly widespread. Of course this has been enabled by the technologies that developed in a rapid term which is not only of great importance in the civil sphere, but also in terms of forces. The international programs listed in the previous chapters provide a framework that can be integrated into different levels of operations of the forces or serve as a kind of objective. We have seen that this is a well-functioning system for the U.S. Military, since they already use such technologies in larger volumes that complement the operations of the forces. At the same time, there was an example of a country with a small army, such as Hungary, where there are similar objectives within the Hungarian Defense Forces. However, that use of renewable energy sources is a costly process and therefore each country needs to decide how much it wants to utilize. However, in the long term, these alternative sources will become increasingly important as the amount of fossil fuels in the future will not be able to meet the needs and in any case have to use some alternative solutions.

<sup>18</sup> Király László, Végvári Zsolt: Energiahatékonyság a Magyar Honvédség béke időszaki működésében Hadtudomány XXVII. Évf, 2017/3-4., pp.56-63, [http://real.mtak.hu/67470/1/Ht\\_201734\\_56\\_75\\_u.pdf](http://real.mtak.hu/67470/1/Ht_201734_56_75_u.pdf)

<sup>19</sup> Greenreport: Napelemeket telepít a Magyar Honvédség, 2018.01.24 <https://greenport.hu/cikk/862-napelemeket-telepit-a-magyar-honvedseg>

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