Delivering Energy At the Tip of the Spear

THE FUTURE OF POWER PROJECTION

REPORT 2

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It has been said since the time of Napoleon that an Army moves on its stomach. It is probably safe to say those words are as accurate today as they were centuries ago, and will likely remain accurate for centuries to come. Increasingly, however, in today's modern and ever-evolving battle space Soldiers, Sailors, Airman and Marines cannot move at all, not by land, by sea, by air, in space or in cyberspace, without significant amounts of energy (in the form of both liquid fuel and electricity). In fact, the modern war fighter is unable to project power without adequate….and that means significant…amounts of energy. This fact is not new-found information, nor is the fact that delivery of energy to the battle space is an incredibly expensive endeavor, both in financial terms and, more importantly, from the perspective of loss of life and limb.

Now, if delivering energy to the troops was as simple as flipping a light switch or a quick trip to the local service station for a fill-up, the military's energy supply chain would be quite mundane. Unfortunately, our war fighters don't live in that kind of a world. Their activities are often conducted in remote and hostile environments, far from the delivery points for traditional energy sources, and certainly complicated by the enemy, intent to disrupt, destroy and take life.

Challenges related to delivering fuel to the battle space have sparked debate among various experts for years now as to the financial cost of fuel delivered to the war fighter. The debate has raged within the Pentagon over the exact formula to calculate the fully burdened cost of fuel, with DoD specialists and a cadre of outside experts providing various methodologies to arrive at the exact number. The calculation of the fully burdened cost of fuel certainly varies depending on delivery method and location, and can range from tens to hundreds of dollars per gallon delivered to point of use. Yet after years of debate and analysis, we have yet to arrive at consensus as to the true fully burdened cost of fuel delivered down range. And while the analysis drags on, the cost to the taxpayer continues and the toll on lives and families weighs heavier by the day.

This situation brings to mind the sage advice provided by General Colin Powell in his well-distributed "A Leadership Primer". The General warns that excessive delays in the name of information gathering breeds "analysis paralysis". And procrastination in the name of reducing risk actually increases risk. Now, with that in mind, look beyond the simple financial cost of fuel delivered to the front lines…factor in the human costs…the lives and limbs of American warriors who man the convoys that deliver fuel, and by the way…water (hold that thought, as

it becomes important later)…to forward operating bases. The "financial" fully burdened cost of fuel quickly becomes almost irrelevant in comparison to the costs to our war fighters, their families and our country in terms of loss of promise from lives cut short manning the supply lines. Although coming to grips with the true cost of energy delivered to the battlefield is indeed important, we know enough now to draw the most important conclusions:

- Delivering fuel to the front lines is extremely expensive in dollar terms;
- The human cost is absolutely unacceptable.

These two factors alone…following General Powell's approach to decision making…lead to only one conclusion. That is, we have enough information now…and probably did several years ago…to suggest it is imperative to identify, develop, test and deploy self-contained alternative energy systems to the battle space with all urgency.

So, using a bit of General Powell's logic, let's do some math and see what it tells us. Ignoring the up-front capital cost to acquire a diesel generator for a moment, focus simply on the variable fuel cost to operate the unit A 10 kilowatt generator set will typically burn about 1 gallon of fuel per hour. At a cost of $2.60 per gallon, that machine will provide power at a fuel cost of about $0.26 per kilowatt hour…probably not all that bad for emergency backup power.

Now, let's take a look at what it would cost to provide a kilowatt hour of electricity (primary power) from such a unit on the battlefield. I've often heard that it is a general rule of thumb that it takes 7 gallons of fuel to deliver one gallon of fuel to a forward operating base…so let's use that rule of thumb for the moment. At the same $2.60 per gallon, the fully burdened cost to deliver one gallon of fuel to a forward unit would equate to $20.60 per gallon. Now, run that gallon of fuel through our generator. We are now producing electricity at over $2.00 a kilowatt hour. Imagine receiving that electric bill at your home in next month's mail!

So, what's the point of the math? Well…let's compare the opportunity presented here to the billions of dollars that were required to be spent in the rapid development and deployment of the fleet of Mine Resistant Ambush Protected (MRAP) vehicles. On May 8, 2007 Defense Secretary Robert Gates said acquisition of MRAPs was DoD's highest priority, with $1.1 billion earmarked for MRAP in FY 2007. Now, no one is going to deny the best equipment to our warrior heroes who put themselves in harm's way…especially since at the time of that decision. Improvised Explosive Devices (IEDs) were causing more than 60% of US deaths in Iraq.

However, a more heavily armored target incentivizes the enemy to develop more lethal weapons. Major General Rick Lynch, who commanded a division in Iraq, noted in an interview with *USA Today* that the MRAP has forced insurgents to build bigger and more sophisticated bombs. Of course, bigger bombs are harder to make and deploy…giving coalition forces a better opportunity to catch the insurgents. However, if the enemy is successful, coalition fighting forces pay the price.

The answer is simple…the risk only goes away when vehicles come off the road. The vehicles only come off the road if they are no longer required to carry cargo to the front lines.

So, if the majority of over-the-road cargo is fuel and water…the only logical answer is to generate power and process clean water at the point of use so that these resources no longer have to be hauled along dangerous roads. It would, of course, be an added bonus if the acquisition of these alternative power generation/water purification units could be offered with minimal impact to taxpayer pocketbooks. More on that concept later.

Frontline commander recognition of the hazards associated with the battlefield supply chain has been well documented. Former US Air Force Chief of Staff T. Michael "Buzz" Moseley, while in a previous role as Commander, US Central Command Air Forces, planned and executed some of the most successful air campaigns in both Afghanistan and in Iraq. In executing these "joint" combat operations, he recognized the risks of ground-based transport of supplies. General Moseley therefore shifted a significant portion of supply delivery to the air…reducing risks to ground forces and reducing the potential for loss of the materials, albeit at a higher cost of delivery. His decision reduced the overall volume of inventory across the roads while at the same time increased the percentage of delivery volume comprised of fuel and water. Overall, this decision resulted in not only a reduced threat to our troops, but also an exponential reduction in delivery times of the critical supplies.

Possibly the most reported acknowledgement of the fuel/water delivery problem is the July 25, 2006 request by then Al-Anbar Commander, USMC Major General Richard Zilmer. He saw first-hand the significant amounts of fuel and water moved in the battle space by road…with some estimates suggesting 70% or more of material moved being fuel and water…presented an unnecessary and unacceptable risk to our military forces.

MG Zilmer's solution? A request for 183 renewable energy systems of various power capacities for deployment in Al-Anbar. The logic was as brilliant as it was simple…and it is exactly what

is stated above. That is, the best way to reduce over-the-road casualties is to reduce the number of vehicles…and the personnel required to operate and protect those vehicles…on the road.

Regrettably, as has been reported, in June of 2007, almost a year after MG Zilmer's original request, it was rejected by the office of the Joint Chiefs of Staff on the grounds of cost and uncertain technologies. It was said that the technology was not mature enough to deploy on the battlefield. The choice was rather to invest in further developing an earlier technology deployed by South Africa and to shape a new capability the MRAP.

Yet MG Zilmer even provided a set of performance standards that would allow the private sector to tailor solutions for the identified need. Those standards are:

- Ability to operate in cold to tropical, wet to dry environments;
- Due to military reliance on JP-5 and JP-8 fuels, any generators or backups must handle these fuels;
- Power output must cover a range of 100-240 volts and have enough storage capacity to run for a minimum of 24 hours;
- Ease of movement of the equipment…to trouble spots and anywhere in the theater.

Fortunately, even though MG Zilmer's request was denied, some work has been done to identify distributed alternative power generation options. A number of technical and business teams within the US military have been working this issue for some time. As one example, recently, the US Air Force announced award of a $3.5 million contract to a partnership of Lockheed Martin and Sky Built Power to develop a containerized Integrated Smart-Bear Power System. Obviously, moving the ball forward in this important area is critical. But, you really have to ask yourself whether there isn't something available today…ready for immediate deployment…that can begin addressing this problem now. The answer is yes there is. A portable renewable power unit with energy storage capability has been developed, tested and has proven itself in initial deployments in harsh battlefield conditions.

Deployable, Portable Renewable Power Units are Ready Today

The US Marines have been testing a deployable sustainable energy system utilizing solar and/or wind energy generation and combining with energy storage capacity and sophisticated en-

ergy management capability. The units being tested by the Marines were developed and are manufactured by ZeroBase Energy, LLC http://thezerobase.com/

ZeroBase unit being assembled at Exercise African Lion and ZeroBase unit in operation during Exercise African Lion

This technology has been developed to date entirely via private sector funding with no grants from DoD. The system, when combined with a portable SLMCO water purification unit, is capable of purifying water in addition to providing energy for lighting and to power electronic equipment. The water purification system can take water from almost any source and via reverse osmosis provide clean drinking water for the war fighter.

Called the Expeditionary Forward Operating Base program or ExFOB, ZeroBase was tested at exercise African Lion in Morocco in May. Stated purposes of ExFOB: (1) cut down on consumption of fossil fuels, (2) help protect the environment, (3) improve safety of overseas operations, and (4) improve comfort for Marines operating in the FOB environment.

African Lion allowed the Marines to test this equipment that is capable of supporting the ExFOB concept in harsh environments similar to what will be experienced in the battle space. Equipment faced sand, dust and significant fluctuations in temperature during the exercise. Based on tests conducted to date, it appears that the equipment is capable of assembly, mainte-

nance and disassembly by deployed forces and has shown the capability to generate power as specified.

Testing is expected to continue at Extended Mohave Viper at Twentynine Palms, CA this summer. For the perspective of the war fighters who lived with these units in the field, refer to the Marine Corps blog at http://www.marines.mil/unit/marforaf/Pages/MarinestestoutalternativeenergysystematAfricanLion.aspx

Again, using General Powell's logic, based on what we know today, why have we not gone to "all hands on deck" to accelerate the testing of the ZeroBase and any other deployment-ready unit by all Services. The units must be fielded as quickly as possible, while at the same time providing a streamlined approach for all potential vendors to get their complementary products tested and in the field. This is especially true where those vendors are willing to self-fund development and are paid based on power produced. The result…convoy vehicles off the roads for good.

The "Nuclear Option"

And what about the near-term horizon? What other emerging technologies offer promise in addressing this critical need? The military is clearly looking down the road for various options to meet the requirement for deployable alternative energy generation systems. On March 30, 2010, the Defense Advanced Research Projects Agency (DARPA) issued a Request for Information in search of innovative technologies that will enable the development of deployable nuclear reactor technologies for the generation of electrical power and military logistics fuel. This focus on nuclear power to meet land-based military need is certainly not new. The military has decades-long experience with fixed base operation of small nuclear reactors.

And, during my time in the Pentagon, we in the Air Force leadership were tasked by Members of Congress in 2007 to take a serious look at whether Small Modular Reactors (SMRs) offered promise to operate military bases as "energy islands" eliminating the risks associated with grid failure. We learned that technologies under development in the US private sector could be within a couple of years of commercial deployment.

In addition, several designs suggested that units in the range of 10-35 megawatts electrical output (the size range most appropriate for a US fixed military installation) could be developed and deployed in the relative short term. As we continued our investigation, it became clear that transportable/deployable small nuclear units were also within reach. The intention of the

DARPA RFI is to identify technologies applicable in areas without a robust grid, not easily accessible for fuel resupply, and that are designed to operate for several years without refueling. The criteria noted above seem to describe attributes critical for a power generating system appropriate for a remote forward operating location.

Desired characteristics for a realistic nuclear power unit capable of deployment would include:

- A design based on a well-developed technology
- A non-weapons grade fuel source
- A safe and easy to use operating system
- A unit that can be moved to where needed and easily removed when the mission is complete…which would mandate a unit requiring minimal field construction…and capable of being transported by the available transport system.
- Power outputs compatible with specific mission need

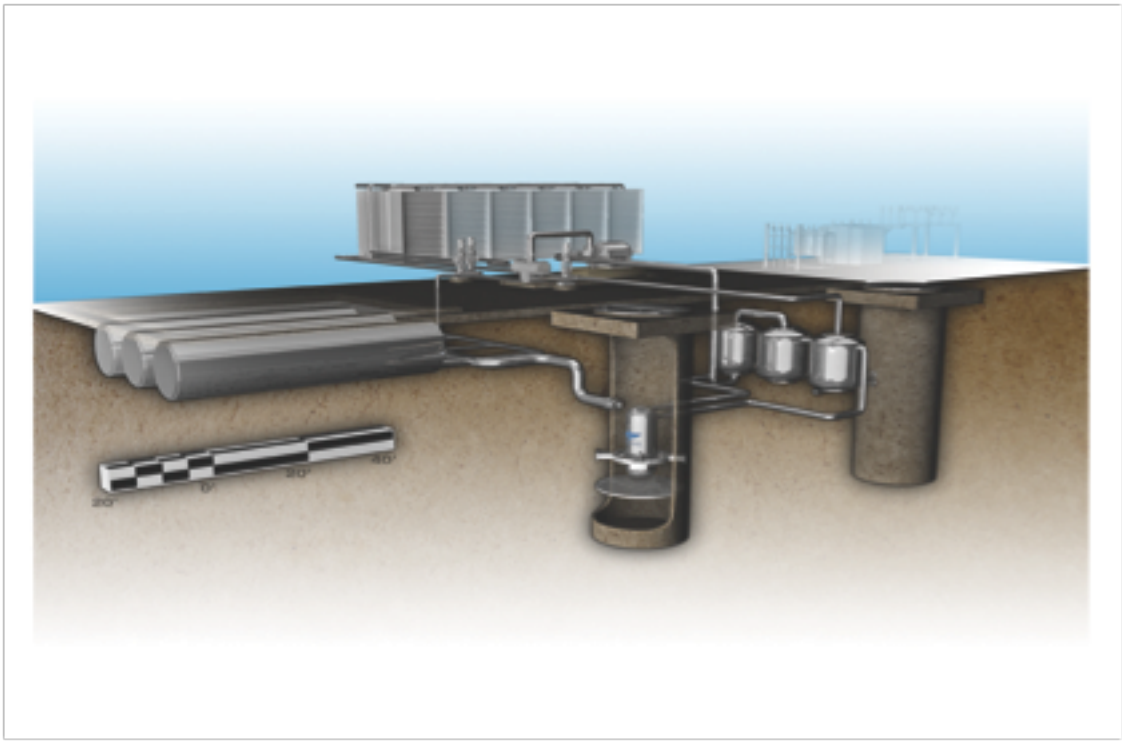
Though the DARPA RFI is seeking technologies that could facilitate the development of deployable nuclear power units, in reality, a set of designs and systems already exist. In fact, various designs and technologies that would easily lend themselves to a deployable/transportable reactor have been studied for over 50 years.

In addition, small reactors in various configurations have seen service for decades. What is needed is the opportunity to build and field test units already developed by the private sector to demonstrate the fitness of these designs to meet the requirements of the military in harsh battle and humanitarian relief environments.

Several US companies have been working to bring various designs for small reactors to the marketplace. The technologies vary from simply downsizing the very familiar light water reactor to introducing to the market for the first time technologies like the Liquid Metal Fast Reactor known for decades to DoE but not yet deployed in the US commercial marketplace. These new reactor designs are referred to as Small Modular Reactors (SMRs) and are sized at 300 megawatts or below. Recently, the concept of the Mini Power Reactor (MPRs)…under 50 megawatts in capacity…is gaining interest.

One company in particular receiving attention is Hyperion Power Generation out of Los Alamos, New Mexico. www.hyperionpowergeneration.com. Hyperion has been perfecting the design of a 25 megawatt electric generation unit that is compact, one piece, loaded and sealed at the factory and transportable.

Sometimes referred to as a "nuclear battery" the power unit is about the size of a hot tub. This output is compatible with power needs of a fixed military base in the US. What may be even more exciting is the possibility of even smaller units…the size of a trash can…with the capability to supply power for military field operations…transportable by Humvee, MRAP, helicopter or fixed-wing transport aircraft directly to a forward operating base.



The Hyperion Power Unit

Nuclear power generation carries with it the added complexity of licensing and regulation by the Nuclear Regulatory Commission (NRC). And, military applications on base and down range present some very different applications of the technology than have been considered before.

Fortunately, the drafters of the Atomic Energy Act had the foresight to exempt the DoD and DoE from NRC licensing under certain circumstances…allowing for the development, testing and deployment of nuclear power units for the exclusive use of DoD and DoE on their installa-

tions. Now, this exemption is not a free pass to deploy untested technologies on every US military base across the world…the DoD has the obligation to permit nuclear installations on their sites, and has done so in the past.

However, this authority does allow for the thoughtful and careful deployment of these new technologies to meet particular military and national security challenges, and can be done so under the watchful eye of the NRC…which should facilitate a more streamlined licensing process for these new machines as they move toward commercial application.

Moving the Ball Forward

Now, what if we could incentivize the private sector to offer distributed alternative energy solutions that could provide energy and potable water at the point of use at forward operating bases and do it without large technology development earmarks…so, not spending an additional dime of taxpayer money? I believe that is exactly what can be done.

Remember the per kilowatt hour cost of energy delivered to the war fighter as we calculated it earlier? Tell any and all private sector vendors that they will be paid $2.00 for every kilowatt hour of electricity produced by alternative energy equipment the vendors would provide at FOBs, and just see how many "takers" would come forward. Now, harsh environment testing would be required to make sure equipment could perform in the battle environment…and that testing could be done in the same accelerated fashion used to develop and deploy the MRAP… but these rough numbers illustrate a rather lucrative incentive…which should ratchet down as equipment costs come down and these new systems stabilize…to trigger development risk taking within the alternative energy technology development world. So, as General Powell recommends, it's time to "go with your gut".

On June 28, 2010, the Undersecretary of Defense for Acquisition, Technology and Logistics outlined a new initiative to reduce inefficiencies in procurement…calling on government contractors to do their part. What better time than in this era of ever-increasing demands and lower budget growth to allow true private sector market forces to identify, develop and offer commercial-ready portable distributed power generation options that are rugged enough to meet peculiar military needs.

This particular initiative could be an excellent target to test a new approach to identifying and deploying technologies that will certainly save lives…significantly reduce the environmental footprint of deployed forces…and might even improve the quality of life for our war fighters

who will no longer be subjected to the noise and fumes of diesel power generating units…and, by the way, the heat signature of these generators which is a security risk in itself.

Certainly in the budget-constrained environment we face today, the DoD challenge to the private sector to assist in reducing waste and inefficiency in the system is a reasonable request. However, when a customer (in this case, the Federal government) demands a change in behavior from suppliers, the customer has an obligation to provide an environment that will support this change in behavior. "Business as usual" on either side of the transaction will impede the desired change.

Furthermore, in the alternative energy space, the innovators are not likely going to be traditional military contractors. Those innovators will likely be private start-ups, NGOs and academic institutions. How do these organizations work their way into the status quo of military acquisition?

Or, maybe a better question might be, if the Pentagon is committed to (1) reducing waste and inefficiency, and (2) quickly finding real solutions to the dangerous and expensive practice of moving fuel and water to the battlefield by road, do we really want these new vendors falling into the acquisition status quo?

The "right" answer here is to facilitate testing and deployment of systems that are ready to go and that have private sector funding to move forward. That type of a market signal will drive innovation and risk taking, a real shake out/separation of good ideas from bad, and the elimination of waste commonly associated with the current military acquisition system.

Challenges Beyond the Military

Although this report has focused on particular military needs in harsh and remote locations, the performance characteristics of the units described above would logically meet requirements to address recovery efforts in natural disaster and homeland security scenarios. The disrupted supply chain, lack of energy feedstocks and limited access to fresh water faced after such catastrophic events beg for the functionality, portability and robust nature of the power units highlighted above.

In natural disaster/homeland security scenarios, speed of response is critical to the survival of those affected. If military organizations across the world utilized these transportable alternative energy units that did not require a feedstock supply chain in their combat operations, similar units would be maintained in reserve and at training bases across the globe. These reserve and training units could be quickly packed up, put on to a transport aircraft and delivered to the site

of a disaster anywhere in the world within hours…providing much needed power and clean water…and certainly saving countless lives in the process.

The Honorable William C. ("Bill") Anderson served as Assistant Secretary of the Air Force for Installations, Environment and Logistics and the Air Force Senior Energy Executive under President George W. Bush from 2005-2008. He currently serves as Chief Executive Officer of Endura Energy Solutions, a portfolio company of Pegasus Capital Advisors, L.P.. The author has business relationships with both ZeroBase and Hyperion Power Generation. He can be contacted at CO2RCR@hotmail.com.