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HADTUDOMÁNYI SZEMLE

Imre GERŐCS

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5. évfolyam 1-2. szám

THE MILITARY AND THE RENEWABLES

PART I.

FOREWORD

This article is a part of a series which examines the possibilities of implementing renewable energy technologies in support of the military force. Starting from the big picture throughout the three article I will follow a path to conclude whether it is feasible or not for the Hungarian Defense Forces to implement such systems.

First – in this work – I would like to paint a picture about the causes of why it is important to talk about this matter on the first place when it comes to the development of the military force. Than I would introduce the renewable energy sources and the technologies that are already in place to convert the clean energy sources to usable heat or power. That will conclude my first article.

In the second article I will investigate the options and possibilities of the renewable and/or alternative energy technologies in the energy chain of the Army in order to narrow the available technologies in support of military operations.

In the last article of the series I will examine the Hungarian Army current situation, whether it is reasonable and relevant for the Army to implement such technologies within the country or throughout deployments.

As a Hungarian military person I traveled around the Globe and have seen different armies, learnt different opinions and had a chance to experience the different way of thinking about the same matter. Also as a renewable energy engineer I'm able to describe technologies and possible solutions for a decentralized energy production.

THE NECESITY FOR CHANGE

It is crucial to understand that moving from fossil-based energy production and consumption is not only economical but rather social and environmental issue. Fossil fuel production is not sustainable at the first place. More than a billion year was required to produce a day of oil and gas consumption today. Sooner or later the last gallon of oil and a last cubic meter of natural gas will be used up. The chart shows the expected fossil fuel production and share of the entire energy demand in time. It is easily foreseeable that nations and mankind at all have to change the way we produce and consume energy. The modern war is energy intensive. Based on the US Army study, the oil usage per soldier has risen 2.6 percent annually over the past 40 years and is projected to rise 1.5 percent annually through 2017[1].

More and more attention is paid to the environmental side of the energy sector. Global warming, climate change, pollution, illnesses and most other negative processes we are experiencing today is somehow the consequence of (or at least connected to) the men's ever increasing fossil-based economy.

[1] Deloitte, Energy Security: America's Best Defense (Washington, DC: Deloitte, November 9, 2009), available at www.deloitte.com/assets/Dcom-UnitedStates/Local Assets/Documents/us_ad_energy security.pdf

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The other problem is rising with the increasing number of population. More people require more energy. Developing countries and regions require even more energy for raise their economy. Less and less fossil fuel are available for an increasing demand. Some point of time the day will come when the demand will outrage the available resources. Before that happens mankind needs to – first – change the way of thinking about energy, than act accordingly.

After finding us in an inconvenient situation of decreasing oils reserves and increasing energy prices one has to start thinking on alternative solutions. The question is: What are the options that mankind facing in order to lower fossil fuel consumption and increase the locally produced renewable energy?

First of all we need to start with the required form of energy that is useful for people. Heat and electricity are the two most common form of energy that a normal people or organizations use. With this two all kinds of different energy needs can be satisfied.

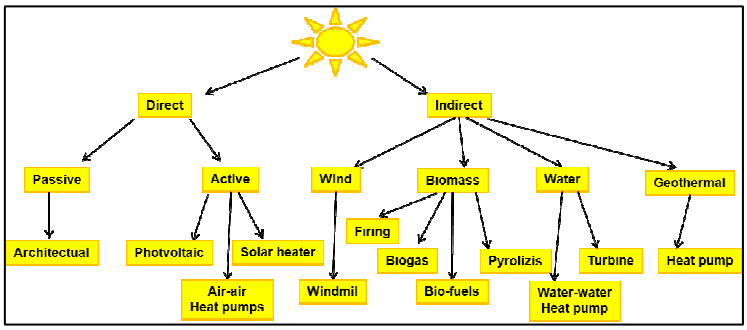
The first step of using less fossil energy is energy efficiency. Experts agree that this is the cheapest way of lowering our energy needs. It means that we operate energy efficient electrical devices or insulating our buildings to retrieve the heat.

RENEWABLE ENERGY TECHNOLOGIES

There are two basic forms of renewable energy that can be used for electricity or heat production. These are the solar energy and the geothermal energy. The geothermal energy is basically the heat flux soaring from the middle of the Earth. Its' heat energy is resupplied by the decomposition of the radioactive materials in the center of the Earth.

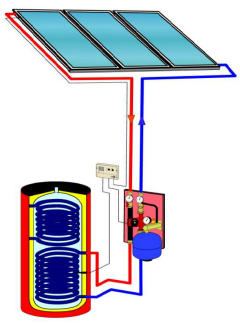
The other form of usable renewable energy is the solar energy. There are some ways of tapping into this form of energy. The chart[2] depicts the direct and indirect ways of taking advantage of the solar energy.

Directly we can take such measures that will ensure us using the most of the sunlight. Most of the time these measures are architectural in nature (such as orienting a building toward South). There are active ways of using the solar energy.



SOLAR HEAT SYSTEMS

The most common form of this is the solar heat systems (also called: solar collectors). These systems need direct sunlight and produce usable heat. A basic solar collector systems contains the collectors that gathering the solar energy and pass it on to the intermediary medium. The intermediary medium is normally some kind of liquid that circulates within the collector. Then the liquid gives up the gathered heat by a heat



[2] Own chart

exchanger. A basic solat heating systems requires a puffer tank to store the energy. The basic set up is shown on the picture[3].

PHOTO VOLTAIC SYSTEMS

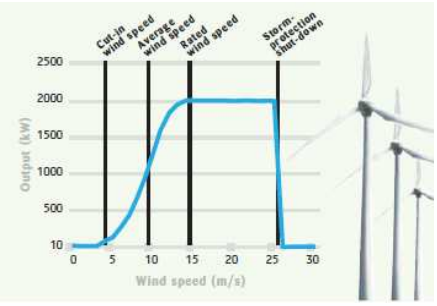
Using the photoelectric phenomena we can directly produce electricity from the sunlight. The devices using this method are called photo voltaic systems. The photo voltaic systems generate electricity using solar (PV) panels. The panels' task is to convert the sunlight into direct current. The inverter converts this current into usable alternating current. A battery pack and a control system is needed to store the energy. Both the solar heating and the photo voltaic system is best produce energy when the direct sunlight hits the panel at a 90 degrees. That is why it is important to know which point of the planet would we like to implement a system.

HEAT PUMPS

Heat pumps are ventilation devices which are able to produce high temperature output using low temperature input. They work like a reverse cycling refrigerator. The air-air heat pumps use the environmental air heat content to produce hot air that can be used for heating. Heat pumps are one of the most modern and environment-friendly ways of producing hot air/water. The Coefficient of performance (COP) characterizes the efficiency of the heat pump. This is a dimensionless number which shows how much energy is needed to produce 1 kWh output energy; or how much energy can be produced from 1 kWh input energy. It means that all of the heat pumps efficiencies are higher than 100%. Of course, higher these numbers better the heat pump. For the air-air (also for the air-water) heat pumps this number is not the best to describe the efficiency since the thermal energy of the environmental air is determined by the temperature. The temperature of the air alters between – 40 - +45 ºC depending on where are we on the planet. For this reason, there is another value that is used to compare air-air heat pumps. This value is the Seasonal Performance Factor (SPF). This number shows the efficiency of the heat pumps in different outsource temperature conditions. The modern air-air or air-water heat pumps can produce usable heat down to environment air temperature of -15 ºC. The COP number alters between 2,6 – 4,5.

WIND GENERATORS

When the sun heats a surface the air above the surface will rise. When that happens cooler air will come into the place of the rising air. This is called wind. So the wind is the indirect form of solar energy. All the devices using wind to produce energy is called wind generators. Wind generators only can produce electricity. It is imperative before one implement a wind generator to have a current wind speed data at least for six months. From this information the expected energy production can be estimated. There are certain limitations of using wind energy. One of them is height. Large wind generators require solid basements. Most of the time, the Army does not have the capacity to build these structures. The other limitation for the wind generators is the technical characteristics[4]. Most wind turbines do not start energy production until the wind speed of 5 m/s (18 km/h).That is

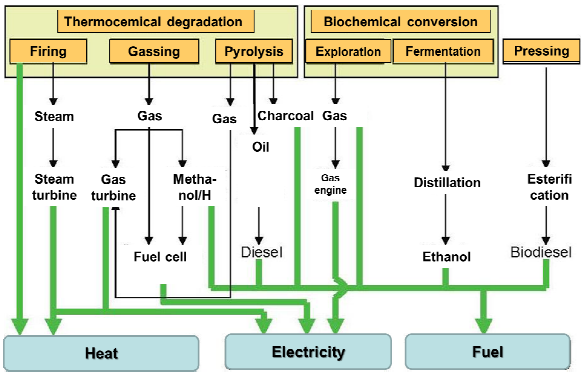


[3] Downloaded from http://naplopo.hu/Napkollektor-ismerteto/napkollektor-rendszer.html 2012. 06. 18.
[4] The picture shows the production characteristics comparing the wind speeds.

because of the mechanical build-up and the friction between the parts. They start to produce some energy at 10 m/s (36 km/h) and they provide their nominal power at about 12-15 m/s (43-54 km/h). Wind generators operate well and can produce energy if the wind speed is at least 30-40 km/h.

BIOENERGY

All the plants on the Earth use solar energy to born and grow. Normally when we talk about biomass, we understand woody or herbaceous plants. (This is not the scientific definition of the biomass) Using this source of energy is at the end using solar energy. There are many ways of getting energy out of biomass. The most common is firing. This was the way for the mankind for centuries to produce heat. There are some modern technologies intending to increase the efficiency of the firing. The chart[5] shows the different methods of getting useful energy out of different biomass. As we can see heat, electricity and fuel can be produce from the same primer energy source.



In larger sizes electricity can be produced by firing using steam turbines. In this case the byproduct is heat that can be used for hot water or heating purposes. When we produce heat and electricity as part of the same process it is called cogeneration. It is important to know about, because this way the process overall efficiency can be increased. Trigeneration is a process when not only heat and electricity is produced but cooling is also involved in the process.

Gassing or biomass gasification means incomplete combustion of biomass resulting in production of combustible gases consisting of Carbon monoxide, Hydrogen and Methane. This mixture is called syngas, wood gas or producer gas. Syngas can be used to generate electricity with internal combustion engines.

There is a relatively new way of producing energy from biomass. That is pyrolysis. Pyrolysis is a thermochemical decomposition of organic materials.[6] In the absence of oxygen the biomass disintegrate into small molecules. This is syngas. From this point using biogas is the same than the above.

Biogas is gaseous material released when biomass decays. It contains methane, carbon monoxide, carbon dioxide and other materials depending on the type of the biomass. Methane is forty-times tougher climate pollutant than carbon dioxide. That is one of the reasons why the artificial fermentation is used to degrade biomass. After the fermentation the biogas can be used to produce electricity and/or heat.

Bio-fuels are fuels produced from biomass. There are two basic form of bio-fuels: biodiesel and bio-alcohol (most commonly: bioethanol). Both are produced using the fermentation technology. Biodiesel can also be produced by pressing (mainly from oilseeds).

[5] The chart is from the Hungarian Renewable Energy Roadmap, downloaded from http://www.eh.gov.hu/gcpdocs/49/NCST/NCST_A.pdf 2012. 2012. 06. 18.
[6] Downloaded from http://en.wikipedia.org/wiki/Pyrolysis 2012. 06. 18.

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ENERGY FROM THE WATER

The large water streams on the planet are caused by a different temperatures in different locations. This is another form of using solar energy indirectly. Using this energy of the water can be done with tide power plants or normal water dams. These structures are static and most of the time large in size. The picture show a typical water dam that produces electricity.[7]

There is another way of using the water to produce energy. This is the hydrothermal energy. Emplacing a water-water heat pump we can use the thermal energy of the water. When having a river, pound, stream or a lake nearby, water-water heat pump is the technology of choice since the temperature of the larger water mass changes a minimum, which enables the heat pump to operate on a continuous well-balanced pace.

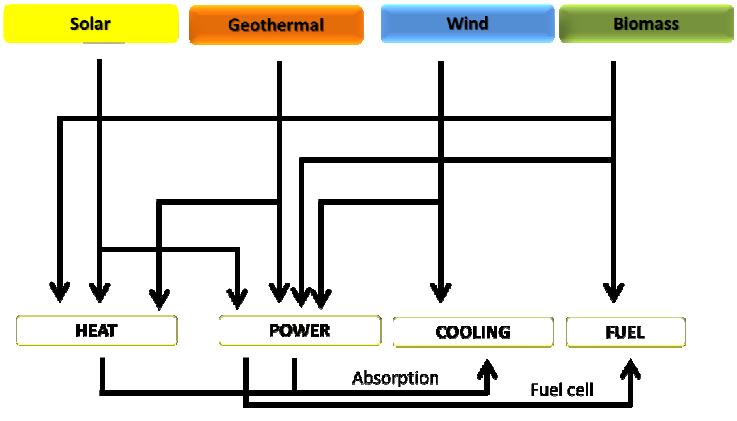
GEOTHERMAL ENERGY

There is a radioactive material decomposition in the center of the Earth. From this continuous decomposition heat is released and taking its way to the surface. This heat is called geothermal energy. Of course, geothermal energy differs from place to place. The geothermal gradient shows how many meters should we go under the surface to increase the temperature with 1 Kelvin/Celsius. There are geothermal power plants all over the planet, where this number is high enough and more than 200 ºC water is available. Most of the time mankind is using the geothermal energy for heating, wellness or health purposes. The best and most common use of the geothermal energy for energy production is using the heat content of the water under the surface with heat pumps.

COMPLEX SOLUTIONS

Most of the time one renewable energy system is not enough to produce all-time available energy in a form we want. That is why a good-working system normally contains at least two or more renewable technologies.

The picture depicts the primer renewable energy sources and the end products using the available technologies. According to the picture heat and power is easy to produce using one or multiple technologies, cooling can be done by using the absorption technology or electricity (ventilation). The only renewable energy that is capable of fuel production is biomass at this moment.



[7] Downloaded from http://www.gyulavarikastely.hu/index.php/megujulo-energia/ 2012. 06. 18.

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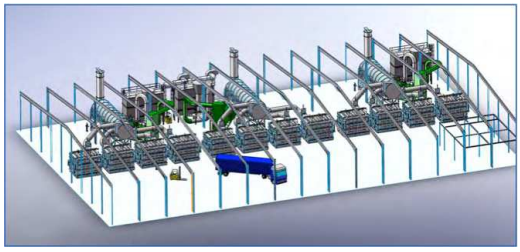
ALTERNATIVE SOLUTIONS

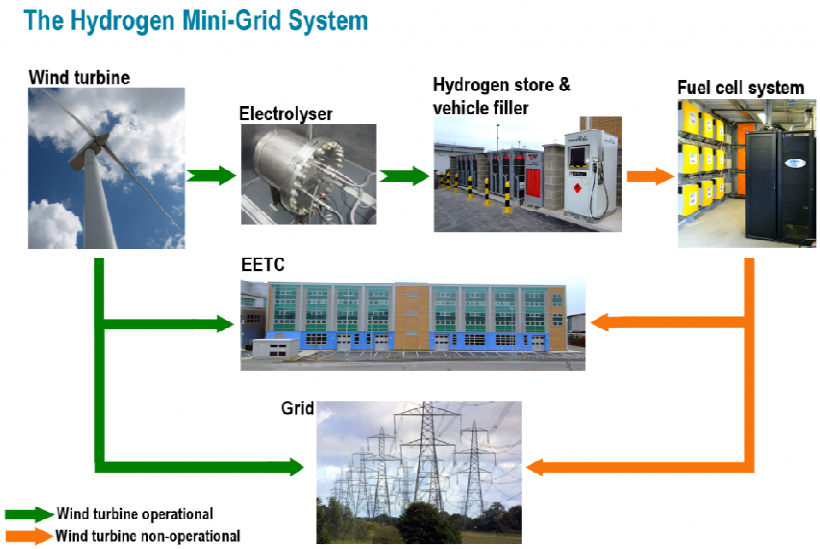


An alternative solution contains methods that are either not renewable in definition or normally not used to generate energy. Such technology can be the plasma technology that is developed to generate energy from garbage. Using the high temperature plasma torch the waste-to-energy concept can be a technology of choice for larger population. The picture[8] shows the WTEC company solution for a continuous waste gasification power plant. Municipal waste contains a lot of energy. Most countries see this way of producing energy excellent is because waste management is also can be solved using this waste-to-energy concept.

FUTURE

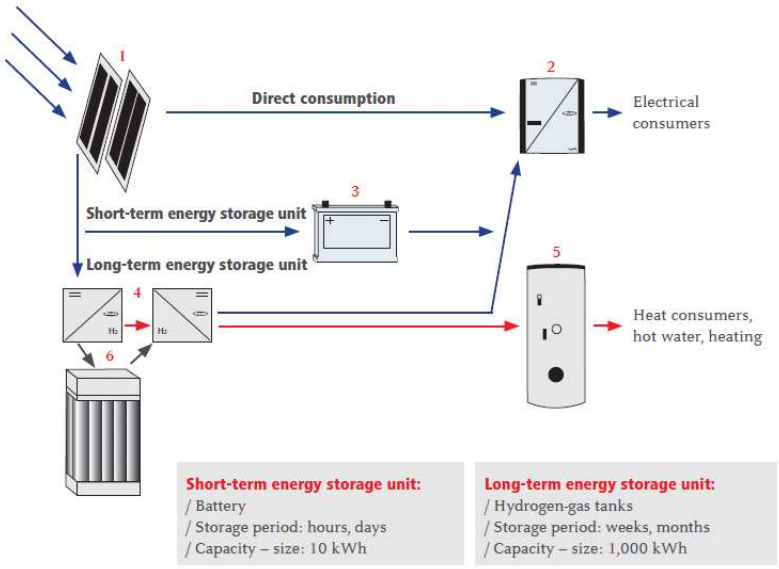
As the Army always plans ahead, the study would be incomplete without mentioning the current developments and concepts in the renewable energy sector.

As we entering the 21st century more and more experts say that the Hydrogen is the most likely source of energy in the future, the near future. The below picture[9] shows a complex renewable energy based Hydrogen system.



Another company vision on future energy production-consumption based on photo voltaic system integrated to a Hydrogen storage is shown on the picture[10]:

[8] The picture is downloaded from the WTEC company web site: www.wtecanada.com
[9] Donwloaded from http://www.upssystems.co.uk/case-studies/fuel-cell-installation-for-the-hybrid-hydrogen-mini-grid-at-the-eetc-rotherham/ 2012. 06.18.
[10] Downloaded from http://www.fronius.com/cps/rde/xbcr/SID-0D1FC96F-F97899BA/fronius_international/Folder_Fronius_Vision_EN.pdf 2012. 06. 18.



Using renewable energy is still not common in military operations. It requires complex survey, careful planning, and precise implementation. With all the changing world and decreasing fossil fuel reserves the military also should start investigating the possibilities of using renewables!

WHAT CAN THE ARMY USE?

Solar energy is available just about everywhere on the planet (at least in those locations, where the Army goes). Therefore using solar heating or photo voltaic devices is always an option. These items are good for heating, cooling and electricity supply and they fulfill the Army's requirements. Heat pumps can also heat and cool accommodations, command posts or other Army installations, if electricity is available. The equipment is portable, easy to use and meets the Army's standards.

I would suggest to have a small-scale wind generators in the Army's renewable energy toolkit since this is a cleanest way of producing energy right on the spot, but we have to understand that wind is not available everywhere.

Small scale biomass gasification devices are available on the market. Most of them work with woodchips and other biomass byproducts. They generate heat and electricity, a good choice for an army installation.

Waste-to-energy concept is one of the way to go with the Army when we talk about larger compounds, bases and installations. Two birds with one shot can be taken with this technology.

CONCLUSION

In this article I have investigated the needs for renewable energy sources for the Army, the technologies currently available, some words were about the future of decentralized energy production and consumption and I have made some suggestions, what to implement if the Army takes renewables into consideration.

One has to see that the fossil-age has come close to the end and without some decades these energy sources will diminish. The Army, as a large energy consumer, has no other choice but starting to look for other solutions. The technology, with the enormous development in the last 20 years is there for implementation. It is only up to the military decision makers, whether they reach out for these solutions or not…

Keywords: renewable energy sources, solar energy, geothermal energy, heat pump, waste-to-energy, army and renewable energy.

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