NATO ENERGY SECURITY CENTRE OF EXCELLENCE

Energy Security: Operational Highlights

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Contents

Editorial

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In September 2014, NATO Heads of States and Governments adopted the Wales Summit Declaration to further develop the capacities of the Alliance to improve its energy security. To this aim, they agreed to concentrate on those areas of competence where NATO can add value.
In particular, the Alliance will increase its competences in supporting the protection of critical energy infrastructures and will continue working towards significantly improving the energy efficiency of NATO military forces[1].

Indeed, enhancing the energy efficiency of armed forces is becoming an important issue for several NATO member states because the need of energy for military operations is enormously increasing. For instance, over the last 70 years, the need of energy supply for a ground soldier has passed from around 1 gal/day at the end of Second World War to more than 20 gal/day in Afghanistan[2]. This tendency, which has been confirmed by studies on the energy needs expectations for the future, will very probably double the operational energy requirements within the next 20 years. Energy is no longer only a good to be provided, but it has become an essential tool for ensuring full military capability.

Furthermore, enhancing energy security implies energy efficiency, which the International Energy Agency (IEA) defines as a "way of managing and restraining the growth in energy consumption. Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input".[3] Therefore, "energy efficiency is the quickest and least cost way of addressing energy security, environmental and economic challenges". [4]

In the military field, energy efficiency will have a positive effect on energy security implementation by reducing the logistic footprint, by increasing the operational capabilities of troops (e.g. less logistic convoys, less escorts and less casualties), and by increasing the overall energy security of operations (e.g. decreasing the need on energy will limit the risk of disruption). Energy efficiency will also reduce the cost of operations (considering the high price of the delivered fuel, as ex-

[1] North Atlantic Treaty Organization. (2014). *Wales Summit Declaration.* http://www.nato.int/cps/en/natohq/official_texts_112964.htm
[2] Deloitte. (2009). *Energy Security, America's Best Defense*. Retrieved from http://www2.deloitte.com/us/en/pages/about-deloitte/articles/about-deloitte.html
[3] International Energy Agency. (2015). *Energy Efficiency.* Retrieved from http://www.iea.org/topics/energyefficiency/
[4] International Energy Agency. (2011). *25 Energy Efficiency Policy, Recommendations*. Retrieved from https://www.iea.org/publications/freepublications/

pressed in the "fully burdened cost of fuel"[5] concept), and will have positive environmental consequences through the limitation of the carbon footprint of NATO armed forces.

Given this background, the ninth issue of 'Energy Security: Operational Highlights' contributes to the debate on energy security in the military by publishing three articles. They are related to two of the dimensions of energy security referred to in the NATO Wales Summit Declaration: the energy efficiency of NATO military forces and the protection of critical energy infrastructure.

In relation to the first dimension, two articles focus on the national efforts to increase energy efficiency. In particular, they take into consideration the Italian case. LT Col. Vincenzo Carì and Major Selected Reserve, Prof. Ciro Aprea discuss the efforts made by the Italian Army for more efficient management of the energy resources. They analyze the several initiatives launched by the Italian Army in the last years for using energy more efficiently. They also illustrate the possibilities for energy savings. Cdr. Pasquale Tripodi's article, instead, deals with the Italian Navy Green Fleet, which has committed itself to increase energy security by reducing, at the same time, the pollution coming from ships. In this context, the use of the GREEN F76 fuel instead of the more traditional F76 is particularly relevant. It is a good tool to achieve the Navy's goals by increasing its security of supply through the exploitation of a higher number of available fuels. The protection of the environment through the GREEN F76 has put the Italian Navy in a leading position in the public sector.

Finally, the third article focuses on the second dimension of energy security in the military concerning the protection of critical energy infrastructure. This issue is of utmost importance because the recent developments with security implications in the European neighbourhood have made NATO member states very much concerned about the protection of their critical energy infrastructure. Therefore, they are enhancing international cooperation in the field and are increasing the involvement of agencies in order to exchange and share knowledge and experience. This dimension of energy security is the subject of Captain Wayne Dahl's article which discusses a specific military exercise held in Latvia in 2014 to increase critical energy infrastructure protection. The peculiarity of this exercise was its aim, namely to hone the skills of the Michigan Army National Guard, Latvian military police, civilian police and other national organizations during civil support operations. The results have clearly shown which the main shortfalls in the protection of the energy infrastructures are, by highlighting the importance of energy security both for civilians and military.

[5] Siegel, Steve. (2008). *Fully Burdened Cost of Fuel Methodology and Calculations for Ground Forces: Sustain the Mission Project 2 (SMP 2).* Energy and Security Group: Reston

Energy resource management **of the Italian army**

Major Selected Reserve, Prof. Ciro Aprea and LT Col. Vincenzo Cari'

This article analyses the several initiatives that the Italian Army has launched over the last years to ensure more efficient management of energy resources. It has produced a special handbook to outline the necessary rules for better energy efficiency and has developed an algorithm comparing the amount of energy theoretically required to this aim to the quantity really consumed in order to assess the energy data of the Army. Additionally, it has carried out two audits and a study about the energy requalification of a swimming-pool located in Rome. In this context, several proposals have been presented. Finally, this article discusses the possibilities for increasing energy savings.

INTRODUCTION

During the last years, the Italian Army has launched several initiatives aiming to ensure more efficient management of energy resources. Its sensitivity to this issue is demonstrated by the decision of reducing energy costs and of adopting specific measures to adapt to the rapidly changing regulatory framework. In so doing, the Italian Army has placed itself in a leading position in the national panorama of initiatives in the energy field.

The Army's activity has been divided into different lines of action whose main purpose is to make every component of the Armed Forces aware of the energy matters in order to ensure correct and careful management of energy resources. The first tool that they have used is communication. They have produced a special handbook that summarizes simple common sense rules for each user for the proper use of energy resources. At the same time, the Army has analyzed the data of energy consumption (water, electricity, gas, diesel fuel) of the Armed Forces, finding sometimes clear signs of a certain underestimation of the problem.

The energy "audits" conducted in two barracks in Rome have demonstrated how much energy could be saved, both through minimal interventions (often without cost like prescriptive and behavioral actions) and through heavy and expensive infrastructural works such as the construction of a cogeneration plant to produce hot water for a swimming pool.

The analysis has shown that a reduction of at least 10% of the energy consumption could be achieved by means of the improvement of the infrastructure and of a correct behavior of

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people. Consequently, the Italian Army could save millions of euro every year.

PRESCRIPTIVE AND BEHAVIORAL ACTIONS

The actions for immediate implementation of measures, aiming at raising the awareness of the users particularly concerned:

- the installation of timer on bathroom electric water heaters, and switching them off during the weekend;
- the deactivation of heat pump of functioning radiators;
- setting up the temperature of the air conditioners at 25-26°C in summer and the imposition of a timing;
- the installation of external temperature sensors for the methane boilers;
- setting up the "saving energy option" in the "control panel" of computers, in order to turn off the monitor and hard drive of each workstation when unused for a reasonable time;
- the positioning of the outside condensing groups of cold storage;
- the optimization of lights timing;
- the removal of radiator covers;
- switching off the stand-by led light of electronic equipment and assessing the adequacy of electricity and gas supply contracts.

INFRASTRUCTURAL WORKS

Infrastructural works were, among others: reducing the centralized heating systems by not using heating for rooms which are not continuously occupied. Other heavy interventions, such as the installation of solar panels for hot water, were not considered appropriate because they did not give acceptable results in terms of cost/benefit ratio.

STATISTICAL ANALYSIS TOOLS

Due to the vastness and the different types of competency frameworks of the Italian Army (e.g. barracks, logistics and health facilities, shooting ranges, factories, etc..), and given the impossibility to carry out energy audits dedicated to each base, an algorithm was developed to immediately identify whether the infrastructure at issue was wasting energy or not. The algorithm, based on data collected in the literature, calculated the average amount of energy theoretically required (both electrical and thermal) on the basis of the type of use of the gross surface area (dormitories, offices, canteen, etc ...) and of the climatic zone both in summer and in winter. The obtained average was compared to the amount of energy effectively consumed. The algorithm gave good results in the testing phase and, after improvement, is supposed to be used for the remote monitoring of consumption data and for the evaluation of their congruence. In this way, attention will be given only to bases that consume excessive amounts of energy compared to the estimated statistical ones, in order to identify the most appropriate interventions that could improve efficiency.

EUROPEAN FUNDING FOR ARMY BASES

The Italian Army participated in the project "JUSTICE" (Join U.S. To Increase Clean Energies), which is funded by the Ministry of Economic Development. This latter has funds

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for increasing the energy efficiency of public buildings. In 2012 the Italian Army initiated a procedure through a tender process open to public administrations in order to finance initiatives in the construction of plants for the production of energy from renewable sources. All the initiatives presented by the Italian Army were deemed worthy of funding. The realization of the plants is in progress and will result in a reduction of current electricity consumption, by about 15% in the bases involved.

ENERGY REQUALIFICATION OF A SWIMMING-POOL: EVAPORATION CONTAINMENT AND COGENERATOR FOR FAST RETURN OF INVESTMENT

In the context of the initiatives aiming at reducing the energy consumption of the ambient air-conditioning system, particular attention has been paid to sports facilities. Many of them were put in place in a period when less attention was given to energy efficiency and less technological solutions were at disposal. The analysis and the subsequent proposal of intervention on an audit case study is particularly interesting. This is the swimming pool close to the General Staff in Rome, which is plagued by inefficiencies at the plant level, so that situations of users discomfort and high energy consumption rates are recorded both in winter and in summer.

The swimming pool, with a size of 25 meters by 12 meters, holds a volume of water of 500 m^3. The water in the tank is currently kept at a constant temperature of about 30° C with two gas boilers, of 350 kW each. The boilers also provide heating to the pool room by means of an air-conditioning plant operating with air. There is no summer cooling plant. The humidity control environment system does not exist and its installation is not possible because of high costs.

ENVIRONMENTAL CONDITIONS IN THE POOL

In the winter season the structure at issue is equipped with a heating system for the air, without any humidity control. In some cases it was necessary to open the windows, which means that airing the room was insufficient or that the system warmed a too large volume of air compared to the needs because the diffusers were placed too high above the water. In the summer season, the lack of an air conditioning system can lead to condensation problems and to a temperature which is scarcely bearable by users.

PROPOSALS FOR IMPROVEMENT

a. *Decreasing the temperature of the pool water*

The temperature of the pool water was too high. On the basis of the recommendations of CONI (Italian Olympic Games Committee) [1], it is possible to keep the temperature of the water at 27°C. According to the regulation, the only requirement is that water does not have to be kept below 24°C. Considering a 5% replacement of water, as required by the current Italian regulation [2], a reduction in the value of the water temperature by 1°C helps to save natural gas for about 1 000 euro per year. Thus, it is clear that a decrease of 3°C is equal to 3 000 euro of annual savings. The decrease of the temperature causes the evaporation of a small quantity of water. This doubly contributes to the decrease of the amount of energy required for heating the water for two reasons. Firstly, the water reintegrated must be heated to reach the temperature of the pool. Secondly, the water that evaporates subtracts the so-called "heat of vaporization" to water that remains in the pool, cooling it. Whereas reducing the value of temperature of 3°C approximately produces 10% less evaporated water, the energy saving is equal to about 2 000 euro per year.

b. *The use of a recovery of the thermal energy of the air*

Setting up a thermal energy recovery unit for the air in the winter season is possible. Indeed, on the basis of the analysis of gas consumption, it is believed that only approximately 20% of the thermal energy is used for heating the replacement of water, while more than 60% of the thermal energy is used for heating the pool room. The correctness of these percentages was verified with the data reported in a study conducted by ENEA (Italian agency for the new technology, the energy and the environment), in cooperation with the University of Rome "La Sapienza". [3] Due to the power involved, the cost of the recovery is around 50 000 euro. This equipment would imply a saving of around 25 000 euro per year, in the likely event that 50% of the "expelled" thermal energy is recoverable. Therefore, the payback time would be just two years, whereas heating the air costs about 50 000 euro of gas per year.

c. *Coverage of the swimming pool at night*

As mentioned above, the pool water is subject to the evaporation phenomenon that leads to a waste of thermal energy. This could be avoided by covering the surface of water when the pool is unused. Assuming that the pool is brushed by air at the speed of 2 m/s, that the air temperature is equal to 27°C with 60% relative humidity and that the water of the pool is maintained at a temperature of 27°C, the average flow of evaporated water in both summer and winter is 1.0 • 10^3 kg per day. This means that it is necessary to provide a thermal power of about 29 kW only to compensate the water cooling due to evaporation. If the pool is covered during the night, it would be likely to hold that the evaporation that is avoided during the year is equal to 150 000 kg of water saved, if there is an average of ten hours of coverage per day throughout the year. In these cases, an amount of energy of about 100 000 kWh would be saved in one year, which corresponds to save around 10 000 euro. Given that the cost of a motorized cover is approximately 20 000 euro, it can be assumed that the time required to get back the investment is 2 years. Of course, it is possible not to mechanize the coverage, in order to get a shorter pay-back time.

d. *Use of cogeneration*

Cogeneration is the simultaneous generation of two forms of energy, usually heat and electricity, from one energy source. Traditional energy generating systems produce only heat or electricity by burning fuel. When an energy system produces electricity, a huge amount of heat has to be vented into the environment according to the second law of the thermodynamics. Cogeneration facilities capture some of the wasted heat and use it. For this reason, cogeneration systems are more efficient than traditional power plants.

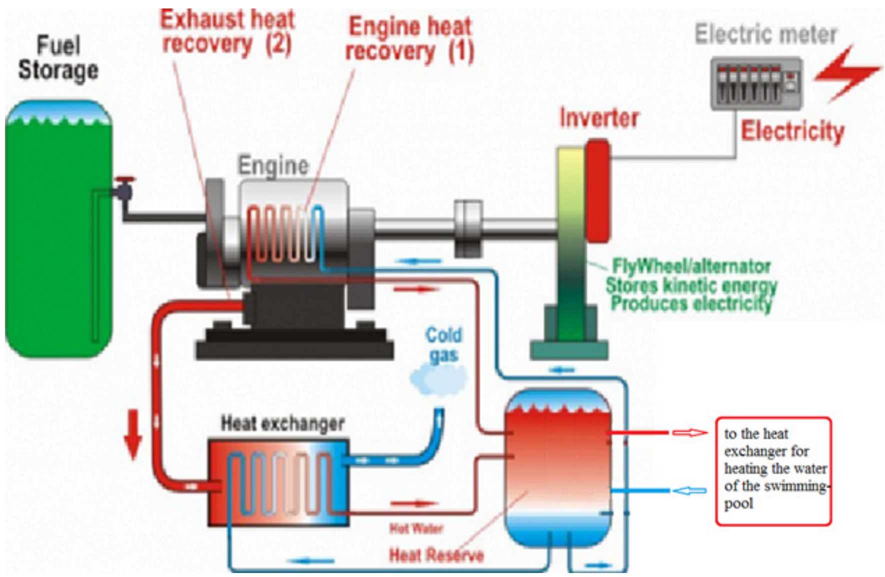

Figure 1. Diagram of cogenerator

The cogeneration technique applied to swimming pools allowing a massive exploitation of the waste heat represents a cost-effective energy solution. Table 1 shows the thermo-economic assessment of the adoption of a cogenerator that has the characteristics of a function of the power steps selected. Please note that the sizing of the co-generator was carried out with reference to the current plant situation, without considering the interventions discussed above.

(1) *Technical Analysis*

The electricity and the heat produced by the co-generator are respectively 1 601 MWh/year and 1 669 MWh/year while the consumption of fuel for the operation of the co-generator unit is 413 572 Sm^3/year, for 4 007 MWh/year primary energy. The consumed electrical energy is 79.13%, while the remaining 20.87% is injected into the network to be sold.

Power steps	[100%]	[75%]	[50%]
Electrical power [kW]	450	338	225
Thermal power [kW]	469	352	235
Thermal efficiency[%]	42.3	41.5	40.9

Table 1. Cogenerator performances at different loads

The investment cost amounts to 500 000 euro including VAT and the cost of maintenance (oil consumption, maintenance, cleaning filters) is 0.01 euro/kWh of the electricity produced. For the energy consumption, the reference was taken from the bills of supplies. Table 2 shows the management of the plant during the year, expressed in terms of percentage of the electrical and thermal output power of the cogenerator.

(2) *High Efficiency Cogeneration Analysis*

According to the Italian legislation, if the co-generator provides relevant primary energy savings, the cogeneration is named "High Efficiency Cogeneration" ("CAR" in Italian). In this case the system enjoys the following benefits:

- Recognition of "white certificates". Price fixed at 93.68 euro/tep for units already in use since 2011, 86.98 euro/tep for units en-

	Days	From 1:00 to 6:00	From 7:00 to 8:00	From 9:00 to 17:00	From 18:00 to 21:00	From 22:00 to 24:00
January-March	Mon - Sun	OFF	75%	100%	100%	OFF
April-June	Mon - Sun	OFF	50%	75%	75%	OFF
July	Mon - Sun	OFF	50%	50%	50%	OFF
August	Mon - Sun	OFF	OFF	OFF	OFF	OFF
September	Mon - Sun	OFF	50%	50%	50%	OFF
October	Mon - Sun	OFF	50%	75%	75%	OFF
November-December	Mon - Sun	OFF	75%	100%	100%	OFF

Table 2. Management of the cogenerator plant.

tered into use in 2012; "tep" is the "equivalent petrol metric ton" spared with the cogenerator; "white certificates" are documents certifying that a certain reduction of energy consumption has been attained;

- Exemption from the obligation to purchase "green certificates" to producers and importers of electricity with annual production and imports from non-renewable sources exceeding 100 GWh; "green certificates" are a tradable commodity proving that electricity is generated by using renewable energy sources;
- Priority in the context of dispatching electricity produced by units "CAR";
- Tax relief on excise duty natural gas used for cogeneration;
- Ability to access the service net metering of electricity produced by "CAR" with rated power up to 200 kW;
- Ability to apply technical and economic conditions for simplified connection to the electrical grid.

(3) *Economic analysis*

In the event of an inflation rate of 1.5% and a discount of 5% with a cost of facility amounting to 500 000 euro (including VAT), of maintenance costs amounting to 16 014 euro/year and of a price average purchase of electricity and natural gas amounting respectively to 0.24 euro/kWh and 0.8 euro/Sm3, the economic analysis provides the following results: the annual availability amounting to 221 530 euro, the Pay Back Period is three years as well as the Discount Pay Back Period (DPB), the NPV (Net Present Value) for 10 years is 1 288 454 euro compared to an initial investment of 500 000 euro, with a profit ratio of 258% while the NPV for 5 years is 478 901 euro, with a profit ratio of 96%. These data can be deduced from Figure 1.

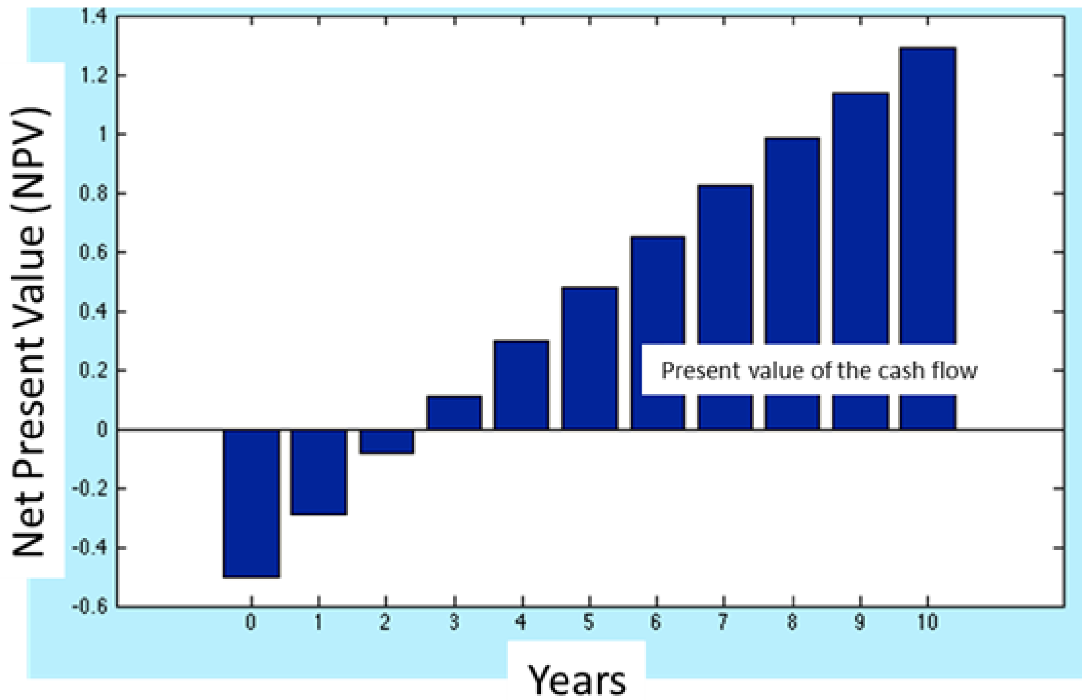

Figure 2. Net Present Value (NPV) for the cogenerator investment.

(4) *Sensitivity of the economic analysis*

The analysis is carried out by taking into consideration a case where there are many variables (inflation rate, discount rate, cost of the plant) which are assumed as known and fixed, but that could change.

Inflation Rate (%)	DPB
1.5	3
10.0	3

Table3. Discount Pay Back (DPB) period (years) for different Inflation Rate

Discount Rate (%)	DPB
1.5	3
5	3
10	3

Table 4. Discount Pay Back (DPB) period (years) for different Discount Rate

Plant cost (€)	DPB
500 000	3
600 000	3
650 000	4

Table 5. Discount Pay Back (DPB) period (years) for different Plant cost

The investment is particularly cost efficient given the reduced DPB. The results are more than acceptable even in the case of any unforeseen financial nature. Obviously, the case used here (see Table 2) is one of the possible configurations of the operation of the CHP unit in terms of management of the cogenerator. Following the interventions, without taking into consideration the CHP installation, the annual savings are around 50 000 euro. As explained, if compared to a short payback period, the CHP involves a NPV of more than one million euro for ten years.

CONCLUSIONS

In conclusion, the way ahead is still long, but early findings have shown significant room for improvement in terms of energy savings. To facilitate this path, the Italian Army has set new goals such as training of personnel, with the activation of no cost courses in video conference modality for its "Energy manager", and the preparation of project type for the subsequent construction of buildings "near zero energy". As explained, if compared to a short payback period, the CHP involves a NPV for ten years of more than one million euro.

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[2] UNI 10637/2006
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APPENDIX

The evaluation of the quantity of evaporated water

The following paragraphs illustrate how the quantity of water evaporating from the swimming-pool can be evaluated. The thermal power required for maintaining water at a constant temperature can be assessed by quantifying the water mass flow rate. The calculation shows that both water and air temperature will be equal to 27°C in winter and in summer. Air in the swimming-pool ambient isn't saturated. For this reason, water evaporates by cooling the water that remains in the swimming-pool. In theory, water could lead to air wet bulb-temperature.

The thermal power necessary to maintain the temperature of water in the swimming-pool constant can be measured with the following relation:

$$\dot{Q}_{RISC} = \dot{M}_{ev} \times R$$

where M_{ev} is the water mass flow rate evaporating and R is the water heat of vaporization. The problem data are the following ones. For the air temperature, a medium acceptable value has been used:

T_{water} = 27°C T_{air} = 27°C φ_{air} (relative humidity) = 0,6 L = 25 m
V_{air} = 2 m/s

S = 25×12 = 300 m^2

$\varphi = \frac{Pvp}{Psat}$ where P_{sat} is a function of the temperature. The water vapor, P_{sat} at 27°C is equal to

3564 Pa. φ_{air} = 0,6 ⟶ P_{vair} = 0,6 × 3564 = 2138 Pa

knowing the pressure difference, it is possible to evaluate the evaporated water mass flow rate (kg/s) as:

$$\dot{M}ev = h_M \times S \times (\rho_{sat} - \rho_{Varia})$$

where:

hM = mass transfer coefficient [m/s], S = swimming-pool surface [m^2]

ρ = air density [kg/m^3]

Considering vapor as a perfect gas, it's possible to apply the gas perfect law:

$$\dot{M}ev = h_M \times S \times \left(\frac{P_{sat} - P_{Varia}}{\frac{R_0 \times T}{\mu}} \right)$$

where R is the constant for the water vapor expressed as $\frac{R_0}{\mu}$ where μ is the molar mass of water vapor equal to 18 kg/kmol.

In order to know the $h_{M,}$ it is necessary to evaluate the Sherwood number (S_{hL}) representing the ratio between the convective mass transfer and the diffusive one.

h_m = DAB × S_{hL} / L where D_{AB} is the molecular diffusion coefficient

The relation allowing the evaluation of the Sherwood number takes into account both the laminar flow regime and the turbulent flow regime that coexist here.

$$Sh_L = \left(0{,}037 \times \mathrm{Re}_L^{\frac{4}{5}} - 871\right) \times Sc^{\frac{1}{3}}$$

where

$$\mathrm{Re}_L = \frac{V_\infty \times L}{\nu_{27°C}} = \frac{2 \times 25}{18{,}58 \times 10^{-6}} = 2{,}7 \times 10^6$$

27°C is the air viscosity at 27°C

and
$$Sc = \frac{\upsilon}{D_{AB}} = \frac{18{,}58 \times 10^{-6}}{26 \times 10^{-6}} = 0{,}71$$

with DAB = 26 x10-6 m²/s (water vapor diffusion coefficient in the air)

Therefore: S_{hL} = 3833 and $h_m = 4{,}0 \times 10^{-3}$ m/s

The evaporating water flow rate is:

$$\dot{M}_{ev} = h_M \times S \times \left(\frac{\frac{P_{sat} - P_{Varia}}{R_0 \times T}}{\mu} \right) = 4{,}0 \times 10^{-3} \times 300 \times \left(\frac{\frac{3564 - 2138}{8314 \times 300}}{18} \right) = 0{,}012$$

equal to 1037 kg/day

The thermal power required for the evaporation is equal to:

$$\dot{Q}_{risc} = \dot{M}_{ev} \times R = 0{,}012 \times 2442300 = 29308W$$

The value of the thermal power required implies a considerable economical cost to heat the water in the swimming-pool. This value is strictly correlated to the air relative humidity:

$$\varphi \uparrow \Rightarrow P_{Vair} \uparrow \Rightarrow \dot{M}_{ev} \downarrow \Rightarrow \dot{Q}_{heat} \downarrow$$

if the air relative humidity increases, the evaporated water will be smaller and, consequently, the thermal power required diminishes. On the contrary, if:

$$\varphi \downarrow \Rightarrow P_{Vair} \downarrow \Rightarrow \dot{M}_{ev} \uparrow \Rightarrow \dot{Q}_{heat}$$

The more the humidity decreases (dried air), the greater the mass of water which evaporates and thus the power required to maintain the temperature of 27°C.

It's obvious that the calculation can be repeated, and then refined, if different temperatures for the air are considered, fixing the water temperature at 27°C. In the case presented above, an average value for the air temperature has been taken into consideration.

Italian Navy Green Fleet

Cdr. Pasquale Tripodi – Italian Navy General Staff – Surface Ships Department

The aim of this article is to discuss the contribution of the Italian Navy to the reduction of pollution coming from ships. In this context, the Flotta Verde initiative is illustrated with particular attention paid to the GREEN F76 fuel, which is a valid alternative to fossil F76. The energy efficiency measures that the Italian Navy has adopted and its collaboration with Ente Nazionale Idrocarburi (ENI) in the field of new generation bio-fuels are also analysed. This shows the strong commitment of the Italian Navy to the fight against pollution.

INTRODUCTION

Meteorologists and climate scientists keep predicting harmful effects on environment and population due to the average temperature increase on the earth over the last decade. These effects of climate change are quite evident for the present generations in Italy and Europe. Extreme meteorological phenomena seem more likely to happen now than in the past and major coastal floods occurrence has been a constant plague in the last few years in many parts of the Italian peninsula. African boat people fleeing from food scarcity caused by severe droughts and water-stress is the other well-known emergency harnessed to climate change that the Italian Navy along with the other institutions ordinarily manage every day of the year. Climate change is therefore a global problem with local drawbacks. Every member of the international community is asked to reduce its own aggregate emissions of greenhouse gasses in order to increase the wellbeing of developing countries while preserving the wealth of the industrialized ones.

The role of the Navies as public institutions could be similar to the "yeast in the flour": a little contribution that makes the difference. Naval vessels are asked to bear the double burden of natural disaster relief intervention and emission reduction contribution. In particular, with its research and experimentation activities on alternatives to petroleum derived fuels, the Italian Navy is leading the national effort towards a more rational and eco-efficient use of energy. With the Flotta Verde initiative some Italian Navy's Vessels are playing an unprecedented role of incubators for innovative fuels in the maritime sector such as Liquefied Natural Gas (LNG) and advanced biofuel blends. LNG is a good alternative fuel: it is still a fossil fuel but inherently cleaner, cheaper and with lower CO2 emis-

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sions than fossil F76. LNG is central for the European Union economy and spreading its use as a fuel in the maritime and naval sector mobility could have a beneficial reduction effect on market prices, helping also the economic crisis recovery process.

THE FLOTTA VERDE INITIATIVE

With the "Flotta Verde" initiative, the Italian Navy has committed itself to reduce the dependency on imported oil up to 50%. This will happen by switching to the use of viable alternative fuels such as biofuels and LNG by 2030. In so doing, the Italian Navy anticipates the EU's 2030 Climate and Energy Policy that sets a greenhouse gas reduction target of at least 40% (more than in 1990) as well as a target of at least 27% for renewable energy and energy savings by 2030.

The third pillar (sustainable renewable biofuels and LNG are the first two pillars) of the Flotta Verde initiative, namely the energy efficiency increasing of the fleet, is particularly meaningful in the context of the Flotta Verde Initiative. Energy efficiency is a valuable tool to reduce the petroleum derived fuel dependency and its related emissions, addressing the need to limit climate change at the same time. Therefore, the Italian Navy is determined to play a leading role in the public sector, setting energy efficiency benchmarks for the whole maritime transport. This can be reached by deploying energy services as well as by adopting other energy efficiency improvement measures.

The Flotta Verde initiative is aimed at:

- Achieving the new advanced Green F76 fuel full scale certification of the Fleet within 2015.
- Performing a naval demonstration in 2016 with up to 50% of the operational energy from alternative sources.
- Reducing up to 40% the Fleet's oil dependency by 2030.

Figure 1. The Flotta Verde's logo.

GREEN F76

GREEN F76 is produced with 50% of renewable green diesel from certified sustainable vegetable oil and from waste and non-food sources such as used cooking oils (UCO). These substances are treated with a hydro treatment process. GREEN F76 is drop-in to existing equipment and meets the NATO F76 specifications for naval fuels interoperability. Green Diesel, the premium GREEN F76 blending component produced through the advanced "ECOFINING" process and developed by ENI and HONEYWELL UOP, is not the same as biodiesel or FAME which is not drop-in and therefore not suitable to be used on board of naval vessels.

The production and the successful operational validation of GREEN 76 are the result of the Italian Navy cooperation with ENI. In 2013 a complete set of small scale tests on components and engines was completed at the ENI's San Donato Milanese laboratories. The subsequent blending of 30 cubic meters of GREEN F76 was done together with half content of Green Diesel produced in a U.S.A. biorefinery plant with the Ecofining eni/Honeywell-UOP technology and half of high quality gasoil from the Sannazzaro refining plant. The Italian commercial scale production of green diesel was therefore started in April 2014 at the ENI biorefinery located in Porto Marghera. The ultimate qualification of the new fuel as a valid alternative to fossil F76 was due by the end of June 2015 with the final trials on board of submarines and of major combatant ships such as the CAVOUR and the ORIZZONTE Class ones.

BIOFUEL FRACTION AS AN ALTERNATIVE TO 100% FOSSIL FUELS FOR SHIPPING

Maritime transport is vital to the world's economy as over 90% of world's trade is shipped by sea. Furthermore, this remains the most cost-effective and environmental efficient/sustainable means for global shipping of goods and raw materials. Maritime shipping contributes to the global CO2 emissions with a share of about 3%[1]. In fact, shipping 1 ton of goods for 1 km by sea produces only 30% of CO2 emissions of the emissions produced over the same distance by land transport and less than 1% of those produced by air transport. On the contrary, the lack of regulations in this sector has pushed shipping companies towards wide use of heavy fuel oil, which is cheaper than refined fuels but definitely more polluting. A recent report of the EU Environmental Agency (EEA) shows that greenhouse gas emissions produced by ships leaving EU ports increased by almost 35% between 1990 and 2010.

In 2008[2], the last revision of the MARPOL convention, implying the amendment of Annex VI[3], allowed the Marine Environment Protection Committee to impose more stringent limits to the emission of the main air pollutants contained in ships exhaust gasses, like Sulphur oxides (SOx) and Nitrous oxides (NOx), and to prohibit deliberate emissions of ozone depleting substances, especially in the so called Emission Control Areas (ECAs)[4].

Under these premises, EU's and IMO's efforts currently focus on the regulation of this sector and on exerting growing pressure on oil companies to carry out research on new and efficient alternative maritime fuels. Shipbuilding industries are also developing new eco cost-efficient technologies and devices. Among the alternative fuels, advanced biofuels are a very promising option.

Although the largest biofuel markets are currently the United States and Brazil, which continue having the largest share of biofuels in their transport fuel consumption than any other country, it is foreseen that the use of biofuels in the EU will more than triple in 2035. In particular, advanced

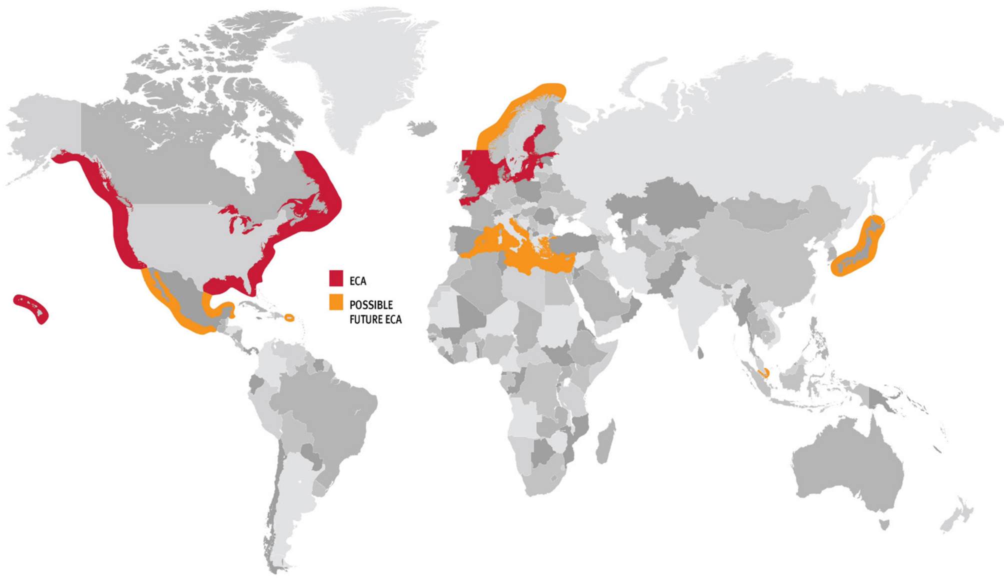

Figure 2. ECAs

[1] About 600-800 Million Tons CO2 per years
[2] In force the 1st July 2010.
[3] The Annex VI regulates the prevention of air pollution from ships
[4] As of 2011 existing ECAs include the Baltic Sea (SOx, adopted 1997; enforced 2005) and the North Sea (SOx, 2005/2006 adopted July 2005; enforced 2006), the North American ECA, including most of US and Canadian coast (NOx & SOx, 2010/2012) and the US Caribbean ECA, including Puerto Rico and the US Virgin Islands (NOx & SOx, 2011/2014).

biofuels offer the prospect of increasing biofuels supply while reducing or eliminating sustainability concerns. The world energy outlook shows that advanced biofuels will become available at the commercial scale in 2020 approximately and that the leaders in the sector will be USA, Europe, China and Brazil. Biorefineries for advanced biofuels production offer also a huge occupation opportunity in the so called green economy business. Besides the environmental aspects, there are other significant factors driving the need and the opportunity for adopting alternative fuels:

- oil prices experiencing long-term upward price pressure;
- sharp increase of diesel engines total ownership costs due to the higher operational expenditures incidence;
- governments willing to reduce the dependence from petroleum, by pursuing new energy solutions and diversification through benefits and incentives for the use of low carbon energy sources.

In recent years, this sector has experienced a huge growth due to the development of many technological and innovative solutions, methods and ideas. Nevertheless, the high production costs still remain the key limiting factor for a large scale market. Therefore, the use of a certain percentage of sustainable biofuels in the conventional fuel, which is the same scheme currently in force for the road transportation fuels, seems to be the right answer for the future. In the case of road transportation, the EU fuel quality directive sets a maximum target of 7% of FAME (Fatty Acid Methyl Ester) in the diesel fuel. FAME is not a drop-in replacement for marine gasoil because of its low oxidation stability. In the maritime transportation, only the replacement of fossil fuels, such as the ECOFINING biofuel that doesn't need any modification in the equipment nor any change in the logistic procedures, should be allowed. Reductions in the production costs, the development of scalable production systems and the availability of refining and distribution capacity are essential elements for the long-term viability of this promising industry. While ground transportation is slowly changing its attitude toward the use of these new products, the maritime sector still remains anchored to the past.

History has shown that the maritime sector can easily adopt new fuels should the right incentives be in place. For instance, in the period between 1914 and 1922, the percentage of vessels using oil rather than coal in their boilers increased from 3% to 24%. The same thing could happen today if there is a shift in fuel prices and energy efficiency through technological improvements, adequate investments in demonstration-scale testing and optimization, systems integration, and production scale. What can the military do to support this process? In spite of the absence of tangible military benefits, the use of alternative fuels could bring important strategic paybacks at the national level. In fact, if national Defenses encourage early production experience, government decision makers, and technology developers, then investors would obtain important information about the technical, financial, and environmental performance of various alternative fuel options. If favorable, that information could lead to a commercial alternative-fuels industry producing significant amounts of fuel in our own countries. Once established, a large commercial and competitive alternative fuel industry would weaken the ability of the Organization of the Petroleum Exporting Countries to exert its powerful influence on the fuel market. Lower world oil prices would yield economic benefits to all fuel users – both civilian and military. Lower prices would also decrease the incomes of "rogue" oil producers, and thereby would also likely decrease financial support to large terrorist organizations. Thus, military services can provide a significant support in the development, the qualification and the certification processes as well as in the evaluation of the performance of these new products. As the Navies historically are the precursors of new technologies, they can perfectly fit this job. As ships' turbine and diesel engine technology, fuel science and refining have evolved throughout decades, the specifications of military fuels have developed, too. Today, all fuels used by the military forces must meet specifications that promote handling as well as safe and reliable use in the high-stress environments associated not only with combat but also with combat training. They are: the minimum acceptable flash point, thermal stability, lubricity and viscosity, freezing point and vapor pressure, storage stability, energy density and last but not least worldwide availability. Two types of alternative fuels have emerged as the nearer-term candidates for military applications:

- Fuels produced through a method known as Fischer-Tropsch synthesis[5];
- Fuels produced by processing vegetable oils and animal fats with hydrogen[6].

Betting on this latter method, the Italian Navy has recently started a collaboration with our National Oil Company – ENI – in the field of new generation bio-fuels. In 2009, ENI and the American Honeywell UOP, developed a state-of-the-art hydrotreated drop-in fuel, called Green Diesel, by using vegetable oils and tallow transformed. To achieve this, ENI and UOP have patented a specific and viable technology, namely ECOFINING. Biomass affords the possibility of fuel production at lifecycle greenhouse gas emission levels that are significantly below those produced by conventional fuels. This happens because the carbon dioxide released into the atmosphere during both liquid fuel production and combustion in a ship, vehicle or aircraft is compensated by the removal of about the same amount of carbon dioxide during the growth of the biomass used to make that fuel from the atmosphere. However, achieving these beneficial low lifecycle greenhouse gas emissions requires that the biomass feedstock is produced in a manner that does not cause a large direct release of greenhouse gases and that does not displace food production. High-scale commercial production of Green Diesel started in the ENI bio-refinery located in Venice in April 2014. This industrial plant is the first oil refinery in the world to be converted into a bio-refinery producing 300 000 tons of Green Diesel per year. The feedstock for the Green Diesel plant is composed of palm oil from certified sustainable supply chains. On average, 10 000m^2 of oil-palm crops can produce 5m^3 of Green Diesel. ENI will go ahead with the use of the so-called "third generation feedstock" and at present it has set a new micro-algae testing plant in Gela (south of Sicily). In this large pools facilities, algae are fed by CO_2 coming from exhausted gasses, with obvious benefit for human health. The area required for algae cultivation is estimated to be significantly smaller than any other biomass source. On average, 10 000m^2 of algae cultivation can potentially produce 50m^3 of Green Diesel per year.

In 2012, ENI and the Italian Navy started a collaboration for producing a new brand of "Green F76", which came out by blending 50% of Green Diesel and 50% of fossil F76. This fuel mix is an ultra-low sulfur blend, which is less dense than F76 and

Figure 3. ENI algae pilot plant in Gela (Sicily).

[5] The FT method can be applied to a variety of carbonaceous feedstocks, including natural gas, coal, and biomass. The FT method begins with the conversion of the feedstock material to a gas containing carbon monoxide and hydrogen. This gaseous mixture, which is often referred to as synthesis gas, is next sent to a chemical reactor, where it is converted to a mixture of liquid hydrocarbons via a process known as FT synthesis. These liquid hydrocarbons can be processed into fuels that can substitute for petroleum-derived transportation fuels.

[6] Vegetable oils or animal fats are first catalytically treated with hydrogen for the purpose of removing oxygen. This step yields straight-chain hydrocarbon molecules. These molecules are then cracked and rearranged to yield a mix of straight-and branched-chain hydrocarbon molecules similar to those found in petroleum-derived jet and diesel fuels. This mixture can be distilled to yield a synthetic diesel fuel for automotive use, a synthetic jet fuel, and, if desired, a synthetic naval distillate.

which comply with the most stringent EU emission rules. Over its entire life cycle, it grants a 50% higher potential carbon footprint reduction compared to F76, depending on the feedstock used for the Green Diesel premium blending component production. High cold weather performance of this blend makes the eco-fining process suitable for producing high quality jet fuel. The Green F76 certification process was successfully completed on January 29th 2014, when the Italian Navy OPV FOSCARI, the first military ship in Europe, sailed by using this blended fuel. A subsequent inspection found the engines to be cleaner than when operating on straight fossil F76. NATO's standard specification protocol on Avio fuel production, composed of 50% green jet fuel, will be concluded soon with a flight demonstration.

Fuel Properties	Final blend		Blending Components	
	AUTOMOTIVE DIESEL (EN 590)	NAVAL DIESEL F76 (STANAG 1385/6)	FAME (EN 14214)	GREEN DIESEL HVO (CEN TS15940 Class A)
Sulfur content (mg/kg)	<10 (0,001% m/m)	≤ 10000(1% m/m)	10 (0,001 % m/m)	<1 (0,0001% m/m)
Oxygen content (%)	0	0	11	0
Cetane Number	> 51	>40	> 51	> 70
FAME content (%v/v)	≤ 7	≤ 0,1%	100	none
Flash point (°C)	> 55	≥ 60	> 101	≥ 60
Density at 15°C (kg/m³)	820÷845	800÷880	860÷900	770÷790
Cloud Point (°C)	-5	≤ -1	-5/15	-30/-15
LHV (MJ/kg)	43	42	38	44
Energy dens. (MJ/l)	36	35	33,5	34,5

Table 1. Fuels properties comparison

ENERGY EFFICIENCY

The promising Italian's Navy Green Fleet will consist of a new class of vessels designed with the most innovative eco-efficiency criteria, but also of vessels already in service, after the implementation of specific energy qualification actions that will increase their fuel efficiency such as:

- solid state lightning;
- electromechanical actuators replacing the conventional hydraulic ones for fins stabilizers and rudders;
- stern flaps and propeller coatings;
- energy dashboard;
- energy savings behavior;
- hybrid propulsion;
- alternative fuels.

It is worth mentioning that the new measures approved in 2011 by IMO, and integrated by the MARPOL Annex VI in 2013, aimed to stimulate steady innovation and technical development of all the components influencing the energy efficiency of a ship since its design phase. The amendments to MARPOL Annex VI Regulations for the prevention of ships' air pollution, which entered into force on 1st January 2013, include a new chapter 4 to Annex VI on Regulations on energy efficiency for ships. The aim is to make the Energy Efficiency Design Index (EEDI) mandatory for new ships and the Ship Energy Efficiency Management Plan compulsory for all ships. The Italian Navy's approach to ships eco-design is synthetized in the following Fuel Efficiency Design Index (FEDI) formula devised by the author.

$$Fuel\ Efficiency\ Design\ Index = \frac{CO_2\ EMISSION}{\Delta_{Full\ load} \cdot Ship\ Range}\left[\frac{gr}{ton \cdot NM}\right]$$

Fuel Efficiency Design Index (FEDI) formula

The following tables illustrate an example of fuel efficiency increasing over the years, for different Italian Navy's Vessel projects.

FEDI	
[gr CO_2/ton NM]	
MAESTRALE ('80)	56
FREMM (TODAY)	43
PPA (2016-2050)	36

Table 2. FEDI for Italian Navy's past and recent shipbuilding projects.

FEDI		
[gr CO_2/ton NM]		
MAESTRALE ('80)	56 →	38
FREMM (TODAY)	43 →	29
PPA (2016-2050)	36 →	24

Table 3. Benefits on FEDI through the use of 50/50 Fossil F76/ECOFINING biofuel for Italian Navy's past and recent shipbuilding projects.

[gr CO_2/ton NM]	
PERRY (70')	87
MAESTRALE (80')	56
ALVARO DE BAZAB (TODAY)*	36
TYPE 45 (TODAY)*	45
FREMM (TODAY)	43
PPA (TODAY)	36
TYPE 26 (FUTURE)*	36
F-125 (FUTURE)*	39

Table 4. FEDI for various shipbuilding projects (open source data), based on diesel engine propulsion.

LIQUFIED NATURAL GAS (LNG)

LNG is a viable alternative fuel for naval application. It will be further evaluated for a future application on board, since its introduction affects multiple military fields such as doctrine, organizations, training, material, leadership and education, personnel and facilities, and since it requires a cultural change and a new mind set. While nowadays the construction of new LNG fuels ship doesn't pose any particular doubts for the national shipbuilding sector, the Italian Navy started an unprecedented pilot project for the dual fuel. This mixes natural gas and gasoil, converts the gasoil currently fuelled diesel engines for propulsion and electric power generation on board of an auxiliary vessel employed for lights, and it buoys transport and maintenance, similar to a mid-size commercial Ro-Ro ship. The activities, based on a gasoil fuelled diesel engine evolution concept (which is quiet common in the automotive sector), include the installation of natural gas fueling kit for each diesel engine and of natural gas system composed of a LNG cryogenic tank, as well as the relevant natural gas vaporization, pressure and mass flow regulation equipment.

The above mentioned pilot project intends to make an existing technology already applied in the automotive sector (where every driver can, at his convenience, ask for natural gas system installation on his originally gasoil fuelled diesel engine car) available for the maritime sector. This will be done through the definition and the adoption of all the necessary technical precautions and safety measures in addition to those that are in place for road transportation. Reduction could be gained with an initially low capital expenditure for the natural gas tank and the diesel engine natural gas fueling kit installation, both items complying with the existing rules and safety standards of the automotive sector, significant operational expenditures, pollutants and green-house gasses emissions. The expected outcomes of this pilot project are repeatability, cost-effectiveness and a high level of safety and

Figure 4. LNG fueling system installation on board of I talian navy's Ro-Ro vessel.

integrity of the engines running on natural gas. This would help accelerating the LNG use as a fuel in the maritime transport sector by making the rules and safety standards necessary for the LNG use on board of the existing fleet available to ship owners. This would help avoiding unbearable capital costs and business risks for the on board diesel engines substitution. The completion of the above mentioned project is a milestone towards the first LNG combatant ship construction.

CONCLUSION

In conclusion, the Italian Navy is contributing to the fight against pollution and it is determined to continue giving its contribution in the future. However, challenges in this new field require strong common commitments as well as a radical transformation of the energy system, which should not only involve all the European Armed Forces and the energy sector, but which also requires a complete overhaul of the society.
The commitments of the Italian Navy for the future are the following:

- by the end of this year our Fleet will be certificated with the new Green F76, classified as "Green" and fully compliant with the most stringent EU emissions' rules. The Italian Fleet will reduce the oil dependency and the relevant dangerous concentration of noxious gases emissions up to 50% by 2030;
- by supporting the Great Green Fleet US Navy's initiative, the Italian fleet is going to conduct a large naval demonstration in the Mediterranean Sea by using up to 50% of the total energy coming from alternative fuels by 2016;
- the construction of LNG major units with multifuel capacity (Green F76, fossil F76 and LNG).
- from now on, all other new constructions will be fitted with efficient green eco-driving propulsion plants;
- on-board systems and devices will be conceived by using state-of-art technologies aimed to reduce ship's functioning energy.

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Exercise "Wolverine Hammer": **Forging Civil-Military Interoperability in Latvia**

Captain Wayne J. Dahl

This article highlights how Operation "Wolverine Hammer" has likely served as a foundational step to critical infrastructure protection in Latvia and as a noteworthy move towards bolstering the capability of a critical shortfall to Alliance security. This civil-military training exercise at the Plavinas Hydroelectric Power Plant can serve as a model for other NATO Allies to follow. If the Latvian National Armed Forces and civil emergency response organizations can effectively tap in-to the experience of the NATO ENSEC, the momentum gained during "Wolverine Hammer" has the power to gain steam and boost energy security in the region and for the Alliance at large.

INTRODUCTION

Every summer, the Latvian National Armed Forces welcome Soldiers from the Michigan Nation-al Guard, Latvia's state partner in the United States, to conduct military-to-military training events. The summer of 2014 was no different as nearly 100 Soldiers from the Michigan Army National Guard (MIANG) arrived to train side-by-side with the Latvian Zemmessardze (Home Guard). What differed from previous events is instead the focus of this summer's exercise, Wolverine Hammer. Its goal was to hone the skills of US and Latvian military police during civil support operations, such as establishing police checkpoints or assisting in maintaining security cordons in support of local police. Also, the US and Latvian Military Police leaders sought to improve the interoperability of these military police units. While local media reported on the field training exercises, one of the most significant civil-military interoperability events was largely overlooked. Therefore, the aim of this article is to discuss the Wolverine Hammer exercise by highlighting its significance and the results obtained.

Aerial View of Plavinas HPP on the Daugava River

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BACKGROUND

The Latvian Security Police chose the Plavinas Power Plant for the Wolverine Hammer exercise because this is an indispensable component of the Latvian energy system. Plavinas is the largest hydroelectric power plant in Latvia and the second largest hydroelectric power plant in the European Union—based on installed capacity, which is 893.5 Megawatts. Moreover, a great amount of capital has been invested in this facility since its construction in 1965. The power plant's hydroelectric turbines have been routinely overhauled or reconstructed to increase electrical output and energy efficiency over the last two decades. As a result of this investment, Plavinas' ten hydroelectric turbine sets provide 1501-2000 Gigawatt hours (GWh) per year. This output is significant when one considers that one hundred and forty nine small Latvian power plants currently provide a combined output of 60 GWh per year. Not only is the Plavinas facility essential to Latvian electrical production, but hydroelectric power is also a critical part of Latvia's energy mix. The series of hydroelectric power plants in Latvia provide two-thirds of the country's electricity. Additionally, hydroelectric and other renewable energy sources became more important to Latvia's energy mix after the closure of the Ignalina nuclear power plant in Lithuania.

Thus, on August 20, 2014, on the banks of the Daugava River, near the town of Aizkraukle, in Latvia, representatives from several civil and military police agencies gathered to conduct a critical infrastructure protection exercise at the Plavinas Hydroelectric Power Plant (HPP). The Chief of Security for Latvenergo, the company that operates the Plavinas Power Plant, the Chief of the Aizkraukle Police Force, the District Chief of the Latvian Security Police, the Anti-terrorism and Critical Site Security Officer of the Latvian Security Police, a Battalion Commander from the Latvian Zemmessardze, a Military Police Officer from the Latvian Land Forces Brigade,

Plavinas HPP

the Company Commander of the 46th Military Police Company (MIANG), and the physical security and antiterrorism officer for the 177th Military Police Brigade (MIANG) all participated in the infrastructure protection exercise at the Plavinas facility. These civilian and military police leaders met to conduct a "table top" coordination exercise as representatives from each agency. They employed their standing operating procedures in response to sixteen various threat scenarios to the Plavinas Hydroelectric Power Plant. The role of the Michigan Army National Guard officers was to create and inject the threat scenarios for the security and police agencies to react to, assess these responses, and provide recommendations for improvements. The threat scenarios ranged from minimal physical security threats, such as an active shooter to catastrophic terrorism threats like Vehicle-Born Improvised Explosive Devices (VBIEDs) and Chemical, Biological, Radiological, Nuclear and high-yield Explosives (CBRNE) attacks against the Plavinas facility. In so doing, local and national leaders sought to utilize the Plavinas infrastructure protection exercise to streamline and synchronize the standing operating procedures of the various Latvian security organizations, develop more effective communication mechanisms between these agencies,

[1] The Michigan Army National Guard first proposed an infrastructure protection exercise, but it was the Latvian Se-curity Police that conducted the critical site selection.
[2] Latvenergo, Hydro Power Plants, accessed on October 6, 2014, http://www.latvenergo.lv/portal/page/portal/english/latvenergo/main1/about_latvenergo/energy_production/hidroelektrostacijas/

and foster engagement between civil and military police agencies and between national and local security organizations.

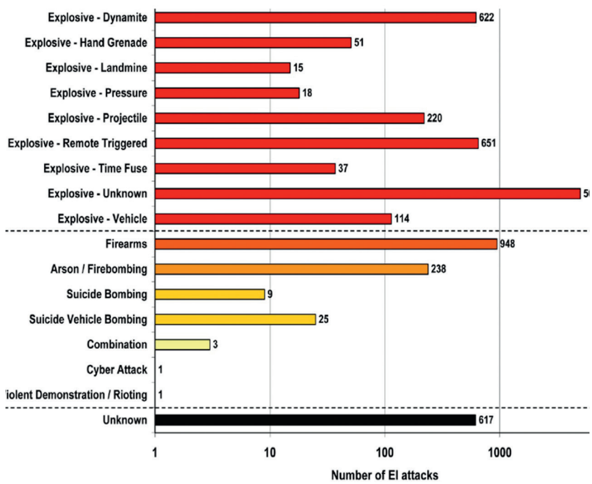
RESULTS

After responding to the sixteen threat scenarios, the exercise participants identified communication infrastructure as their critical shortfall. The current communication hierarchy between organizations may not be reliable as the various agencies utilize differing communication systems. In the aftermath of a natural disaster or terrorist attack, interagency communication is critical. Therefore, the leaders of the police agencies agreed to develop a communication plan that provides communication redundancy in the event of failure of the primary communication method.

Conversely, during the exercise, it became evident that Latvian civil and military police agencies do have adequate standing operating procedures to react to terrorist and physical security threats—once they occur. The operating procedures of these agencies already have coordination mechanisms built in, which resulted in timely, streamlined coordination during the training exercise. Thus, interagency synchronization, during the "table-top" portion of the event, was effective and the various agencies were able to agree on command and control structures and on the agency taking the lead during different threat scenarios. Additionally, the various agencies came to an agreement on rules-of-engagement during varying threat responses. Beyond exercising command, control, and communication methods, the Plavinas HPP exercise was truly beneficial as a civil-military engagement activity. Prior to the exercise at Plavinas, many of these key leaders and groups had not coordinated face-to-face.

SIGNIFICANCE

Energy security has become a watchword of the contemporary security environment. However, when most leaders speak of energy security, it often seems they are referring to major investment to diversify energy resources or infrastructure against energy blackmail or unreliable energy suppliers. This concern is not unwarranted, especially in light of Gazprom's warning to the European Union concerning possible gas disruption to Ukraine and subsequently to the EU. It is in this context that on the 24th September 2014 Russian Energy Minister, Aleksandr Novak, affirmed during an interview with the German newspaper Handelsblatt that the EU would face repercussions if it supported Ukraine with natural gas deliveries. He stated that "the contract does not allow for re-exports. We hope that our European partners will adhere to the agreements. Only this can guarantee uninterrupted supplies to European consumers." Yet, nations face myriad threats to energy security and one of the greatest energy security threats is to physical infrastructure itself. According to the Energy Infrastructure



NUMBER AND TYPE OF EI ATTACKS-SINCE 1980
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Attack Database, compiled and maintained by the Center for Security Studies, ETH Zurich, almost 70 percent of the 9,930 energy infrastructure (EI) attacks committed from 1980 until 2011 were perpetrated by non-state actors using some form of explosives (see Figure 1). Moreover, 80 percent of these attacks were correlated with ongoing conflicts within the nation or region. For example, on August, 5, 2008—some days before the 2008 Georgia War broke out, the Baku Tbilisi Ceyhan Pipeline was attacked. The PKK assumed responsibility for this incident. In spite of this, some U.S. intelligence officials assert that the explosion may have been the result of a cyber-attack, which deactivated safety protocols and increased pipeline pressure until it caused an explosion. Additionally, one U.S. intelligence official named Russia as the primary suspect in this cyber-attack and sabotage. Thus, NATO Allies may be susceptible to energy security attacks as part of a hybrid attack in the future. Yet, NATO is not without a response. During the 2010 Lisbon Summit, Alliance members agreed that protecting all aspects of the populace, including protecting energy infrastructure, was part of the Alliance's responsibility and that NATO must develop and maintain capabilities to provide this protection.

> The Plavinas HPP infrastructure protection exercise addressed one of the greatest threats to energy security that the Alliance is specifically tooled to affect.

It is worth noting that the Plavinas HPP infrastructure protection exercise addressed one of the greatest threats to energy security that the Alliance is specifically tooled to affect, namely infrastructure attacks. However, the Plavinas event was more than a military exercise. This critical infrastructure protection rehearsal created an environment that allowed civil police organizations to take the lead in planning and executing response to kinetic attacks against critical infrastructure. Responding to hybrid threats (civil disturbances or terrorist attacks) often falls under the purview of the Ministry of Interior or police organizations, while the military usually plays a supporting role. Yet, it seems that it is often difficult for the military to take a supporting role during crisis response operations because military leaders are regularly more-than-willing to commit their considerable manpower and equipment resources against emergent problems. Additionally, the support staffs that military commanders possess often overpower the planning capabilities of many civil organizations. Accordingly, the Plavinas exercise was also significant because it allowed Latvian civil and military agencies to establish their roles and responsibilities in response to varying threats to critical infrastructure.

FUTURE IMPLICATIONS

The Plavinas exercise was a foundational step to critical infrastructure protection in Latvia and it can serve as a model for other NATO allies to follow as an initial leaders' rehearsal for larger, follow-on training events. After the completion of this exercise, the civilian and military police representatives agreed to conduct an infrastructure protection exercise with forces from each agency—akin to "Blackout 2014," which occurred in Prague on February 26, 2014. A large-scale infrastructure protection exercise will more effectively stress the communication infrastructure between civil and military police units and will test the interoperability of these agencies, and their standing operating procedures, when these organizations are separated by time and distance—while working through the friction of cooperating during a crisis situation. In addition to civil and military police agencies, local fire departments and environmental agencies will be invited to participate in Latvia's next infrastructure protection exercise. The gains made during the Plavinas training exercise can also be expanded with the inclusion of other regional Allies, such as Lithuania or Estonia, in future energy security events. Additionally, the Latvian civilian and military police agencies suggested protecting a natural gas facility during future infrastructure protection exercises. This venue may be more relevant to Allies or partners that are highly dependent on natural gas imports.

As the Latvian civil police organizations and National Armed Forces begin planning the next phase of interoperability exercises in the sphere of infrastructure protection or disaster response, the NATO Energy Security Center of Excellence (ENSEC COE) is one agency that should not be overlooked. As a NATO COE, the ENSEC COE has been specifically established to provide expert advice as well as tactical and operational learned lessons concerning energy security related issues—including infrastructure protection and analyzing energy security risks. This COE also has access to the combined knowledge and experience of academia, industry, and NATO military forces. The ENSEC COE has played a significant role in the planning and execution of several significant multinational and NATO exercise—including ENERGEX 2012, Steadfast Jazz 2013, Sabre Strike 2014, Ukrainian-led Rapid Trident 2014, and Baltic Host 2013 and 2014. During these events, Subject Matter Experts (SMEs) from the COE not only aided in the planning process, but also created and injected several energy security related scenarios into the training exercises. These SMEs also support NATO's annual Crisis Management Exercise. Although the Crisis Management Exercise is executed at the NATO Headquarters and Strategic Command Level, without operational forces, the SME's expertise and understanding of common problems and effective solutions are valuable to any NATO member or partner nation planning or executing a table-top crisis response or infrastructure protection exercise. For example, in October 2014, the ENSEC COE organized and hosted the Table Top 2014 exercise on the 'Protection of Critical Energy Infrastructure.' During this event, senior civil emergency planners and crisis management officers from NATO nations and Istanbul Cooperation Initiative partner countries responded to various threat scenarios including cyber vulnerabilities to port facilities and energy infrastructure. Furthermore, the ENSEC COE participated in Vigilant Guard 2014—a US-led disaster-response exercise focused on assessing military readiness in supporting civil agencies during crisis response operations. Therefore, requesting the support of the ENSEC COE would almost-certainly prove invaluable during the planning and execution of Latvia's next civil-military infrastructure protection exercise as a follow-on training event to the Plavinas HPP exercise.

> NATO Allies may be susceptible to energy security attacks as part of a hybrid attack in the future

CONCLUSION

Although the Plavinas event was not highly publicized, it was a noteworthy step towards bolstering the capability of a critical shortfall to Alliance security. If the Latvian National Armed Forces and civil emergency response organizations can effectively tap into the experience and expertise of the NATO ENSEC SMEs, then the momentum gained during the civil-military exercise at the Plavinas HPP has the power to gain steam and boost energy security in the region and for the Alliance at large.

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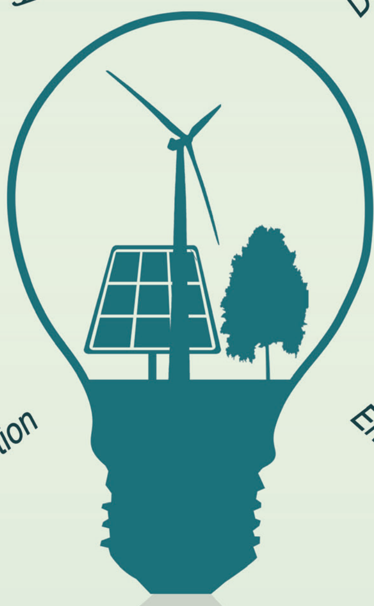

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