Energy Optimization

A combat multiplier

by Capt Anthony Pollman

>Capt Pollman enlisted in the Marine Corps in 1994. He has deployed several times and is currently serving as the Deputy Director, ANSF Communications, Combined Security Transition Command, Kabul, Afghanistan.

After 12 years of war, in the midst of a drawdown, in the aftermath of sequestration, and with an uncertain future, the Marine Corps has entered into a natural period of self-reflection. A recent *Marine Corps Gazette* online survey questions one of our core competencies:[1]

> The amphibious forcible entry capability is no longer a critical requirement for the Nation. Agree or disagree? Vote!"[2]

As we reflect on our past, present, and future roles and contributions, it is only fitting that we ask such fundamental questions.

It is also fitting that we take a moment to compare our actual organization with our ideals. What is the Marine Corps? We like to view ourselves as a small (or middleweight, if you prefer), fast, lethal, austere, and elite expeditionary force who operate in remote, harsh environments—modern-day descendants of Spartan culture.[3] But how does this ideal compare with reality?

In reality, while we have become more lethal over the past 10 years, this lethality has come at a cost. We have become anything but Spartan. Exponential equipment and capability growth has made us much heavier and much less agile. This equipment growth has come with a commensurate growth in fuel and energy consumption, which ties us to long and vulnerable logistics trains. Our enemies have recognized and successfully exploited this vulnerability.[4]

The Commandant of the Marine Corps also recognized this vulnerability and in August 2009 declared energy a top priority.[5] Then, in October 2009, the Commandant created the Expeditionary Energy Office (E^2O).[6] E^2O's mission is to analyze, develop, and direct the Marine Corps' energy strategy in order to optimize expeditionary capabilities across warfighting functions.[7] [8] As part of this mission, E^2O also seeks to change our individual and organizational assumptions and ethos related to energy. In addition, E^2O strives to increase energy efficiency and find suitable energy alternatives. In short, E^2O is a change agent that works to strike a balance between lethality and agility—to change energy from a vulnerability to a combat enabler.

Marines receive GREEN training onboard the* Gunston Hall.** ***(Photo courtesy of DVIDSHUB.)

Yet, as members of the E^2O staff engage Marines at all levels in the Operating Forces and Supporting Establishment, there is a persistent notion that its mission is about politics, saving the environment, or "going green."[9] This article intends to help change that notion and illustrate how energy optimization is, in fact, a combat multiplier.

Energy as Vulnerability

E^2O's seminal document, *The Marine Corps' Expeditionary Energy Strategy and Implementation Plan* has its roots in the long war.[10] Nothing illustrates energy as a critical vulnerability—and makes the case for energy optimization and alternatives—like data gathered from the wars in Iraq and Afghanistan. As a critical vulnerability, ultimately the price of our energy addiction (in war) can be measured in Marine casualties. Again, this dependence is tied to systems that increase our lethality but

that are energy hungry—so let's begin by outlining some of this growth.

In 2001, a Marine infantry battalion had 64 HMMWVs. The average battalion in Afghanistan in 2010 had 173 MRAPs or M-ATVs (MRAP all-terrain vehicles). In addition, the hardened vehicles of 2010 were about 75 percent heavier than regular HMMWVs, and as a result were about 30 percent less fuel efficient.[11] Consequently, Marine infantry companies in 2010 used more fuel than infantry battalions did just 10 years prior.[12]

Over the same decade, unit radio assets increased 250 percent and computer assets increased 300 percent.[13] This change prompted rapid growth in the demand for electricity and battery power. In the late 1980s, the Marine Corps' total power generation capability was 65 megawatts (MW), enough to power about 54,000 average American households or a city just over twice the size of Jacksonville, NC, circa 2010.[14] The Marine Corps' total power generation capacity grew to 303 MW by 2010 (enough to power about 235,000 average American homes or a city slightly larger than Kansas City circa 2010).[15] During Operation Enduring Freedom, Marine Corps units forward used 64 MW of capacity. This capacity was enough to provide 3.4 kilowatts (kW) of continuous power for every Marine deployed.[16] About 60 percent of this power generation was used to run environmental control units to keep electronic equipment operating properly.[17]

As a result of these growths, in 2011 the Marine Corps consumed more than 200,000 gallons of fuel per day in Afghanistan.[18] And, each of the more than 100 Marine forward operating bases (in Afghanistan during the same period) consumed at least 300 gallons of diesel fuel daily.[19] This fuel had to be trucked over long distances through difficult and dangerous terrain, often in challenging weather conditions. Convoys were exposed targets that increased mission risk and diverted combat power to protect them. In addition, many fuel convoys had to come from Pakistan and were thereby susceptible to changing political climates.[20] Although the equipment changes outlined above had tangible benefits, they carried the unintended (but foreseeable) consequence of tying us to long and vulnerable logistics chains. During a given 3-month period, 6 Marines were wounded or killed hauling fuel to bases in Afghanistan during 299 convoys. This equates to 1 Marine casualty for every 50 convoys.[21] [22] [23]

These casualties highlight how energy—particularly fuel and batteries transported via convoy—can be a critical vulnerability. These casualties make a strong and poignant case for a return to greater austerity on the battlefield. Intuition and the available data suggest that there may be an optimal balance between increased capability and efficient use of limited resources (between gain and risk in the warfighting sense). When properly balanced, a situation arises in which capabilities are gained with minimal negative trade-offs. When this balance is made, energy becomes a true combat multiplier. We failed to find that balance in Afghanistan and Iraq. E^{2}O is working to strike that balance as we transition to the postwar years.

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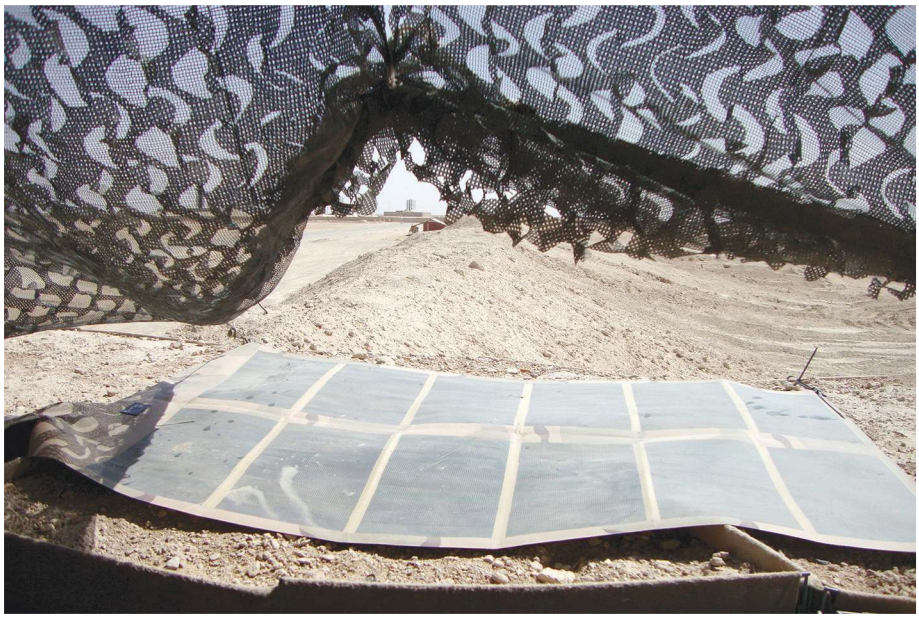
Energy as Combat Multiplier

Most Marines tend to think of capabilities lost when discussing energy optimization and efficiency. A more thoughtful investigation reveals that energy optimization can be equivalently thought of as a combat enabler or combat multiplier. Optimized energy is about balance, promising the potential of maximizing our lethal capabilities for a minimum energy input. This balance is necessary in any resource-constrained environment (all environments are ultimately resource-constrained), to include warfare. At a very fundamental level, warfare is about choosing when, where, and how to apply a minimum amount of energy, in many different forms, to achieve a desired result. And, it could be argued that the side that does so the best is likely to prevail. The following paragraphs outline how energy optimization can be a combat multiplier at the tactical, operational, and strategic levels, but first we must take a moment to clarify what energy optimization means.

Energy optimization is simply using limited resources in the most intelligent and efficient way possible. Generator data, gathered by the E^{2}O staff, presents an excellent example. The standalone generator strategy of providing power provides no flexibility in matching load variations. Data taken from units in Afghanistan reveal that low loads on generators are the norm (generators have less than 50 percent load, 70 percent of the time), with peaks tied to changing outside temperature for billeting spaces and tied to equipment usage for combat operations centers.[24] As already mentioned, about 60 percent of our power generation in Afghanistan was used to run environmental control units to keep electronic equipment operating properly. Night and day temperatures vary, resulting in natural demand peaks and valleys. Our generators do not have the ability (the control systems) to provide just the energy needed—although these control systems are common in commercial applications. Marine operators have no choice but to scale their power source to the peak demand (no matter how little time that amount of power is needed) in order to ensure adequate power is supplied when suddenly demanded and to prevent the power outages that could result. This presents three problems: (1) poor fuel efficiency, (2) increased generator maintenance, and (3) decreased generator lifespan due



SPACES harvesting energy to recharge batteries. *(Photo by Maj Sean Sadler.)*

to constant runtime for only limited energy demand.

To exacerbate the problem, temperature control isn't always needed, yet Marines often leave the environmental control unit on, continuously cooling in the summer and heating in the winter (sometimes to unnecessary and often uncomfortable temperatures, or even cooling/heating empty shelters).[25] Part of this tendency is due to lack of feedback (a thermostat) on many tactical environmental control units (they just don't realize how cold or hot a space really is).[26] Part of it is failure to fully appreciate how this wastes resources, creates a demand for unnecessary fuel, and ultimately puts Marines' lives at risk, and then modifying their behavior accordingly.

E^2O works to identify problems like these and find creative solutions across the combat integration spectrum (doctrine, organization, training, materiel, leadership, personnel, and facilities (known as DOTMLPF)) to optimize energy, eliminate this kind of waste, reduce convoys, save lives, and win wars. From this example, it is not much of a leap to see how energy optimization can be a tactical combat multiplier.

At the tactical level, optimized energy equates to greater endurance and agility, more combat units focused on the enemy (more "tooth," less "tail"), more options for the commander, and less risk. Through a combination of enabling technologies, training, and Spartan ethos, optimized energy promises to increase the length of time that a deployed unit can operate without resupply of liquid fuel and batteries. As endurance increases, the number of logistics convoys decreases. Fewer logistics convoys results in less exposure to unnecessary risk. With fewer convoys to protect, the commander is also free to divert and focus combat power on the enemy or utilize this power to perform various other missions. Finally, freeing the commander from the "tether of energy" results in increased agility and speed. These effects, taken in combination, serve to illustrate how optimized energy is a tactical combat multiplier.

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The SPACES solar battery charger is an excellent example of this logic in action.[27] As part of an E^2O effort, training was conducted and solar panels were issued to combat units in Afghanistan.[28] These solar panels were used to recharge tactical radio batteries. When properly utilized and maintained, these solar panels drastically reduced the number of batteries needed to operate a radio. Small units in Afghanistan were able to patrol for 3 weeks without a battery resupply (normally these units would have needed a battery resupply about every 3 days).[29] The resultant reduction in combat load was a welcome development to the young infantry Marines, not to mention freeing up space for ammunition!

The same logic that enabled us to see energy optimization as a tactical combat multiplier is also directly applicable to the operational level. Fewer convoys are synonymous with greater operational reach. And again, this means fewer units are needed to protect the convoys. These units become available to planners for use elsewhere. Thus, at the operational level, optimized energy equates to fewer logistics restraints and force multiplication, both of which enable longer sustained campaigns.

While the Marine Corps mostly operates at the tactical and operational levels, we should not disregard the strategic implications of energy consumption. At the strategic level, energy optimization is about increased readiness, increased budget stability, and more options for our national leadership. The global energy environment is changing rapidly, and these changes impact our Nation and the way we fight. World energy consumption is expected to grow 40 percent over the next 25 years, with most of that growth dependent on fossil fuels.[30] The United States imports about 57 percent of its petroleum.[31] Supply is not unlimited and countries that are prone to conflict command more than three-fourths of the world's known reserves.[32] In addition, volatile oil prices have a dramatic impact on the defense budget. An increase of $10 per barrel for DoD consumption at 2010 levels is an increase equivalent to the entire Marine Corps' procurement budget.[33] Finally, our home installations rely on the commercial electric grid and gas infrastructure to power their training and support missions that prepare Ma-

rines for combat. Thus, secure energy resources are central to our ability to train and maintain readiness, and any disruption puts our operations at risk.[34] As budgets get tighter, the need for energy optimization for strategic purposes is even more pressing, as expressed in recent remarks by the Commandant:

> Marines, I need you to understand how you fit in on this. . . . I ask you to save every round, every gallon of gas, that you take every single aspect or opportunity in training to get the most bang for the buck . . . we are all in this together. At the end of the day, the Marine Corps has got to be ready to deploy, and that's why our focus is on a high state of readiness.[35]

Institutionalizing Energy Optimization

As discussed, energy optimization is a tactical, operational, and strategic combat multiplier, and has the potential to revolutionize the way we fight. Revolutions are characterized by rapid change and are often driven by innovation. However, absent an existential threat, large organizations resist innovation. Innovation requires change and most people resist disruptions to the status quo. However, in the case of energy consumption, the status quo is a dangerous and possibly untenable option. As we transition out of Afghanistan, it is imperative that we do not forget the lessons of the long war and continue to innovate to create a force less dependent on energy while retaining lethality. It is imperative that we institutionalize energy optimization and advocate for a return to our Spartan roots. Part of our future relevance (as a Service) hinges on our ability to balance austerity and lethality.

Efforts to institutionalize energy optimization and enable the requisite innovation span the DOTMLPF spectrum. The *Marine Corps Expeditionary Energy Strategy* outlines our general way forward.[36] Specific recent efforts include rewriting small portions of *Training and Readiness Manual, Volume I* (*NAVMC 3500.18B, Common Skills*, Headquarters Marine Corps, Washington, DC, May 2012) to incorporate energy ethos; incorporating energy concepts into resident and nonresident profession military education courses; new equipment training; changing requirements and acquisitions instructions to incorporate energy consideration into future equipment decisions; Ex-FOB (experimental forward operating base) to identify promising materiel solutions and partnerships; and partnering with Naval Postgraduate School to perform integrative energy research.

Leadership and education are central to institutionalizing energy optimization and continued progress in energy innovation. In many ways, the institutionalization effort is well on its way. Senior leaders like the Secretary of Defense, the Secretary of the Navy, and the Commandant of the Marine Corps are all in agreement about the importance of energy optimization.[37] However, without every Marine getting involved, this effort can only go so far.

This article is part of a larger effort to educate Marines about the need for and merits of using energy intelligently and efficiently, and to incorporate energy ethos into their daily lives. We must find balance.

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Notes

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28. Fielding, testing, experimentation of GREENS, SPACES, and several other systems were performed by E^{2}O in September 2010 with India Company, 3d Battalion, 5th Marines, on-site in Afghanistan. Quoted data points from conversation between author and Director of E^{2}O, 27 February 2013. Data points validated by E^{2}O technical review of this article (see acknowledgements).

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